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Harold M. Campbell

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## Glossary

AAR	After Action Reviews
AG	Asynchronous Groupware
AGT	Asynchronous Groupware Technology
AR	Action Research
APQC	American Productivity and Quality Center
BI	Business Intelligence
BP	British Petroleum
BPR	Business Process Reengineering
BSD	Business System Design
CA	Competitive Advantage
CALL	Center for Army Lessons Learned
CC	Customer Capital
CFA	Confirmatory Factor Analysis
CPMS	Computerised Personnel Management System
CRM	Customer Relationship Management
CSCW	Computer- support Cooperated Work
EDI	Electronic Data Interchange
EC	e-mail Conferencing
EFA	Exploratory Factor Analysis
e-mail	Electronic Messages
GDN	Government Data Network
GDSS	Group Decision Support System
HC	Human Capital
HK	Human Knowledge
IAS	Integrated Activity System
IBM	International Business Machines (Botswana)
IC	Intellectual Capital
ICT	Information Communication Technology
IS	Information Systems
Infinium	The Infinium HRM software application

IT	Information Technology
KM	Knowledge Management
KMP	KM Practices
KRAs	Key Result Areas
KS	Knowledge Systems
LAN	Local Area Network
MBO	Management by Objective
MoA	Ministry of Agriculture
MoE	Ministry of Education
MFDP	Ministry of Finance and Development Planning
MIS	Management Information Systems
MoH	Ministry of Health
MLH	Ministry of Lands and Housing
MMEWA	Ministry of Mineral, Energy and Water Affairs
OCR	Optical Character Recognition
OECD	Organisation for Economic Corporation and Development
ORB	Object Request Broker
PA	Performance Analysis
R&D	Research and Design
SC	Structural Capital
SG	Synchronous Groupware
SPSS	Statistical Package for the Social Science
TQM	Total Quality Management
VTW	Virtual Team Working
WAN	Wide Area Network
WIT	Work Improvement Team
WMS	Workflow Management System
WWW	World Wide Web

## Part I

# Introduction

# Chapter 1

## Introduction

---

*Knowledge is your most important raw material. Knowledge is your most important source of added value. Knowledge is your most important output. If you are not managing knowledge, you are not paying attention to business.*

*T.A. Stewart<sup>1</sup>*

### 1.1 Research Motivation

This research project was initially motivated by our interest in finding out what effects a newly developed family of computer systems known as groupware, might have on the implementation of knowledge management (KM) strategies, and how they affect quality and performance management issues on groups in organisations. This interest emerged from the researcher's previous implementation of change management and business process re-engineering (BPR) projects, and the related development of a workflow management system (WMS). The methodology used for that project, the WMS, relied on the work of small organisational staff groups to implement a human resource management (HRM) information system and related KM strategies, using in the main, the concepts of work improvement teams (WITS). These teams will be hereafter referred to as KM groups.

The researcher's interest was then sharpened by his application of groupware technology to support the BPR of HRM through the development of a workflow management system, in the public service of the Republic of Botswana, as part of consulting work towards the implementation of a computerised personnel management system (CPMS). This consulting work narrowed our technology interest to asynchronous groupware systems – that is, groupware systems supporting distributed and time-disconnected interaction between groups of users – as it provided evidence that quality and productivity improvement groups would benefit more from asynchronous than synchronous groupware support [Kock and McQueen, 1995; 1997]. The researcher had a dis-

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<sup>1</sup>The Wealth of Knowledge – Intellectual Capital and the Twenty-first century organization – Thomas A. Stewart (2001):109

cussion with the organisation in dense, dynamic, and mutually supportive interactive pattern to the consolidation of this interest as a general research question. These discussions were held, while the literature review on KM and groupware studies (see Chapters 2, 3 and 4) were being conducted. In line with previous field studies, these contacts involved intense negotiation, where attempts were made to match the prospective client's organisation's view of the opportunities for liberating organisational knowledge and the researcher's view of the related opportunities for the generation of research knowledge. This support was strengthened by the ecology metaphor of the environment, where the organisation was viewed as a community of interdependent value-creating processes, which are driven by people and enabled by technological systems. The value creation was derived from the knowledge management strategies that are the "glue" for the self-organisation context of the knowledge space. These strategies further motivated the researcher to frame the central research question. The specific strategies, which are so responsible, and their place in the research question are discussed next.

### 1.1.1 Central Research Question

In our view, the final definition of our central research question was strongly motivated by the researcher's implicit desire to steer away from temporary management "fads", and towards the study of issues which would most likely have a lasting and broader scope of application in organisations in general. This choice was also seen as likely to increase the external validity of the research findings [Argyris et al., 1985; Cook and Campbell, 1976]. In this context, one tries to focus on one of the underlying change dynamics of four relevant management movements of the 1980s, 1990s and the new millennium:

- total quality management;
- business process re-engineering;
- information management, and
- knowledge management;

rather than on specific issues related to only one of these management movements. Since our initial interest from an information systems (IS) perspective was in groupware, and knowledge systems and that interest was further narrowed down to asynchronous groupware systems and knowledge management strategies, it was natural that one should focus on the strategies for liberating knowledge. This process of liberating knowledge is what the researcher refers to in



this thesis as the ‘knowledge spiral’, which one sees as the mechanism, or ‘knowledge journey’, necessary for the successful implementation of KM. In fact, one believes that in order to better understand the ‘ecology’ of the self-organisation of the knowledge space, organisations must be able to:

- capture the value of organisational intellectual capital;
- improve customer relations, and
- harness the enabling technologies;

by the use of lessons from the life sciences and learning from experience, in order to create organisational intelligence and preserving corporate memory. The knowledge journey is not only a journey – it is a race. The most innovative organisations have already started on the journey. Leading organisations in virtually every sector have shown, through an ever-growing number of case study examples, that more effective use of knowledge and insight gives them a competitive edge.

Business success is not about amassing assets, but rather about how organisations use their BI to leverage in putting them to work more competitively [Spear and Bowen 1999; Hendriks and Vriens 1999; Wah 1999; Edvinsson and Sullivan; Petrash 1996].

### 1.1.2 Statement of the Problem

It is evident, thus, that this research intends to place KM in an historical perspective, to frame some of the key questions and challenges to be addressed as it rides the waves of acceptance, and to highlight some of the new opportunities within KM, as well as cover some of the traditions on which it rests.

Terminology notwithstanding, successful organisations which have implemented KM projects, usually map their KM efforts – their knowledge strategies – to some key aspects of their business strategies. Consequently, a holistic approach must be used to address the three main aspects of any KM project, namely technology, process, and people. This holistic approach is normally used to encourage virtual teams(VT) – working in active knowledge sharing [Currie, 1998]. For most organisations, that means focussing on one or more of the following four areas:

- **innovation** – finding and nurturing new ideas, bring people together in “virtual” devel-

opment teams, creating forums for brainstorming and collaboration;

- **responsiveness** – giving people access to the information they need when they need it, so they can solve customer problems more quickly, make better decisions faster, and respond more quickly to changing market conditions;
- **productivity** – capturing and sharing best practices and other reusable knowledge assets to shorten cycle times and minimize duplication of efforts;
- **competency** – developing the skills and expertise of employees through on-the-job, online training, and “distance” learning [Lotus, 1998].

This research emerged from an interest in the study of group-based KM efforts and the effects that a newly developed set of computer technologies to support organisational work groups, collectively known as groupware [Johansen, 1988; Coleman, 1992], would likely have on KM groups, and how these KM groups could impact organisational learning towards creating a KM framework. A review of the empirical literature on groupware support for groups in general led to the identification of a dearth of studies of groupware-supported KM groups, and, in the few representative examples of such studies, a bias towards a specific class of synchronous groupware known as group decision support systems (GDSSs). In this research, one will try to move away from this, by conducting the investigation around the following research question:

How are knowledge management strategies enabled by the support of asynchronous groupware systems?

Since KM strategies are seen as likely to follow a process, this research question caused us some initial concerns. In particular about the nature of asynchronous groupware, enabling role on the efficiency and effectiveness of the process followed by knowledge-based firms. The organisational implications, or otherwise, of organisational efficiency and effectiveness, in terms of their relationship between KM techniques, strategies, and practices is our primary objectives.

In this milieu, organisational efficiency is related not only to the productivity of the knowledge-based firms, which use KM initiatives and practices to adapt and improve their business processes, but also to individual and organisational direct and indirect costs, which are used to support and coordinate their KM oriented activities. Organisational effectiveness, on the other hand, is related to the actual impact of the work of KM groups, and *communities of practice* on the business processes targeted by them by a KM framework, and the consequent impact on the organisational unit to which those processes belong.

## Statement of sub-problems

Whether an organisation knows it or not, KM is at the heart of its business. Simply stated, KM supports the ability of every organisation to prosper. Every action and every output that delivers value must be aligned with one of the three platforms around which all businesses compete:

- cost,
- time, and
- differentiation.

Effective KM is what makes this possible. The transition of KM from concept to practice, has revolutionised the ways in which practitioners can operationalise the growing body of theory [Davenport et al., 1997; Lotus, 1997; Sveiby, 1996; Stewart, 2001:87].

It is against this background that the research objectives and hypotheses were framed. There is a primary research question, and a secondary research question, which are then cascaded into four research hypotheses. These are presented next.

## 1.2 Research Objectives Hypothesis and Supporting Literature

### 1.2.1 Research Objectives

The aim of this research is twofold:

- firstly, to examine how KM strategies are enabled by the support of asynchronous groupware systems; and
- secondly, to examine how organisations are successfully implementing KM projects and practices in order to improve their competitive advantage (CA) and business intelligence (BI).

The objectives of this research are to answer the following fundamental questions in terms of how an organisation maps its KM efforts – (its knowledge strategy) – to the key performance aspects of its business strategy, through the support and use of asynchronous groupware systems:

### 1.2.2 Primary Research Question

The primary research question, which is the seminal interest of this research, is:

How KM strategies are enabled by the support of asynchronous groupware systems?

This research question gives rise to three subsidiary research questions which will form the basis for a number of the constructs and metrics of this research. These are discussed next:

1. How can organisations successfully integrate asynchronous groupware technology into their KM efforts with a view to self-improve their quality, productivity and overall competitiveness?
2. How are organisations assessing the productivity and performance-oriented initiatives attributed to the efforts of task-related and group-related outcomes in their use of asynchronous groupware technology?
3. How are organisations assessing the productivity and performance-oriented initiatives attributed to the efforts of the individual in terms of the task-related and team-related outcomes, in their use of asynchronous technology?

### 1.2.3 Secondary Research Question

If implemented successfully, KM will help organisations short-cycle internal process, cut costs, and operate more effectively. Some organisations have realized millions in cost-saving benefits from knowledge efforts. The secondary research question is therefore concerned with:

How can organisations successfully implement KM projects and practices?

The underlying challenge in this research for any knowledge-focused organisation operating in the knowledge economy is sustaining high performance levels and achieving a competitive advantage. This will be the major objective of this research in investigating how organisations may successfully embark on a knowledge-focused strategy.

### 1.2.4 Hypothesis and Supporting Literature

The four hypotheses and the supporting literature are discussed with a view to set the stage for the rest of this research:

## Hypothesis 1

The first of the four hypotheses are discussed next where it is framed from the main research objectives.

**Null hypothesis 1 ( $H_{o1}$ ) :** *There is no statistically significant correlation or relationship between the policies and strategies used in organisations for KM practices, and those of asynchronous groupware systems, to self-improve their quality, productivity and competitiveness.*

**Research hypothesis 1 ( $H_{R1}$ ) :** *There will be a statistically significant positive correlation between the policies and strategies used in organisation for KM practices, and those of asynchronous groupware systems, to self-improve their quality, productivity and competitiveness.*

These hypotheses can be supported by the following research [Lotus, 1998], and be further supported by the following research: according to Currie (1998), Lotus (1998) and Davenport, et al. (1996), Prusak (1997) who purport that the technology is of no use if people are not open to share what they know with others. Currie (1998) also found that in group-based interactions and VT, the case of British Petroleum (BP) used about 60% of its budget to address behaviour related issues.

In that particular study [Currie, 1998], VT coaches spend no more than 20% of their time on technical support. During the other 80% of their time, coaches worked with business staff units to:

- co-develop an approach to align the benefits of VT with the units' existing business goals;
- facilitate exploitation of teamwork, knowledge, and the enabling technology; and
- challenge, guide, participate, and observe the team at work to help them get maximum results from this new way of working.

From Lotus (1998) two aspects of a KM framework must be addressed in the research hypothesis above. These are accommodating organisational culture and design technology to overcome barriers:

- Collaboration – the process of creating, sharing and applying knowledge involves varying degrees of collaboration. Some knowledge activities, such as individual learning (competency) or reusing well-defined best practices (productivity) require some collaboration, though perhaps not much. In these activities, employees are more likely to find knowledge resources in documents and databases, rather than through interaction with co-workers. Of course, the degree of collaboration varies within a sector itself: an instructor-led course is more collaborative than, say, browsing the web (even though both are competency-building activities). In general, activities related to competency and productivity are relatively low on the collaboration scale overall.

By contrast, knowledge activities related to innovation and responsiveness are much more collaborative. For example, brainstorming sessions (innovation) and strategy planning meetings (responsiveness) are usually highly interactive, involving multiple people.

- Organisational Scale – the second dimension of this KM framework is scalability – that is, the extent to which KM activities and output can be leveraged throughout the organization. Competency building and innovation typically occur on a small scale, at the individual or work group level. For example, people may attend conferences, workshops and training sessions to improve their individual competency; however, what they learn is not easily accessible for use throughout the organization. It is not scalable knowledge. Only when the output of individual learning or an innovation is packaged for reuse, can the results be leveraged throughout the organization. A company can only perform well in the productivity and responsiveness sectors if it reuses knowledge assets created by individuals or groups and leverages those assets on an organizational scale. For example, in resolving customer problems, a productive organization's help desk might reuse a knowledge base of previously answered questions (say, frequently asked questions). It is important to remember, of course, that scale does not necessarily imply a finite limit. KM is often successful when it is applied across and beyond organizational boundaries.

This framework implies some interdependencies among the sectors. Without competent individuals, innovation, productivity and responsiveness are difficult to achieve. Similarly, innovation, productivity and competency are prerequisites for responsiveness. To extend the help desk example, a responsive organization might dip into communities of experts to resolve problems that have never been seen before. To be responsive, the help desk staff needs to be more than merely plugged into a repeatable process, they need to be able to leverage the competence and

innovation of the organization at large.

At the same time, these sectors are not wholly dependent on one another. A company doesn't need to reach KM perfection in the competency sector before it can begin tackling innovation and productivity, or achieve excellence in all three before it can become responsive. There are modest, practical investments a company can make in any sector that can have appreciable returns in the short term. These investments do not presume complete KM success within the other sectors.

## Hypothesis 2

The second hypothesis is now discussed, where the first of the three subsidiary research question is used:

**Null hypothesis 2 ( $H_{o2}$ ) :** *There are no statistically significant correlations or relationships between the integration of asynchronous groupware technology into organisations' KM practices and their strategies to self-improve their quality, productivity and overall competitiveness.*

**Research hypothesis 2 ( $H_{R2}$ ) :** *There will be a statistically significant positive correlation between the integration of asynchronous groupware technology into organisations' KM practices and their strategies to self-improve their quality, productivity and overall competitiveness.*

The above research hypothesis is supported by Ruggles (1997), who, in his research, identified how technological tools may be used to support the automation or augmentation of organisational knowledge management. Also, the research shows (IBM, 1995, Liu and Sachdev, 1999) that “reengineering” and “business transformation” are significant concepts and calls for action in our fast-paced global society.

Increased competition, a global marketplace, and the pursuit of great expectations for performance are causing businesses to focus on efficiency, productivity, and quality – yet, leadership, innovation, and creativity must also be maintained. Emerging global economies and the structures of the business environment within those economies present disparate approaches and methodologies for evaluating and restructuring business enterprises. Often, “reengineering” and “business transformation” involve the complete assessment, restructure and redesign of entire

businesses – including how an enterprise manages its Information Technology (IT) assets, as a tool to improve its overall competitiveness.

### **Hypothesis 3**

This hypothesis is supported by Neef (1997), who in his research “Making the case for KM: the bigger picture”, indicate that increasingly knowledge organisations are high-value service opportunities, and maximize the way in which employ their most creative knowledge workers, Thus becoming learning organizations which provide a culture where increasingly responsible employees can flourish.

**Null hypothesis 3 ( $H_{o3}$ ) :** *There is no statistically significant difference between the way organisations assess the productivity and performance-oriented initiatives attributed to the efforts of task-related outcomes, and those of group in the use of asynchronous groupware technology.*

**Research hypothesis 3 ( $H_{R3}$ ) :** *There will be a statistically significant difference between the way organisations assess the productivity and performance-oriented initiatives attributed to the efforts of task-related outcomes, and those of group-related outcomes in the use of asynchronous groupware technology.*

This is to enable their workers to obtain the knowledge necessary for growth and innovation. Organizations must then devise both a cultural and technical infrastructure that will promote a free-flow of information and knowledge throughout the organization. This view is also supported by Dixon (2000), who reported how the United States of America Army uses the concept of strategic knowledge transfer to develop a model to assemble, assimilate and leverage the knowledge that the Army learns in the field in order to respond to change. The four-step model on which the CALL, the Center for Army Lessons Learned, is based, involves the following components:

- identifying learning opportunities,
- observing and collecting knowledge,
- creating knowledge products, and



- deploying expertise (Dixon, 2000:106).

In the CALL, the processes of collection, interpretation, and dissemination are intertwined rather than being discrete or sequential. Army personnel then translate the lessons learned in a knowledge repository that may be accessed and reused, in order to make better decisions. This is used to improve the strategic positions of the Army.

The above hypotheses can be further supported by the following research which is discussed next.

According to Neef (1997) one of the most obvious and direct effects of the knowledge-based economy on organizational level KM, is that more and more positions within an ever increasing number of organizations require high-skill, knowledge based workers whose role in the firm and expected behaviour is very different from those of past generations. Knowledge workers, strategists, designers, research scientists have much greater responsibilities, span and control than production-based company employees had in the past. Firms today are beginning to realize that they don't hire the brightest people in order to have a cadre of intermediate managers tell those employees what to do. Senior management is beginning to expect (or allow) knowledge workers to work more freely with colleagues in order to create innovative new products and operational efficiencies, and to take the initiative to put these ideas into effect. In this regard, the legacy of downsizing and business process reengineering, too, has had unexpectedly positive (as well as the more obvious, disappointingly negative) effects. Hierarchy and strict union-based wage and responsibility levels have begun to erode as traditional roles have been eliminated, stretched or combined with other positions all allowing for greater individual responsibility and less of a command-and-control culture. The wide use of teams in BPR and process improvement efforts has given senior management new found faith in the ability of skilled knowledge workers to understand, re-shape and improve their own work. Such empowerment has also lent increasing self-confidence to the workforce, which is becoming more highly educated, more independent and more willing to take on broader responsibilities in return for flexible work styles, merit-based pay, remunerative packages, and performance related rewards.

#### **Hypothesis 4**

The final hypothesis is now discussed, where the third subsidiary research question is used.

**Research hypothesis 4 ( $H_{o4}$ ) :** *There are no statistically significant differences between the ways organisations assess the productivity and performance-oriented initiatives attributed to the efforts of the individual in task-related outcomes in their use of asynchronous technology, and those of individuals in team-related outcomes.*

**Research hypothesis 4 ( $H_{R4}$ ) :** *There will be a statistically significant difference between the ways organisations assess the productivity and performance-oriented initiatives attributed to the efforts of the individual in task-related outcomes, and those of team-related outcomes in the use of asynchronous groupware technology.*

For each organization then, the need to adopt KM strategies and techniques becomes essential to retaining their competitive advantage. For this research the following questions are relevant:

1. Are there different strategies, which may be used in managing the knowledge of organisations?
2. What are these key elements of knowledge management, which make up the future knowledge foundation of sophisticated companies?

These two questions are the seminal objective of this research . The framed hypotheses will therefore have a focus on KM strategic requirements, which will be discussed next. The criteria for selecting one type of knowledge transfer over another, from the above transfer framed into a decision tree. The questions, which inform the decision, are:

1. Will the same team be using what has been learned?
2. Is the knowledge tacit?
3. Does the knowledge impact the whole organisation?
4. Is the task routine and frequent?

From these questions a framework may be developed to assist firms to select a preferred type of transfer type. This is illustrated in Figure 1.1.

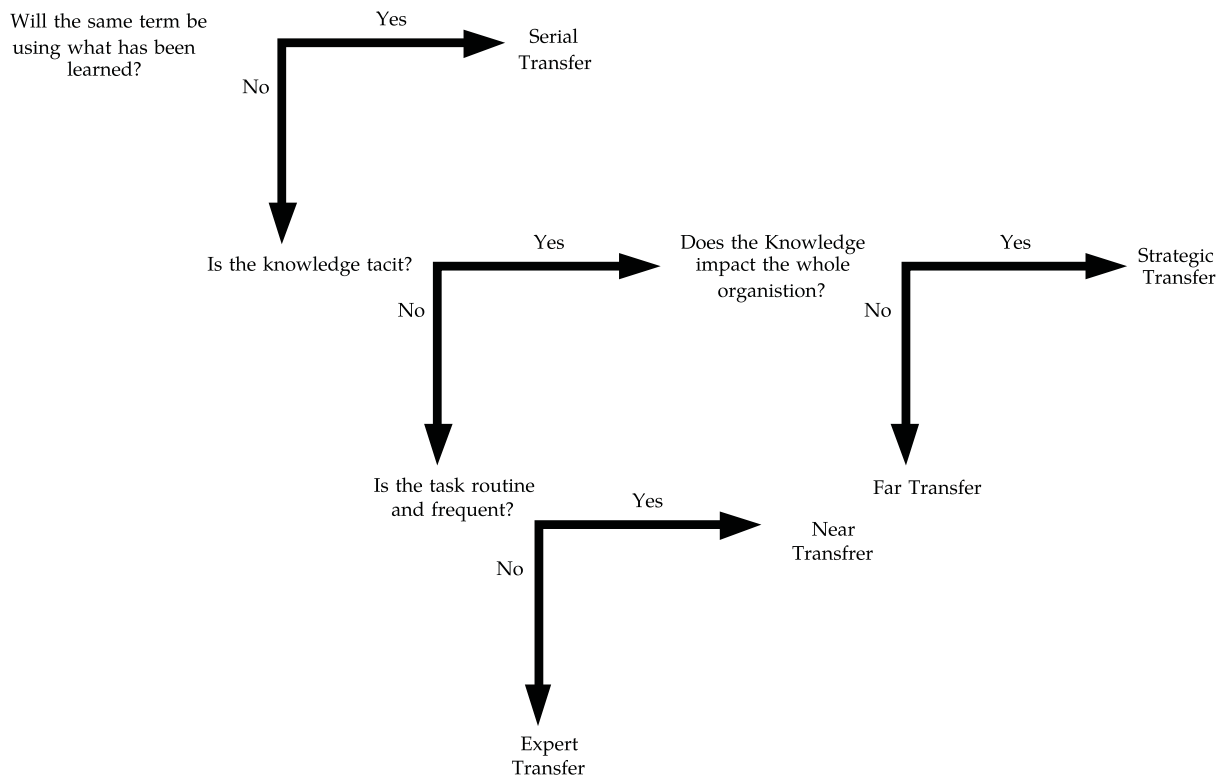


Figure 1.1: Decision Tree for selecting type of transfer [from Dixon, 2000:139]

## 1.3 KM Strategic Requirements

### 1.3.1 A Knowledge Sharing Culture

Of all aspects of KM promoting a knowledge-sharing culture is probably the most important and the most difficult. In order to compete in the global, knowledge-based economy, firms today need to establish a KM framework, based on a strategic purpose and supported by employees from all strata of the organisation. In terms of programme management, this means a firm-wide appreciation of the case for action, dedicated resource, strong and widespread leadership, and a company-wide campaign based on providing employees at all levels a shared understanding of the strategic goals of the company. It also means using tools such as knowledge mapping to understand what knowledge is needed and available by whom and when, on a global basis.

Key to this process is developing human networks of complementary skills and interests, or communities of practice, with knowledge workers being encouraged to share productivity-enhancing leading practices, new techniques, and lessons learned with colleagues worldwide. For this to be possible though, there should be a robust technical infrastructure in place. This will be discussed

next. The first two constructs in the instrument of the survey: current state of KM, and human knowledge [Appendix B: Pilot Survey Questionnaire]. The measures of the knowledge sharing culture motivated in this work will be addressed here.

### **1.3.2 A Technical Support Infrastructure**

In order to capture, organize and transfer information and knowledge, organizations need to take advantage of the new computing and telecommunications technologies now available and develop a technical infrastructure capable of delivering information to employees worldwide. Organisations need to transfer many different kinds of knowledge for many different purposes. Dixon [2000:146] found that many of the organisations which she studied have developed multiple ways to transfer knowledge. The main transfer systems include:

1. the US Army: uses both after action reviews (AAR), which include Serial Transfer and Strategic Transfer.
2. BP uses AARs, that is Serial Transfer, Knowledge Assets (Strategic Transfer) Connect (Expert Transfer), Peer Assist (Far Transfer), and Intranet discussion groups among networked members (Expert Transfer).

This model provides a framework for BP, in terms of, learning before, learning during, and learning after, the event or process. The benefit here is that this approach to knowledge transfer, that processes become easy to remember and serves to remind teams that knowledge is involved in every part of their work. The researcher will attempt to discuss in more detail the concepts of knowledge transfer, as it relates to serial, strategic, expert, and far transfer.

The structural knowledge and technological infrastructure constructs [cf. appendix B: Pilot Questionnaire] shall address the measures of the technological infrastructure and transfer systems aspects of this research. The constructs [cf. Appendix B. Pilot Survey] shall address the measures embedded in knowledge stewardship.

### 1.3.3 Knowledge Stewardship: Organizing and Distributing Corporate Knowledge

With such an enormous capacity for information transfer available, it is critical for firms to develop a consistent and well-organized method for identifying, capturing, organizing, formatting and distributing information on the knowledge web. This means dedicated resources and clear methods for submitting, organizing and retrieving information electronically. Nancy Dixon (2000:2-15), cautions, however, that organisations should not hastily create such systems or methods without proper strategic focus. She sets out three myths, or for that matter, three assumptions that organisations usually embarked on, in an effort to implement a knowledge sharing regime. These being:

- build it and they will come,
- technology can replace face-to-face, and
- first you have to create a learning culture (Dixon, 2000).

These assumptions, at first, seem reasonable but have been found to be difficult when it comes to implementation. These assumptions will be revisited in Chapter 3, where one will attempt to discuss various components of KM.

### 1.3.4 Content and Corporate Memory

Consequently, as many firms are beginning to find, KM is much more than just putting in a knowledge web delivery system. Firms must identify their knowledge requirements, in order to make the most of the intellectual capital that resides within their organisation. This point is reinforced by the views of Friso den Hertog and Edward Huizenga [den Hertog, and Huizenga, 2000:6], in their book. They argue that firms are becoming aware that new opportunities will be elusive and dry up if the supply of knowledge is not constantly renewed and recharged.

This, they asserted

...implies three things:

1. the firm should invest more in long-term knowledge development;

2. the knowledge potential within the firm should be utilized more effectively;
3. it is imperative that the firm develop knowledge synergy with other firms and make use of the knowledge available at universities and other public research institutions.

If one takes a global perspective, it must then be understood that firms need instant access and analysis to customer information, market trends, regulations, competitors' activities, journals, and the location of subject matter experts for instant consultation. Performance information, key lessons learned, and sources of internal skills and expertise must be identified from within the organisation. This view is supported by (Doz, Yves, Santos, José, and Williamson, Peter; 2001) where they discuss the requirements which must be in place, for firms if they want to successfully deploy knowledge throughout the organisation. The four requirements which they identified as being critical were:

1. The need to recognize and find a way of handling tacit knowledge, instead of relying on the exchange of explicit, codified knowledge, blueprints, or specifications.
2. The need for parties involved to share an understanding of their different context before knowledge can be transferred.
3. The need to establish an effective structure to promote knowledge melding, rather than assuming it will happen either spontaneously or through a simple, linear process of handing over knowledge between separate organisations.
4. The need for teams and champions with incentives, budgets, and overall responsibility for delivering Metanational innovations [Doz, et al., 2001].

These they also summarised in a model for measuring the knowledge complexity posed by what they called *The Tyranny of Distance*. There are four stages in the knowledge complexity model, These being:

1. explicit knowledge;
2. experiential knowledge;
3. endemic knowledge, and

#### 4. existential knowledge [Doz,et al, 2001].

These stages range from simple knowledge to complex knowledge. This being so, is echoed by den Hertog and Huizenga (2000:17) who identify five basic elements which firms may employee to harness the full potentials of KM. This takes the form of a system approach, where the firm may be seen as a knowledge system. The concept of the *knowledge system* may be construed to be too narrow, as used in the information technology field. The authors, in question, proposed the use of the term “knowledge enterprise.” The concept of the knowledge enterprise, here embraces the intuitive concept of knowledge management, and more importantly, reduces the confusion of the concept, knowledge management, as echoed by Dixon (2000:10). Her concerns were the *management* part of the term, which sometimes gives the wrong connotation and mistaken perspective that Management, which is the executive staff function, was responsible for all aspect of knowledge transfer and sharing. The *knowledge*, part, on the one hand conjures up images of another management *fad*. While on the other hand, the *enterprise*, part addresses the entrepreneurship activities, processes and modes of the firm. It is the movement: setting and keeping an organisation in motion based on a vision; making choices by weighing opportunities and risks; making better choices by learning from one’s own and other people’s experiences; and supplying adequate organisational tools to utilise opportunities and reduce risks. These are the basic elements of the knowledge enterprise. [den Hertog and Huizenga, 2000]

The researcher shall discuss the knowledge complexity model [Doz, et al., 2000:120] in more detail in Chapter 3. Finally, even with the best taxonomies and delivery systems, it is often necessary in order to make information relevant and meaningful for a subject-matter expert to place it in context. Accordingly, the need for customized, business research and analysis will grow with the complexities of the global marketplace and the ever-increasing capacity of systems to be inundated with information.

The performance analysis (PA) construct [cf. Appendix B: Pilot Survey Questionnaire: KM Questionnaire] of the research shall address the measures embedded in the content and corporate memory component mentioned above. The methodology one intends to use to operationalise the research aim, objectives, questions and hypotheses will not be discussed in section 1.4: Research Method.

## 1.4 Research Method

At the start of this research there seemed to be a bias in groupware research in general towards experimental studies (Davison, 1995). This was, perhaps, a consequence of the predominance of positivist research approaches in the IS discipline in general [Orlikowski and Baroudi, 1991]. It was also observed that there was a lack of consistency in the research frameworks used [Pervan, 1994]. In this, it is concluded that these characteristics of groupware research may have contributed substantially to the large number of contradictory research findings regarding the impacts of groupware technologies on KM strategies and initiatives, and also the effects these groupware systems have on group processes and task attributes [Gartner Group, 1999, DeSanctis et al., 1993, Dennis and Gallupe, 1993].

It may be argued that the groupware research bias towards experimental studies has led to difficulties in the replication of findings in organisations. It is our considered belief that one of the main reasons for these difficulties is the suppression (or artificial inclusion), even in field experiments where little control is applied, of the effects of variables present in (or absent from) actual organisational contexts. This can in turn lead to startling discrepancies in technology impact findings, as posited in Orlikowski's (1992) study of the influence of organisational culture on the adoption of groupware technology, and the contrast of its findings with those of previous experimental studies on groupware adoption and use [Lillemor and Hjelmquist, 1991, Sheffield and Gallupe, 1993]. It is our intention, here, to change the conventional research approach by adopting an approach that tries to take into account the full richness of organisational interactions and yet exert a minimal amount of artificial control on the organisational environment being studied. This research approach is a combination of AR and case study, but not action research in its strictest sense. The culture of the organisation plays a significant role in the organisation being studied; as such the nuances and characteristics of the people motivated the outcome of this research. The approach then is a hybrid of classical AR, and one which may be classified as an ethnographic approach. This ethnographic approach to intervention in the organisation takes into consideration the culture of both the organisation and the employees within this milieu. This is a cross fertilisation of the action research approach and the case study approach. The two are merged and will hereafter be called the "case study", or alternatively, *action research*. This is for ease of explanation and acceptance. This research will also be validated through two exploratory surveys on the awareness of KM practices and strategies in organisations, and how these strategies are being implemented using AG systems.



### 1.4.1 Action Research

Organisational action research (AR) studies are characterised by the researcher applying positive intervention to the client organisation, while collecting field data about the organisation and the effects of the intervention [Lewin, 1946; Peters and Robinson, 1984; Jonsson, 1991]. This characteristic of ethnographic AR provides a particularly solid ground for our decision to use AR in this study.

In one's search for prospective organisations in which to conduct the AR component of this research, the researcher visited a number of organisations in Botswana, only the Public Service was found to be using asynchronous groupware (AG), in a limited way, to support group-based KM efforts. This was however, still in its infancy. Because of the state of the implementation of an AG management system in the Botswana Public Service, it was decided that both an on-site and an interview-based case study approach would be used with the AR methodology. The motivation here is to inform the development of a model, which could be used to foster better BI through a more robust component interaction in, distributed systems.

In this thesis, the researcher opts for two alternative research approaches. Firstly, survey research, which is characterised by a certain degree of artificial control, but still, permits a clear and rigorous elaboration of a logical model, which clarifies the deterministic system of cause and effect. Secondly, action research, which has its foundation in socio-psychological studies of social and work life issues. AR is often uniquely identified by its dual goal of both improving the organisation participating in the research, usually referred to as client organisation, and at the same time rigorously generating valid and consistent knowledge. Although typically applying very little, if any, control on the environment being studied, the AR practitioner is expected to apply positive intervention to this environment. Typical instances are the study of asynchronous groupware support effects on process improvement groups conducted in a service organisation by Kock and McQueen (1995b); and the research on the participatory development and introduction of an expert system in a welding plant conducted by Candlin and Wright (1991). The AR strategy is used to attempt to explain some of the implementation challenges being faced by the Directorate in its efforts to implement a HRM workflow management system.. The findings and results from the main survey research will be used as the hermeneutics, in the main, to inform the action research taxonomy.

Given the previous research bias towards experimental research and its likely negative conse-

quences, one naturally opts for the AR approach. It is nevertheless felt that because of the scope and opportunities of KM, the survey research methodology will also be used to validate the outcome of the iterations from the AR taxonomy.

The client organisation of this study was the Directorate, a department of the Botswana Government with offices spread throughout the country. The specific action research approach followed is described in Chapter 5, and is modelled on the taxonomies in [Stringer, 1999, Kock, McQueen and Fernandes, 1995] and [Kock, McQueen and Scott, 1995]. The approach is centred on the AR cycle proposed by Susman and Evered (1978), which comprises five stages, with their related expected outcomes in each stage:

1. Diagnosing: The researcher and client organisation identify and specify an opportunity for organisational productivity and improvement in the client organisation and match it with the research goals;
2. Action Planning: The researcher and client organisation consider alternative courses of action to attain the improvement and change orientations identified, and devise a plan to implement one of these alternative courses of action;
3. Action Taking: The researcher and client organisation implement the devised plan;
4. Evaluating: The researcher and client organisation assess the outcomes of the plan implementation, and
5. Specifying Learning: The researcher identifies and describes “general findings” based on the information generated in the previous stage.

### **1.4.2 Survey Research**

This research approach has its roots in the work of economists and sociologists. In survey research, the researcher typically has a considerable sample to be analysed, which suggests the use of questionnaires with questions that are easy to be answered and that permit quantitative evaluation a posteriori or extensive collection and analysis of secondary data (e.g. financial reports). Survey research is typically applied to validate models or hypotheses by statistical generalisation. Typical instances are the survey involving:

1. Forty-nine organisations in Southern California performed by Winter (1993), which shows that computers can act as symbols of status;
2. Brynjolfsson and Hitt's (1993) survey based on firm-level data from 1987 to 1991 about 380 large firms, which evaluates those firms' return on investment in information systems (IS);
3. Gartner Group's survey<sup>2</sup> on 811 randomly selected North American and European respondents; the sample included 609 North American enterprises and 202 European, which measure user perceptions and intentions of knowledge management;
4. Intellectual capital – an exploratory study, by Nick Bontis, that develops models in Ontario, Canada [Bontis, 1998], to measure the use and awareness of intellectual capital in Canadian organisations;
5. Survey of Innovation, 1999 – of Statistic Canada (Statistic Canada, 1999) to assess the usage of innovation in Canada, and
6. Survey of Knowledge Management Practices, 1999 – of Statistic Canada (Statistic Canada, 1998) to measure the use of KM practices in Canadian firms and organisations.

### **Data collection and analysis – An action research iteration**

The study consisted of facilitating and studying face-to-face and asynchronous groupware-supported KM groups in the client organisation. Several iterations of the AR cycle were conducted in the client organisation, and the study reports on one such iteration in Chapter 8. It involves the sub-iterations of six processes at the Directorate, where four KM groups were indirectly facilitated (through mentoring and supervision of group facilitators).

The iterative basis of the research provided an opportunity for cross-organisational and longitudinal comparison of research findings, and allowed for the design and refinement of a research framework during the research study. This research framework, whose main components were the three sub-units (organisation, group, and individual) of analysis on asynchronous groupware and respective variables, formed the basis on which research data was collected and analysed.

Data was collected through participant observation, interviews, and compilation of transcripts of

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<sup>2</sup>GartnerGroup's ITXPO '99 Symposium – Day 1, 1-4 November 1999, Cannes, France., 1999.

electronic messages (emails) from KM group members. Complementary data about the organisation and its main (core) processes was obtained from procedure manuals, policy documents, e.g. directives, saving rams, etc.; internal archival records, such as service records and memoranda. Another source of complementary data was documents published by the organisation, such as organisational reports, white papers and the organisation's management journal.

The data analysis was framed on the assumption that one should operationalise the answer to the research question, that is, the main findings of our research, in the form of a set of causal models. This was seen as appropriate since the main research topic chosen, AG support to the creation and enabling of KM strategies, had received very little attention so far (perhaps because of the novelty of both AG technology and KM practices and strategies. The approaches to harness the former to harvest the later, towards the enabling of BI, which prevented the researcher from finding models that could be properly tested. In addition, the decision to build knowledge in the form of causal models was highly consistent with previous characterisations of the research approach the researcher decides to adopt, that is, action research combined with survey research [Jonsson, 1991, Galliers, 1992, and Yin, 1994].

The general mode of analysis used in this research is the one referred to as explanation building by Yin [1989:113; 1994:110], who points out that "To explain a phenomenon is to stipulate a set of causal links about it", and as grounded theory building by Strauss and Corbin [1990; 1994] and Glaser [1992]. In the context of approaches such as these, sets of causal links are typically seen as being among the basic elements of a theoretical framework [Davis, 1985].

The iteration at Directorate - a public service Division in the Republic of Botswana. The iteration is discussed in more detail in Chapter 10 was sub-divided into three sub-iterations. Sub-interaction one maps the KM groups one and two, sub-iteration two maps KM group two, sub-iteration three maps KM groups three and four. The researcher facilitated these KM groups. The objective of each interaction was to develop a set of workflow management processes, for the HRM actions under consideration. In this case, each iteration led to the building of descriptive and explanatory causal models (six in all: recruitment, promotion, personnel upgrading, personnel transfers, manpower planning, and training administration) – based on an enterprise model and on the analysis of the evidence gathered during the iterations. At the end of each sub-iteration, one then compares the evidence relating asynchronous groupware support effects obtained during the iteration with evidence obtained in previous iterations. In this comparison, one highlights invariable patterns and tries to explain discrepancies, and exceptions. This

comparison of evidence obtained across iterations benefited from the summarisation of previous evidence in the form of descriptive causal models.

### The KM groups

A model is now presented, illustrating how knowledge is transferred in a distributive context. This is how the KM groups at the Directorate were organised in facilitating the iterations of the AR cycle. This Model in Figure 1.2, shows that the four groups A,B,C and D, models the groups' interactions at Directorate. This model shows that Group A's knowledge is shared with groups B and C while Group B's knowledge is shared with group A and Group C's Knowledge is shared with Group B and D, and Group D is shared with Group C and D.

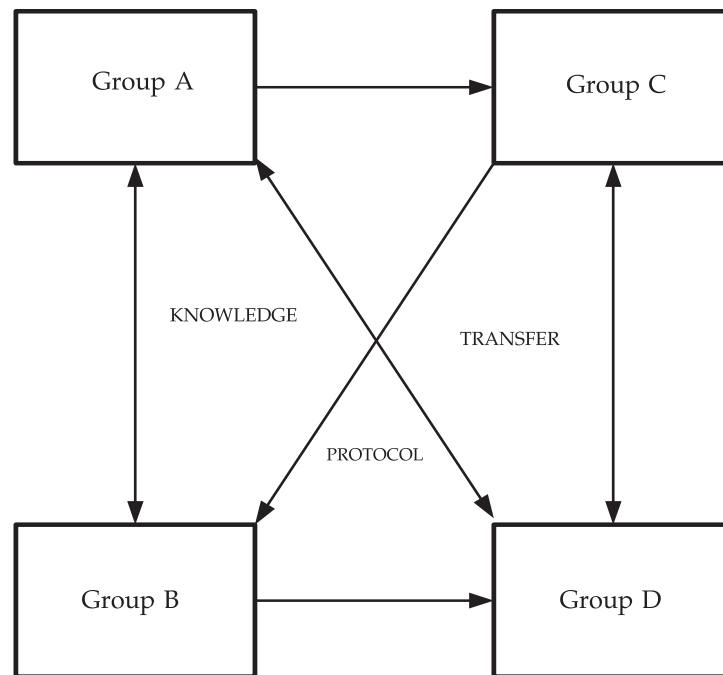


Figure 1.2: A distributed model for knowledge transfer among groups

In this model one sees that knowledge flows from multiple sources to multiple receivers. The model demonstrates that knowledge is transferred in a distributed manner among equals.

The computer tool used to support the KM groups was a simple e-mail system, implemented using functions of the Lotus Notes [Lotus Corporation, 1995] e-mail systems. Group e-mail distribution lists comprising KM group members were implemented to support each of the KM groups using simple high-level programming features of the systems. The group distribution

lists used in the research were similar to an electronic mail distribution lists. The e-mail system allowed KM group members to exchange one-to-one electronic messages within the group and with other staff of the respective divisions of the organisation (Directorate), as well as post messages and replies to the whole group. The system supported a calendaring system, which allowed group members to share calendars for easy setting up of appointments and arranging meetings, and online collaborative net-meetings. Members were also able to attach documents such as forms, directives, memoranda, letters, graphs, and so on, to their email messages. Attachments could be easily read by opening the document icon, which accompanies the email message. These attachments were then downloaded into specific folders created for the purpose of the project.

All KM groups had a leader, a facilitator and ordinary members. The researcher by means of the organisation's own group facilitators indirectly facilitated all four groups. All group leaders and ordinary members were staff of the Directorate. The researcher provided technical and methodological support to the KM groups usually by helping group leaders to build messages where individual contributions of group members were summarised and group stages were initiated and completed. In the majority of the KM groups the researcher, who tried to limit his influence only to the structure of those discussions, exerted no influence on the content of group discussions.

### **1.4.3 Main research phases**

The research can be seen as having been conducted along five main phases:

1. Thesis Proposal and Literature Review – from September 1998 to October 1999;
2. Research Design – from February 2000 to November 2002;
3. Survey Research – Pilot Survey: from February 2000 to March 2000, and the Main Survey: from July 2000 to July 2001;
4. Action Research iterations – from April 2001 to August 2001, and
5. Thesis Writing – from September 2001 to January 2005.

These stages are illustrated in Figure 1.3 with the respective start and end dates. Phase 1 comprised a research proposal and a literature review of empirical research on groupware, small group behaviour, KM strategies and organisational cognition.

Based on this, the investigation precedes to Phase 2, where one prepares and submits a final research design to the School of Business Leadership, University of South Africa (UNISA). Once that research design was approved on then moves on to Phase 3, which comprises the development of a KM-BI model. This model was informed by a pilot survey research conducted among 26 countries of the Commonwealth of Nations (previously British colonies), with a view to test several aspects of our research design, and the KM-BI Model. This test included the sample design, the research instrument, the data collection methodology, the data processing procedures, and the analysis of the research.

The objectives were, therefore, to establish the extent to which organisations are aware of KM, take it seriously and are pursuing initiatives to implement it, and benefit from it. Respondents were questioned about their current implementation, awareness and future plans for KM. These aims addressed the four research hypotheses of this thesis. The findings from this survey were used to develop the main survey research, which was conducted among 4 countries (Australia, Canada, New Zealand and the United Kingdom). These countries are members of both the OECD and the Commonwealth. They were included in the Pilot Survey, and were selected because it was assumed that they have the greatest evidence of the use of ICT.

This survey was also used to validate the casual models formulated from the Action Research cycle at Directorate, both in the first sub-iteration and in the subsequent sub-interactions. It was also used to validate the relevance of the hypotheses and the hermeneutics of the KM-BI model as it relates to organisational memory, and intellectual capital in the context of the research question.

Phase 4 comprised the Action Research (AR cycle iterations) at the Directorate. The iteration at the Directorate was divided into 3 sub-iterations, and was without any structural research framework, in terms of a specific form of units of analysis and variables. The first sub-iteration was aimed at direct intervention into the Directorate, in order to better scope and appreciate the metric of the process orientation of the problem. This sub-iteration stage of the AR cycle provided valuable information on the project's motivation and terms of reference, and insights from the detailed literature review.

The second sub-iteration phase of the AR cycle allowed us to perfect the use of the Lotus Notes e-mail support tool. Competency training was held for all group members on the use of the Lotus Notes e-mail system. A procedure manual was developed to be used as a guide by KM groups throughout the project. Examples of group members' interactions were incorporated in the manual. These were however, disguised so that members would be unable to identify the contributors. A structured research framework was developed during this AR cycle. Both the perception and insights from this sub-iteration and the previous sub-iteration aided this framework for the purposes of data collection and analysis. The framework was composed of three units of analysis, and a number of complementary and related research variables.

In the final sub-iteration, data collection and analysis were conducted in a more structured way than in the previous sub-iterations, as they were based on the structured research framework generated in the second sub-iteration. These led to both the refinement of the research framework and the development of set findings based on the evidence collected from the sub-iterations. The consistency between the findings from the sub-iterations informed us that some saturation had been achieved in the model and knowledge building process.

The researcher therefore concludes the iterative process of the Action Research, and moved into the final stages of Phase 5 – Thesis writing, which began approximately one month after the final sub-iteration was completed – where one summarises the research work, and reports the findings obtained from the analysis of the data.

## **1.5 Thesis Overview**

This thesis comprises 11 chapters, 10 appendices, 63 figures, and 20 equations. Chapters 2 and 3 provide a comprehensive literature review of KM and KM strategies respectively. In Chapter 2, the researcher gives various definitions of knowledge and KM as well as related terms, like tacit knowledge and IC, are discussed from a philosophical, a technological and a business point of view. The major components of KM are then described in Chapter 3 from a process perspective, a functional perspective, and then a technological perspective. The chapter also describes different approaches and insights on KM from the literature.

The chapter also describes the inclusive relationship between KM strategies and organisations, and defines knowledge management from two different perspectives. These include the value



adding elements, and the set of interrelated activities and perspectives of KM. This is followed by a description of the KM characteristics, KM stages, and a discussion on what distinguishes “good” KM from “bad” KM strategies. This is according to the normative literature in the field of intellectual capital, in terms of a four-step process in developing an intellectual capital strategy. The study describes the KM imperatives and the technology option requirements of KM, and the relationship between tacit and explicit knowledge. Finally, one describes the disciplines of a knowledge business. Here, one attempts to characterise how firms may sell and manage knowledge products, support knowledge processes for creating and sharing knowledge; and develop a knowledge perspective.

Chapter 4 reviews the groupware literature from two different perspectives, firstly with a brief overview of the technologies used in groupware technology, with specific emphasis on knowledge management. The emphasis then shifts to a review of the groupware literature, but with particular focus on asynchronous groupware. In this Chapter, one defines groupware and discusses two relevant taxonomies of groupware systems, the application-level and time-space taxonomies, enriching the discussion with a comparison and integration of these two taxonomies. The study then discusses, based on a review of empirical research on groupware, advantages and disadvantages of asynchronous groupware interaction in comparison to both synchronous groupware interaction and non groupware-supported interaction. Finally, one discusses some studies of groupware support to KM groups, whereby a bias towards experimental studies and synchronous groupware is identified.

Chapters 5 and 6 describes the research method. It starts with a cursory treatment of the introduction to the research methodology and the discussion of the consequences of the research framework with some emphasis on its units of analysis and respective variables.

The chapter then describes the research methodology and the development of the model for BI through KM. It continues with a review of AR and follows with a description of the AR cycle. AR is characterised as a distinctive research approach. This characterisation is supplemented by the development of some historical considerations about AR and its relationship with positivism. An explanation of the ethnographic approach used as an improvement on the basic action research approaches in common usage. In this explanation, the author echoes his concerns and bias for some elements of positivism. The author then turns his attention to his choice of combining action research with survey methodology, as a means to explain the findings from the Directorate. The survey research was conducted concurrently. In order to explain the multi-method research

approach, the author gave some justifications for the use of the survey strategy.

A detailed description of the research site and method is then provided, with a focus on the data collection and analysis procedures and techniques used. The chapter concludes with a discussion of possible sources of bias in the research and how the present study dealt with them. The researcher then discusses the logic of survey sampling, and the multivariate techniques used for validating the action research methodology, and the AR taxonomy, in particular the Factor Analysis and Cronbach's alpha for reliability analysis techniques. The chapter also provides a detailed description of each of the research sub-iterations. This chapter is structured around the AR cycle, and thus its main sections reflect the five (5) stages of the AR cycle - diagnosing, action planning, action taking, evaluating, and specifying learning. The chapter also comprises an introductory section, where general information about the client organisation - Directorate, and the research iteration is provided.

Chapters 7 and 8 report the results of the findings from both the Pilot Survey component of the research, and the Main Survey on KM practices in 121 Firms in Australia, Canada, New Zealand, and the United Kingdom, respectively. These chapters present both the analyses and discussions of the results of how asynchronous groupware impact the various knowledge management practices and strategies being used by firms and organisations. They present an objective presentation of the findings from the two survey instruments. These findings are presented so as to report on the reliability of the instruments used in this research, and also in the form of descriptive statistics, that is, frequency distribution tables, bar and pie charts, and of histograms. Having done this for both survey results, one then presents the findings in terms of four null hypotheses.

Nonparametric statistics were used in the main, in Chapters 7 and 8, to show how the findings relate to the research questions. Bivariate statistical analyses shall also be used to test the correlation and relationship of pairs of variables. The analyses of the research questions will also be undertaken in these chapters for hypotheses 1 to 4 [Chapter 7], and 3 and 4 [Chapter 8], respectively.

In Chapter 9, the results from the various research approaches are discussed, and suggestions made how they may be used to develop a model for the facilitation of KM and BI through the innovative use of asynchronous groupware technologies and the interactions of communities of practice in the bid to harness the IC and thus, the BI of the organisation. This chapter

is the seminal chapter of this research, which proposes a grounded theory of KM. It discusses the various perspectives of knowledge and knowledge management in organisations. A theoretical framework based on Michael Polanyi's epistemology [Sveiby, 1994] and information theory is developed on a constructive foundation. This grounded theory on KM resulted from using this framework to focus the empirical data through a knowledge perspective. The researchers discusses the intellectual capital (IC) model as proposed by Karl-Erik Sveiby [1997:190]. The chapter also reports on the experiences gained in practice, and the framework developed to implement various KM projects. The researcher then, having being informed by the literature and the results from Chapters 6, and 7 proposes a model for the facilitation of knowledge management and business intelligence (BI) through the use of asynchronous groupware (AG) technologies. This model, [Figure 9.8 KM – BI Model], is driven by the heuristics of the knowledge portal. The heuristics of the portal are discussed in much more detail in an attempt to explain how firms/organisations may transfer knowledge among their employees, business units, and business partners. The mathematical specifications of the heuristics will not be discussed in this chapter, as the author feels it, is out of the scope of this research.

A cursory treatment of the various measurement strategies which firms may use in implementing knowledge management practices, in general, and the proposed KM-BI model [cf. Figure 2.1 Model for KM-BI (from Campbell and Pellissier, 2000)] specifically is discussed.

In Chapter 10, the researcher reports on the case study undertaken at Directorate. The results of the iterations shall be discussed on the process maps drawn up from the iterations of the four groups will be presented in Chapter 9.

Chapter 11 provides a summary of the research findings, classifying these findings according to apparent intensity and degree of external validity. This is followed by a discussion of implications of the research findings for practitioners; particularly those involved in the planning and (or) implementation of organisation-wide KM projects, and for the current academic debate on asynchronous groupware and media adoption theories.

The study also explores the future of the knowledge-based organisations, and examines the way forward for these organisations operating in the knowledge-based economy. The chapter also offers some suggestions of how these organisations may restructure themselves, in developing a knowledge sharing culture, the requisite technical infrastructure, the facilitation of knowledge stewardship: organising and distributing corporate knowledge; and the development of content

and corporate memory [Dixon, 2000, den Hertog and Huizenga, 2000].

Appendix B contains a summary of the survey items used in the pilot survey. Appendix E, contains a summary of the survey items used in the KM practices survey.

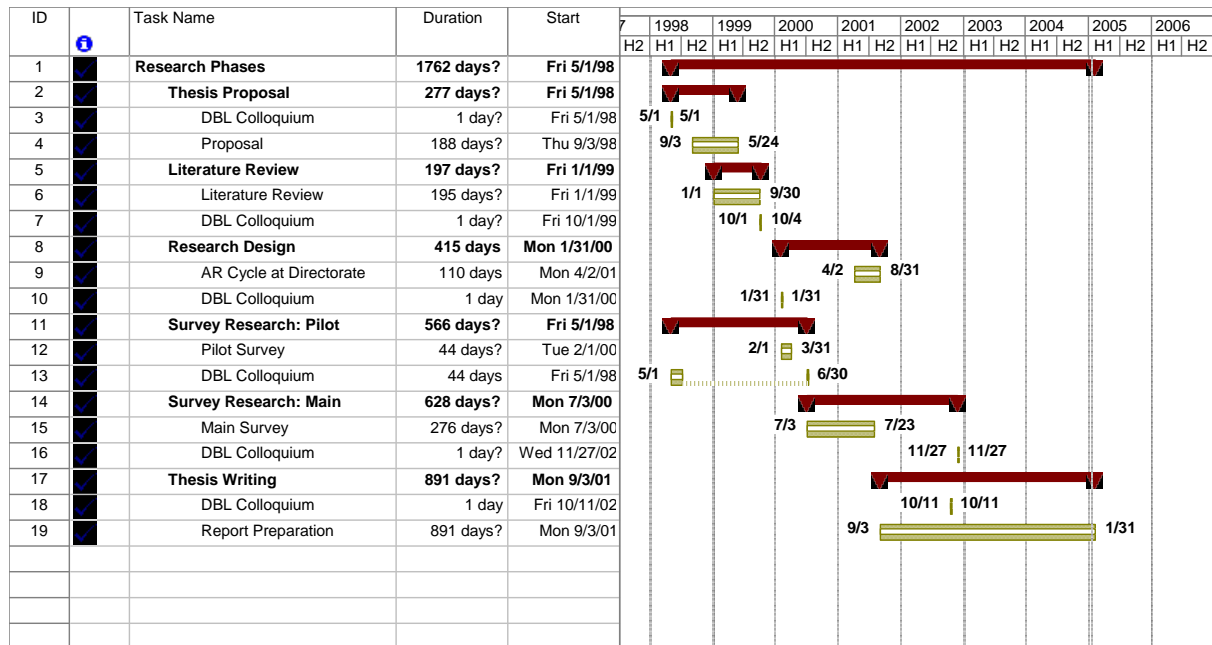


Figure 1.3: Research Phases

## Chapter 2

### Knowledge Management

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*We are drowning in information but starved of knowledge.*

*John Naisbitt, Megatrends*

#### 2.1 Introduction

The chapter seeks to provide a detailed discussion of the theoretical basis of the philosophies on which the discipline of KM rests. In so doing, it is hoped that a grounded theory of KM will emerge which may be used to develop a clearer definition of KM, and a framework that may be used to implement KM projects in organizations. The approach being taken here, in section 2.2, is firstly to look at the various terms used to describe knowledge, and to determine, at a philosophical level what is meant by the said concept – ‘*knowledge*’. It is the author’s belief that before one can ably understand KM, and how it impacts the knowledge economy and the emergence of the e-corporation, one must have a clear understanding of what is meant by the concept, knowledge, and the underlying philosophy on which it rests.

The author then provides an overview, in section 2.6, of KM, where the basic concept of KM is discussed. A discussion of its aims and objectives for creating enterprise value in the knowledge economy is then undertaken. In the chapter the scope of KM for capturing and harnessing the knowledge and wisdom of individuals, in terms of the components of innovation, responsiveness, productivity and competency are also discussed. This relates to the strategic and operational dimensions of planning and controlling, organisational and technological, and cultural and employee involvement. Taking cognisance of these four dimensions, attention was then turned to 11 of the most frequent components of KM, which will be discussed in greater detail in Chapter 3. This section ends by exploring the various life cycle models proposed in the literature.

The final paragraph, section 2.7, outlines the emerging trends of KM, and the characteristics most frequently used to describe the context in which KM exists in the knowledge-based enterprise, in terms of the identification of the knowledge assets of the e-corporation as they (the

assets) relate to the firm's value chain, and the resulting value network. The chapter ends by briefly looking at six KM strategies and techniques, which will be revisited in Chapter 9.

## 2.2 Definitions of Knowledge Management

### 2.2.1 Knowledge

#### Theory of Knowledge

The author is of the firm belief that the best approach towards an unambiguous understanding of the term 'knowledge', is to classify the various definitions and interpretations of knowledge into an acceptable, and agreed working definition. Such a classification of the various types of knowledge may be derived from a distinction between three forms of knowledge precepts. These are, "*knowledge-that*", "*knowledge-of*" and "*knowledge-like*" [Moser, 1995]. These, in general, are the classification of propositional knowledge, which may be further subdivided into empirical (a posterior) knowledge and non-empirical (a priori) knowledge. Here, one has knowledge derived from one's acquaintance, and awareness, which comes from the verb '*to know*'. This lends credence to the fact that one needs to know something in relation to one's previous experience. One draws on the past acquaintances and past experiences to make a comparison in order to determine one's knowledge of the present reality.

This then brings us to the controversial question of the distinction between '*know-how*' and '*skills*', when one tries to discuss the concept of 'knowledge-like' an accepted learning regime, education or experience towards a generally accepted and certified end [Dieng, Corby, Giboin, and Ribière, 1998]. In general, whether one considers '*knowledge-on*', '*knowledge-that*', and '*knowledge-like*' to be similar or contentious epistemology, the categorisations are all relevant and meaningful. The question is the degree of distinction one wishes to place on this categorisation of knowledge. The case of a priori knowledge is apropos.

In discussing the relationship between a priori knowledge and a posteriori knowledge, the views of rationalists such as Descartes, Leibniz and Spinoza are relevant. They held the belief that all real knowledge is a priori. On the other hand, the opinions of empiricists, such as Locke, Berkeley and Hume, are that all knowledge is justified in terms of one's experience. Kant (1781, 1788, & 1790) tried to merge these two theories in his three critiques, thus giving rise to a

modern understanding and characteristics of epistemology.

The definition of the characteristics of knowledge may be traced to the time of Plato. He may be credited for this through his treatise on propositional knowledge, which is the definition of knowledge as it relates to the search for truth. His treatise demands that one must believe in something, in order to know it. It expresses the intuitive understanding of most philosophers that knowledge requires some form of psychological relationship between the '*knower*' (person) and its knowledge. The tenets of this view were often criticised because of the lack of definitive justification, acceptable literature and research to support the view were not forthcoming, and as such the tenets of this view were often criticized.

Notwithstanding this, however, the basis of the '*truth condition*' as a predicate of epistemology, and the act of knowing were hardly ever contradicted. The justifiable argument is not whether there are sufficient conditions to indicate where '*truth*' begins but rather if it helps to clarify the theory of knowledge. The crux of the argument, is that this must be in congruence with the realities of the situation under question. Coherency theories, over time, use the '*truth*' term, however, as the grounded definition for internal consistency (different predicates) of knowledge. In addition, '*truth*' can be seen as having both a pragmatic and cognitive value.

A grounded theory and a sound justification are required for a clearer understanding, and generally accepted principle of knowledge. This being so, if one is intent on calling predicates knowledge, which are true and which one also believes, but an understanding and realisation to which one came, only by advice or pure coincidence, may be used to hermeneutically place these predicates within the body of the epistemology theory. In the contemporary theory of knowledge, the justification of knowledge may be supported by three criteria. These will now be discussed, but the argument is whether the justification of knowledge itself is a normative concept.

Gettier (1963) points out that the concept of truth in the justification of knowledge is not sufficiently grounded, as such it is weak. His argument follows that the predicates of truth should lead to the justification of knowledge. So one should be able to design situations in which one is able to have justified belief, and award the status of knowledge, to that belief. The author is however, of the firm belief that a justified belief in the predicate cannot be considered as knowledge.

Arising from the foregoing are different forms of scepticisms, which are to be considered when discussing the theory of knowledge. This is expected, given that there is much doubt and confusion about knowledge in general, and whether one can really know something in its entirety. The argument that there is no truth, and that knowledge is justified belief or the opinion that what anyone can ever possibly believe in is justified belief.

The theory of knowledge has had a different history in different cultures, but in Japan the term knowledge is based on the following three principles, as set out below [Nonaka, and Takeuchi, 1995]:

1. the unit of man and nature;
2. the unit of body and spirit; and
3. the unit of the specific context or experience within one's environment.

The principle of the unit of man and nature is expressed during speech by the use of imagery, which is context specific, and is centred, on the language and the nature of the thinking used. The other two elements are subsets of the first.

The absence of a 'formal-knowledge' theoretical tradition helps to explain the Japanese's attitude of mind:

Japanese have a tendency to stay in their own world of experience without appealing to any abstract or metaphysical theory in order to determine the relationship between human thought and nature [Nonaka, and Takeuchi, 1995: 29]

.

## **Characteristics of Knowledge**

The foregoing now allows the explanation of the the characteristics of knowledge, as a result of the brief discussion of some of the philosophical basis on which knowledge derives its principles. The technical and management literature on knowledge is reviewed next. Firstly, the current study will look at the characteristics of knowledge, as it relates to the various terms used in the literature [cf. 2.2.1], is studied. Secondly, the more specific definitions and the terms attributed to knowledge, with regard to the concept of implicit knowledge [cf. 2.3], is discussed. The value creation concept of IC [cf. 2.4], the hermeneutics of IC as it relates to human capital [cf. 2.4.1 is then also discussed. Finally, the infrastructural context of SC and its inextricable relationship with IC and KM [cf. 2.4.2], and those concepts of knowledge which are embedded



in the marketing channels and customer relationships of the firm are referred to as customer capital [cf. 2.4.3], and the hierarchical concept of knowledge. [cf. 2.5] are also discussed.

- **General**

Time, place and culture play an important role in the structuring of knowledge. The context in which knowledge is harvested, depends on the quality of the data and information being deployed.

It is generally accepted that knowledge is aimed at people. It is also accepted that various forms of knowledge exist in documents, products, systems and processes [Mentzas, and Apostolou, 1998]. In some areas it is argued that knowledge is embodied as artefacts and may be regarded as localisable, recordable and transmittable. Given this thinking, the term, knowledge, can be explained as “knowledge” of “*expertise*” (“*performance of knowledge*”) [Poitou, 1998].

This research takes the view that knowledge is the result of learning. This view is supported by contributions from the literature, specifically from the fields of psychology and education. This therefore leads to the impact of learning, and its current perspective on the (“organizational learning”) body corporate. The outcomes and results of practice and action orientation are sufficient classification of the characteristics of knowledge. It is also a required condition for knowledge validation and collaboration [Sierhuis, and Clancey, 1997].

Determining whether knowledge is directly measurable will assist us to better identify the effectiveness and the results of knowledge. The results of knowledge may be distributed through such artefacts as estimates, expertise, pattern recognition, recycling and innovative thinking et cetera [Huang, 1998], or more particularly in the business context such as customer retention or protection of patents [Garner, 1999]. “Knowledge does not only have to be rational, but there should also be a clear understanding between the intuitive component of knowledge and that of pure rational knowledge. This differentiation will affirm the value proposition of the complementarities of rational and intuitive knowledge” [Denning, 1998].

- **Economic aspects**

The characteristics of knowledge with regard to economics and the factors of production may be delineated as follows:

- knowledge by use is valuable;
- knowledge can be possessed several times;
- the costs of knowledge are difficult to identify.

The literature supports the author's view that any real valuation of the inventory of organisational knowledge is difficult. As such, the characteristics of the net assets of a business are difficult to measure [Day, and Wendler, 1998], in terms of IC and BI [Bontis, 2000, Campbell, and Pellissier, 2001]. Understandably, though, IC, in particular, is of "increasing interest to firms that derive their profits from innovation and knowledge-intensive services" [Edvinsson, and Sullivan, 1996]. These aspects IC will be discussed more fully in paragraph 2.4 [cf. 2.4].

### 2.2.2 Fundamental Definitions

A discussion of some of the fundamental definitions of knowledge is required before the difference between implicit and explicit knowledge is explored. The relationship between data, information and knowledge, will be examined later [cf. 2.5]. These definitions will be in the context of the hierarchical concept of knowledge, and will be discussed in paragraph 2.5 [cf. 2.5].

Broadly speaking, knowledge can generally be defined as those facts, experiences, et cetera, which can be used as the basis for future experience, and insights:

Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied into the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories, but also in organizational routines, processes, practices, and norms. [Davenport, T.H. and Prusak, L., 2000:5]

It can also find utility as a basis for forecasts of future conditions, events, instances and behaviours of both things and people. The more general and common definitions of knowledge, deal with the action orientation and basis of knowledge. The definition takes on the character of knowledge as a "*capacity to act*" [Sveiby, 1997:37], or the aspect of decision-making where it has the ability to transform information into high-quality decisions. It is important to note, however, that in many instances the non-standard aspect, where knowledge is regarded as a personal ability by which an individual can execute a certain function or activity is rarely emphasised. This view is corroborated by Alavi and Leidner who assert that:

Knowledge is a justified personal belief that increases an individual's capacity to take effective action. [Alavi, and Leidner, 1999: 2]

From the foregoing, it can be surmised that if 'action' is the basis of knowledge, then it must be understood to be both intellectually physical and cognitive. These are the sentiments echoed by Wigg:

Knowledge consists of truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and know-how and is possessed by humans, agents, or other active entities and is used to receive information and to recognise and identify; analyse, interpret, and evaluate; synthesise and decide; plan, implement, monitor, and adapt – i.e., to act more or less intelligently. In other words, knowledge is used to determine what a specific situation means and how to handle it. [Wigg, 1998:1]

Contrary to these action-oriented definitions of knowledge in the context of the organisation, one tends naturally to regard only the mental context of the individual. Knowledge can also be paper-based where it is embedded in different types of documents:

*Knowledge* means the knowledge into the business about customers, products, processes, competitors and in such a way on, which can be locked away in people's minds or filed on paper or in electronics form. [KPMG Management Consulting, 1998:5]

Information and data external to the organisation can also be used to arrive at a definition, while maintaining the overarching role and the control position of the individual as a consumer of knowledge:

Knowledge is an organisational member's experience and values combined with and shaped by the information contained into various systems and data provided to the person. It is intrinsic to organizational members and of focuses on the information recipient. [Ginsburg, and Kambil, 1999:1]

Thomas A. Stewart supports the foregoing discourse, in his recent book, *The Wealth of Knowledge*. He asserts, "*Knowledge is what we do.*" [Stewart, 2001:9]. In this seemingly simple statement he captures the true relationship of knowledge and the individual, and for that matter, the organisation. He goes on to say, "*Ideas, knowledge, and information have always mattered, but today they define our working life, and this is unprecedented.*" [Stewart, 2001:9]

Stewart (2001) makes the point that knowledge does matter in what one buys, sells and does, in one's normal working life. The argument is that if organisations want to compete successfully in the new knowledge economy they should do so with three pillars which characterise the knowledge-based economy. These pillars are described as:

1. knowledge is what we buy, sell, and do;
2. knowledge asset – intellectual capital – has become more important to companies than financial and physical assets; and
3. new vocabularies, new management techniques, new technologies and new strategies are needed if companies are to prosper in the new economy and exploit these newly vital assets.

The research suggests that all the new economy's laws and profits, for that matter, rest on these three pillars. The discussion of explicit and tacit knowledge will next be undertaken. From the literature, cognisance is taken of the concept of the knowledge-worker, and how the application of tacit and explicit knowledge, and an understanding of the various roles of individuals and organisations can inform the development of a model for implementing these elements of KM.

### 2.3 Implicit Knowledge

The most common classification of knowledge in the knowledge management literature, to date, is the distinction between '*explicit knowledge*' and '*tacit knowledge*'. Explicit, comes from Latin, meaning "*to unfold, that is to be open, to arrange, to explain, and to document*". Explicit knowledge is codified or articulatable in a formal manner, for example in the form of grammatical predicates, mathematical formulas, design specifications, procedure manuals, et cetera. [Nonaka, and Takeuchi, 1995] Explicit knowledge can be easily passed on from one medium to another; therefore, one can say it is transferable. It is on this form of knowledge that the western philosophical, historical, and religious traditions rest.

'*Tacit knowledge*' on the other hand, may be seen as implicit knowledge or hidden knowledge, as opposed to explicit knowledge. Tacit knowledge, or implicit knowledge, is personal knowledge, which is bound to the individual. This is not embedded in some process nor easily transmitted and shared without some systematic effort. The characteristics of tacit knowledge are a subjective view or understanding of a topic, an artefact, an intuition or an internal feeling in the sense of a cultural prejudice, experience, tradition or belief. Tacit, implicit, knowledge, it would seem, is therefore based on informal metrics, non-standard experience, personal conceptions or convictions, faith, perspectives, cultural biases, ideals, values and emotions. The literature supports the view that tacit knowledge consists of ability, routine actions, convictions, faith and

beliefs, and intellectual property rights, copyrights and patents [Nonaka, and Takeuchi, 1995].

One can easily differentiate between the technical and the cognitive dimensions of implicit knowledge. The technical dimension is formed by know-how, such as the informal and latent abilities and talents one cultivates over time, both in relation to the dexterity in crafts and in the pursuit of intellectual actualisation. The cognitive dimension, however, consists of our tacit acceptance of our environment, which is usually manifested in the adage - *'let nature take its course'*. Nonaka, et al. summarise these views with more exactness by iterating that:

It consists of schemata, mental models, beliefs, and perceptions so ingrained that we take them for granted. The cognitive dimension of tacit knowledge reflects our image of reality (what is) and our vision for the future (what ought to be). [Nonaka, I. and Takeuchi, 1995:8]

## 2.4 Intellectual Capital

Organisational knowledge for the entire enterprise must include the use of intellectual capital. In this context, intellectual capital includes both the personal resources of the individual, and the processes and routines embedded within the organization's repositories, such as patents, know-how, etc. This also includes such artefacts as the organization's culture, corporate memory, customers and suppliers' relations.

The term IC is occasionally used in referring to intangible assets, or simply intangibles. However, IC as a concept is accepted at a theoretical level. The mindset and process for transforming this concept into corporate metrics are some of the goals and expectations of this research thesis. Leif Edvinsson, Director of Intellectual Capital, Skandia of Sweden, defined intellectual capital *"as the sum of human capital, structural capital, including customer capital"* [Edvinsson and Sullivan 1996]. Edvinsson et al. (1996) further assert that:

[I]n the beginning of its evolution two very different perspectives emerged as significant focus on value-creation. Organisations with value-creation in mind tended to focus their management energies on the human capital of knowledge of the firm: how it is organised, how it is directed, how knowledge is created and how it provides value to the firm. The second perspective on intellectual capital management involved companies interested in value-extraction. Companies with value extraction (or profits) as their focus direct their energies to the intellectual assets of the firm: intellectual properties and commercialisable intangible assets. [Edvinsson, L. and Sullivan P., 1996]

Given the foregoing, the concepts of IC will now be reviewed in greater detail, so that a better understanding may be gained in terms of its measurement and evaluation. In addition to the above, there have been a number of focussed researches on IC management [Bontis, 1999; Roos et al., 1997], which have extensively reviewed the IC literature. The study offers the following six definitions in an attempt to summarise the highlights of previous research in this field:

1. IC is elusive, but once it is discovered and exploited, it may provide an organisation with a new resource-base from which to compete and win [Bontis, 1996];
2. IC is the term given to the combined intangible assets of - market, intellectual property, human-centred and infrastructure -, which enable the company to function [Brooking, 1996];
3. IC includes all the processes and the assets, which are not normally shown on the balance sheet, and all the intangible assets (trademarks, patents and brands) which modern accounting methods consider ... it includes the sum of the knowledge of its members and the practical translation of his/her knowledge [Roos et. al., 1997];
4. IC is intellectual material – knowledge, information, and intellectual property, experience – that can be put to use to create wealth. It is a collective brainpower or packaged useful knowledge [Stewart, 1997];
5. IC is the pursuit of effective use of knowledge (the finished product) as opposed to information (the raw material) [Bontis, 1998], and
6. IC is regarded as an element of the company's market value as well as a market premium [Olve et al., 1999].

One motivation of this research is the tremendous opportunity that IC can offer to firms for both knowledge generation and value-added services. The motivation stems from realisation that better utilisation of a firm's corporate memory, its strategy for utilising its knowledge and for that matter its IC. In fact, it is within this context that the desire to model and measure IC originates, and coincides with the two research questions from hypothesis 4. The literature informs that researchers in the field of IC have identified three main constructs of IC that include, human capital (HC), structural capital (SC) and customer capital (CC) [cf. 2.4.1, and 2.4.2 and 2.4.3] respectively.

### 2.4.1 Human Capital

HC represents the individual knowledge inventory of an organisation as represented by its employees [Bontis et al., 2001]. Roos et.al. (1997) argue that employees generate IC through their competence, their attitude and their intellectual agility. Competence includes skills and education, while attitude covers the behavioural component of the employees' work. Intellectual agility enables one to change practices and to think of innovative solutions to problems. Even though employees are considered the most important corporate asset in a learning organisation, they are not owned by the organisation. There is much argument as to whether new knowledge generated by employees belongs to the organisation or not. Case in point, consider the reality of an employee designing a piece of widget at home in his spare time, and the company stakes its claim to the intellectual rights of the product, in other words the codified knowledge of the employee.

The literature offers some additional examples and hermeneutics of IC as it relates to codified knowledge, and for that matter human capital. Hudson (1993) defines HC as a combination of: genetic inheritance; education; experience, and attitudes about life and business. Bontis (1998) describes HC as the firm's collective capability to extract the best solutions from the knowledge of its individuals. Unfortunately, people's departure can result in the loss of corporate memory and hence become a threat to the organisation. Another school of thought believes that the departure of some individuals in a firm may be considered good, since it forces the firm to consider fresh new perspectives from replacement employees.

Bontis (1999) argues that HC is important because it is a source of innovation and strategic renewal, whether it is from brainstorming in a research lab, daydreaming at the office, throwing out old files, re-engineering new processes, improving personal skills or developing new leads in a sales rep's little black book. He further asserts that

... [T]he scope of human capital is limited to the knowledge node (i.e. internal to the mind of the employee). It can be measured (although it is difficult) as a function of volume (i.e. a third degree measure encompassing size, location and time). It is also the hardest of the three sub-domains of intellectual capital to codify. [Bontis, 1999:65]

The essence of HC is the sheer intelligence of the organisational member. This is the view, which motivates the researcher to develop the conceptual model of KM-BI proposed in this thesis.

### 2.4.2 Structural Capital

If HC is the decisive factor for the improvement in population quality and advances in knowledge, then SC is structural tacit knowledge – includes all the mechanisms and structures of the organisation that are used to support employees in their quest for organisational excellence, and overall business performance. The SC of an organisation includes all the non-human storehouses of knowledge in organisations that include the databases, organisational charts, process manuals, strategies, routines and anything whose value to the company is higher than its material value. Roos et al., (1998:42) describe SC as “*what remains in the company when employees go home for the night*”. SC arises from processes and organisational value, reflecting the external and internal foci of the company, plus renewal and development value for the future. According to [Bontis, 1998:66], if an organisation has poor systems and procedures by which to track its actions, the overall IC will not reach its fullest potential. Organisations with strong SC will have a supportive culture that allows individuals to try new things, to learn, and to fail. SC is the critical link that allows IC to be measured at the organisational level of analysis.

### 2.4.3 Customer Capital

The main theme of CC is the knowledge embedded in the marketing channels and customer relationships that an organisation develops through the course of conducting business. CC represents the potential an organisation has due to ex-firm intangibles [Bontis, 1999]. Although originally conceptualised by Hubert Saint-Onge while at CIBC, more recent definitions have broadened the category to include relational capital which in effect encompasses the knowledge embedded in all the relationships an organisation develops whether it be from customers, from the competition, from suppliers, from trade associations or from the government [Bontis, 1999]. One manifestation of relational capital that can be leveraged from customers is often referred to as “*market orientation*”. There is no consensus on a definition of market orientation but Kohli and Jaworski (1990) define it as the organisation-wide generation of market intelligence pertaining to the current and future needs of customers. Ultimately, the dissemination of this intelligence must be done horizontally and vertically within the organisation so that a competency in organisation-wide action or responsiveness to market changes can be developed.

Recent work in the service profit chain has emphasised the causal relationships among employee satisfaction, customer satisfaction, customer loyalty and financial performance [Kaplan and Nor-



ton, 1996]. The literature informs that rapid delivery satisfies customers [Olve et al., 1999]. Additionally, the literature reports that companies often have difficulty in retaining employees because they have not put enough time and energy in ensuring that the mission and values are truly shared [Senge, 1990]. Further research shows that “*customer*” loyalty can be predicted by measuring “*employee*” loyalty [Horibe, 1999]. These studies provide further evidence of the importance that CC represents an important unit of an organisation’s overall IC.

## 2.5 The Hierarchical Aspects

A full understanding of the concept of knowledge must be viewed against a framework of a hierarchy of terms such as, data, information and knowledge, itself. This hierarchical concept is discussed exhaustively in the literature. The hierarchy exists, on the one hand in the temporal sense, through a temporal sequentiality, that is, information develops from data, and knowledge then develops from information. On the other hand, there is the value hierarchy, where knowledge is considered as high order information, while information is considered to be high order data. Tuomi supports this view, as follows:

... most of the time knowledge is conceptualised as meaningful, accurate, and usable representation of facts in context. The underlying concept also assumes sequentiality; a process model where something simple is converted into something more complex and valuable. [Tuomi, 1999: 2]

The literature is full with different interpretation of the three terms (data, information and knowledge), and their meanings vary from author to author. Typically, from a process perspective, and also hermeneutically, from an organisational perspective, information is regarded as structured data or data in context, while knowledge is regarded as interpreted information or information with meaning. Alternatively, the interpretation of data is syntactical and involves the role of rules, the heuristics and grammar, which bind the syntax of instances and primitive characters of the data to the information to give it meaning. Knowledge is then derived through networking, context and experience from the information so interpreted.

The distinction between “*knowledge*” and “*wisdom*” is also occasionally differentiated in the literature. There are many instances, in the literature, however, that one of these two terms is at times used as an assertion for the other, without any clear definitive distinction. This research thesis concurs with the views expressed by Amidon (1997) who asserts that:

Data are elements of analysis. Information is data with context. Knowledge is information with meaning. Wisdom is knowledge plus insight. [Amidon, D.M., 1997:17]

This thesis will continue to explore this tripartite relationship: data, information and knowledge, with the hope of arriving at a set of concrete definitions and the relationship of these terms with each other. The research will take a very critical view of these terms, in order to derive our KM-BI model [cf. Figure 2.1 Model for KM-BI (from Campbell and Pellissier, 2000)]. This will be discussed in greater detail in Chapter 9, which proposes a grounded theory of KM. It discusses the various perspectives and metrics of knowledge and KM in organisations. A theoretical framework is developed as approaches for application techniques to make KM practical and applicable in the construction of knowledge bases in practice.

### **2.5.1 Data**

Conceptually, data is regarded, in the literature, as isolated facts, or their representations. In the case where data are the symbolic representations of numbers, quantities, variables or facts, then it is arguable that, for the purposes of this thesis, that data may be viewed as the basis for information and knowledge. From the foregoing, this research found congruency with the arguments of Kock, McQueen, and Corner (1997):

Data is a carrier of knowledge and information, a means through which knowledge and information can be stored and transferred. Both information and knowledge are communicated through data, and by means of data storage and transfer device and of system. [Kock, McQueen, and Corner, 1997]

This view is strengthened with the organisational viewpoint taken by Davenport and Prusak (2000):

Data is a set of discrete, objective facts about events. In an organizational context, data is usefully described as structured records of transactions. [Davenport, and Prusak, 2000:2]

### **2.5.2 Information**

The meanings and definitions ascribed to the term, information, are just as controversial. Information, the literature informed us, requires an understanding of the relationship between data and information. Information, conceptually, comes from relations or predicates about that data:

Data comes into the form of measurements... Information is a statement of fact about these measurements. [Applehans, Globe, and Laugero, 1998:18]

The role that people play in the provision, creation, and harvesting of information has also been defined:

Information is meant to change the way the receiver perceives something, to have an impact on his judgment and behaviour. It must inform; its data that makes a difference. [Davenport, and Prusak, 2000:3]

In particular the evaluation by people can make a difference in how the relationship between information and data is viewed:

Information consists of data passed through a person's mind and found meaningful. [Huang, 1998]

Davenport and Prusak argue that data becomes information when meaning is added to it. They identified several methods how such value may be added to data in order to create information. These are set out next:

- **Conceptualised** – we know for what purpose the data was gathered;
- **Categorised** – we know the unit of analysis or key components of the data;
- **Calculated** – the data may have been analysed mathematically or statistically;
- **Corrected** – errors have been removed from the data, and
- **Condensed** – the data may have been summarised in a more concise form. [Davenport, and Prusak, 2000:4].

Information viewed from the next level in the hierarchy, knowledge, is viewed as synonymous with explicit or coded knowledge.

### 2.5.3 Knowledge

The intuitive concept of knowledge may also be considered as information: “*Knowledge could be defined as information that has been combined with experience, context, interpretation, and reflection*” [Davenport, delong, and Beers, 1997:1].

The dividing lines between information and knowledge are, however, difficult to determine, since one does not usually assume that knowledge comes from information (for instance the reading of a book, does not in itself connote knowledge of the material therein) [Godbout, 1998]. The point being made here is that knowledge does not take place, generally, by means of the contents, but via the processing of the particular information. Alavi and Leidner (1999) summarised our point of view by positing that:

What we consider key to effectively distinguishing between information and knowledge is not found into the content, structure, accuracy, or utility of the supposed information or knowledge. Rather, knowledge is information possessed in the mind of an individual: it is personalized or subjective information related to facts, procedures, concepts, interpretations, ideas, observations and judgments (which may or may not be unique, useful, accurate, or structurable). [Alavi, and Leidner, 1999:2]

In this research a distinction is made between the processes of articulated or communicated knowledge and information, whether they can be viewed as cognitive knowledge. The literature seems to suggest that knowledge is information and does not have to be processed only through people. That is to say, “*Knowledge is information associated with a specified context and is processed by an intelligent component*” [Roepnack, Schindler, and Schwan, 1998].

The criterion of the context mentioned so far is that the definition of knowledge is the same as information in context, and the requisite understanding of how it should be used for effectiveness in the employment of business knowledge. The challenge here, in this thesis, is how organisations can successfully implement KM projects and practices. This being the secondary research question as set out in Chapter 1, paragraph 1.2.3. It is therefore understandably that one agrees with the following:

Knowledge is information in context, together with an understanding of how to use it. [Applehans, Globe, and Laugero, 1998: 18]

In considering the central role of people in business knowledge creation from information, the following processes have been proposed [Davenport, deLong, and Beers, 1997: 6]:

1. comparison of the information in different situations; actions;
2. estimation of the consequences of the information on decisions and
3. identification of information in different directions, given by relations; between different types of information; and
4. conversation, evaluation of opinions and definitions of the process of knowledge representation, and understanding the requirement or syntactical bindings of that knowledge to an objective reality of the organisation.

Tuomi (1999) also supports this view by asserting that:

Organisational information processing literature and much of the organizational decision-making literature adopts the associated idea of knowledge as representations of objective reality stored in memory. [Tuomi, 1999:2]

This view gives credence to our proposed model for KM-BI framework for the creation of a conceptual knowledge base for the representation of KM. Conceptually, support is found in the literature to strengthen the definitions given so far in this thesis, and acknowledgement from the following:

More specifically, the information we call knowledge is information that has been subjected to, and passed tests of validation. [Firestone, 1998]

So far, the research has evidenced and reviewed the close relationship between data, information and knowledge. The hierarchical structure resulting from these three metrics form the foundation of the modern organisation. The framework has a number of processes, which are the primitive components of these agents of KM. The value adding propositions of knowledge acquisition and representation require the right mix of both information and data. Applehans, Globe and Langer (1998) shared these sentiments, by taking the view that, “knowledge is the ability to turn information and data into effective action” [Applehans, Globe, and Laugero, 1998:18].

The definitions used so far in this research thesis, as supported by the literature, was the author’s attempt to posit the relevance of the various metrics on which (KM) rests. The context of knowledge is one of evaluated actions [Dorfman, 1997]. This action-oriented criterion of knowledge is on the intellectual premise that information, which informed knowledge (business intelligence), that is, is very descriptive in making decisions for competitive advantage. Understandably, the relationship between information and knowledge in their roles for both creating corporate memory and their predictive role in the decisions-making and strategic nexus of the modern organisation cannot be neither underscored nor overemphasised. The argument of the following authors is apropos:

While information is descriptive, that is, it relates to the past and the present, knowledge is eminently predictive, that is, it provides the basis for the prediction of the future with a certain degree of certainty based on information about the past and the present. [Kock, McQueen, and Corner, 1997]

Knowledge whether, informal or formal, at the social organisational level does not necessarily have to be universally accepted. The information, which informed this knowledge, only needs to

have credibility, and acceptance by members of the domain (knowledge environment) in question. Godbout (1998) indicates that information is converted into knowledge when it is accepted and retained for future use and decision-making. He contrasts the differences between organisational and common knowledge. These views are set out next:

Information becomes individual knowledge when it is accepted and retained by an individual as being a proper understanding of what is true and a valid interpretation of the reality. Conversely, organizational or social knowledge exists when it is accepted by a consensus of a group of people. Common knowledge does not require necessarily to be shared by all members to exist, the fact that it is accepted amongst a group of informed persons can be considered a sufficient condition. [Godbout, 1998]

It is clear that, one needs to differentiate between the knowledge that has economic value; from an organisational perspective, and pure knowledge that is common knowledge. The value of which, the common knowledge, depends on the information structures in the organisation for converting that knowledge into value. This is the, “*knowledge is information internalised by means of research, study or experience, that has value for the organization*” [Kerssens-Van Drongelen, de Weerd-Nederhof, and Fisscher, 1996: 214].

## 2.6 Knowledge Management – An Overview

In this research the term ‘knowledge’ is interpreted differently in the literature. Notwithstanding the fact, that is not a unique or singles all embracing definitive definition for the concept ‘*knowledge*’, it is appropriate to say, pointed by Denning (1998) that debates about the exact meaning of the term knowledge will continue for a long time as it has been for centuries:

Debates about the meaning of knowledge have continued for thousands of years, and seem likely to continue for some time to come. [Denning, 1998:4]

In this thesis, though, the use of the various terms and meanings derived from the literature, to place the term ‘knowledge’ conceptually into the application of organisational knowledge is relevant. The next sections review briefly the different aspects of this organisational knowledge, and its strategic evolution to ‘*knowledge management*’.

KM is nothing new. The concept may be defined broadly as:

the practice of adding actionable value to information by capturing, filtering, synthesizing, summarizing, storing, retrieving and disseminating tangible and intangible knowledge; developing customized profiles of knowledge for individuals so they can get at the kind of

information they need when they need it; and creating an interactive learning environment where people transfer and share what they know and apply it to create new knowledge. [Management Review, 1999]

Understandably, knowledge, knowledge workers, and KM are topics receiving increasing attention from a variety of disciplines, such as the life sciences, finance, manufacturing, management consulting. These issues are not new, however, because for hundreds of years, owners of family businesses have passed on their wisdom to their children, master craftsmen have taught their trades to apprentices, and workers have exchanged ideas and know-how on the job [Hansen; Nohria, and Tierney 1999]. There is an inevitable and incontrovertible movement from a post-industrial to a knowledge-based economy [Drucker, 1993; Davenport and Prusak, 1998; Tapscott and Caston 1993], while at the same time new technologies have emerged to better enable the management of knowledge [Lotus Development Corporation 1997, Ruggles 1997].

In this emergence of KM, KPMG Management Consulting (1998) takes the view that:

*Knowledge Management means a systematic and organised attempt to use knowledge within an organization to transform its ability to store and use knowledge to improve performance.* [KPMG Management Consulting, 1998:5]

and that this impacts the competitive power of the organisation. So,

by KM, we mean the strategies and processes of identifying, capturing, and leveraging knowledge to help the firm compete. [APQC Study, 1996: 7]

The systems used for harnessing the various components of KM must take into consideration the needs of the organisational processes and the requirements of the users – individuals of any such KM system. One is able, from the informed sources of the literature, that the specification of:

A system for managing the gathering, organizing, refining, analysing, and disseminating of knowledge in all of its forms, within an organization. It supports organizational functions while addressing the needs of the individual within a purposeful context. [Jackson, 1998]

Additionally, a more specific and business oriented definition of the use of KM deals with the techniques, strategies and “... the task of developing and exploiting an organisation’s tangible and intangible knowledge resources. Knowledge management covers organisational and technological issues” [Woods, and Sheina, 1998:7].

As KM has emerged as a management concept and tool, there are many different interpretations as to what KM means and how to best address the emerging questions, such as how to effectively

use its potential power [Davenport and Prusak 1997, Edvinsson and Malone 1997, Nonaka and Takeuchi 1995, Wiig, 1995]. These differing emerging points of view are influenced by a person's work experience, as well as their professional education and training.

It is arguable that anyone participating in the field of KM must understand that KM is an emerging discipline. As such there is no agreed upon industry standard definition of KM, nor is there a framework as to what the correct focus should be – whether on the individual or the enterprise. Larry Prusak, the executive director of IBM's Institute for KM believes that it should be neither, but instead be on groupings of people who share some common context, stories or passion around a subject. He refers to a grouping of this nature as “*a community*” [Hildebrand 1999]. It is important to understand that, like the management of knowledge, the facilitation of communities is not a new concept – just newly framed and enabled by new technologies, media, devices, and techniques. It will take time for these new capabilities to fully evolve and for their opportunities and effects to be fully understood.

## 2.7 Aims of KM

From the foregoing, it can be seen that there is a need for organisations to develop a set of broad aims and objectives for KM having agreed on a working definition of the concept. In this research, the view is accepted that one of the main objectives of KM is to make knowledge accessible and re-usable [O'Leary, 1998, March]. There is also a very close relationship between tangible and intangible knowledge resources as a central theme [Woods, and Sheina, 1998].

—Additionally, the author accepts that KM in any form requires a deliberate effort to utilise all the resources available to the organisation to harness its competitive advantage. It follows that another aim of KM is that:

Knowledge management is about using existing resources and skills more productively, but it is also about widening our perspectives, increasing the channels for the communication of information, and therefore increasing adaptively.[Woods, and Sheina, 1998:24]

The American productivity and Quality Center (APQC) study (1998) on knowledge management and the learning organisation takes the view that there are four basic objectives for employing practical KM initiatives in organisations. These are iterated as [APQC Study, 1998:9]:

1. exploring existing knowledge in the best possible way to make it more productive;



2. renewing the knowledge of individuals and enterprises based on internal and external learning processes to complement each other;
3. the individual or tacit knowledge into structural capital of the enterprise, which can be used to transform the organisation; and
4. the business strategy on the basis of existing core competencies and capabilities to be used for organisational transformation.

In order to achieve these objectives, enterprises use various instruments and interventions, focussed on:

- management style and leadership;
- organisational structures and rules;
- cultural issues, and
- IT enablers [APQC Study, 1998:9].

And, also concertedly,

On an individual level, the aim of knowledge management is also concerned with developing one's ability, that is, knowledge, in terms of 'expertise'. [Poitou, 1998]

This chapter explores the opportunities and constraints, present in the attempt to integrate IT, with KM, and suggest how organizations may manage their competitive BI, in the global, knowledge-based economy. Some of the reasons for the emerging interests in KM as a management practice will be discussed in the context that during the last decade, the basis for competition has started to shift towards how well knowledge and other intellectual assets are focused on reducing costs, increasing speed, and meeting customer needs. Additionally, other factors and trends, such as the new age of the BI economy, and the classification of information delivery systems, will be discussed in the context of their convergence to create an awareness of knowledge as an asset. These metrics will focus on the emerging virtual workplace and tele-computing practice as enablers for e-business.

### 2.7.1 Scope

In this regard, the author will discuss KM within the context of the approach involved in capturing the knowledge, the wisdom, and the value-added experiences of individuals within an organisation. The potential uses, features, and benefits of the current incarnation of KM are still being defined as more people and organizations explore this new form of communication and organizational learning [Walton 1989; Wiig 1995].

Consequently, in this chapter and the next the study will also suggest how organisations may use KM as their primary business competitive tool, given its current status of evolution. In this context, there is cognisance of the fact that knowledge is very mobile and it exists independent of space. According to Stephen Denning of the World Bank, one needs to create space where innovation can flourish. If one gets rid of all the space, one ends up with a dead organisation [Wah, 1999]. Notwithstanding this, however, many businesses are coming to recognize that knowledge is an invaluable asset, and not merely a fad, as were some 'foster children' of the management schools of the 1980s and mid-1990s, such as management by objectives (MBO), one minute management, total quality management (TQM), and BPR. Each of these was thought to be the answer for organizational success.

Guidelines will be offered in Chapter 3, on how organizations should manage their knowledge, and some of the current obstacles to the implementation of KM practices in certain organizations will be explored. The discussion will be on three strategic value propositions of the organization, namely:

1. The need to manage their staff members as assets, who add meaning to information;
2. The need to set up structures that allow staff members to gather and distribute information, but most importantly to convert that information into bottom-line income; and
3. The need to be in touch with, and responsive to, the needs of the customers of the organisations; they are the best, and final, arbiters of an organisation's actions.

This research proposes a model [cf. Figure 2.1 Model for KM-BI (from Campbell and Pellissier, 2000)] for creating BI through KM. This model will aid the discussion of some key questions and challenges, which can lead to a better understanding, and explanation of the current form of KM strategies being practised. The specific objectives and themes of this Chapter and the next, are on four dimensions (components) of KM and BI, namely [Lotus Development Corporation, 1995]:

- **Innovation** – finding and nurturing new ideas, bringing people together in 'virtual' development teams, creating forums for brainstorming and collaboration;
- **Responsiveness** – giving people access to the information they need, when they need it,

so that they can solve customer problems more quickly, make better decisions faster, and respond more quickly to changing market conditions;

- **Productivity** – capturing and sharing best practices and other re-usable knowledge assets to shorten cycle times and minimize duplication of efforts; and
- **Competency** – developing the skills and expertise of employees through on-the-job, and online training, and distance learning.

This model aids the understanding that KM contains at least the generation, the distribution and use of knowledge [Roepnack, A. Schindler, M., and Schwan, T., 1998]. This is against the perspective that KM as a broader concept, its focus and measurement include several strategic and operational dimensions:

- planning, controlling and controlling;
- organizational and technological; and
- cultural and employee-referred.

These four dimensions of KM , mentioned previously as innovation, responsiveness, productivity, and competency, set the scope of the different components of KM, which will discussed in more detail in Chapter 3. Here, however, 11 of the most frequent components from the literature:

1. identification of knowledge
2. evaluation of knowledge
3. acquisition of knowledge
4. development of knowledge
5. retaining of knowledge
6. editing of knowledge
7. classification of knowledge
8. storage of knowledge

9. distribution of knowledge
10. use of knowledge
11. transfer of knowledge

An understanding of the life cycle models of KM is a prerequisite if the full extent of the scope of KM is to be appreciated. The models recommended by Scheer and Markus (1999) are set out next:

- knowledge acquisition;
- knowledge presentation;
- knowledge transfer;
- knowledge use; and
- knowledge distance.

On a more technical level is the study of Alavi and Leidner [Alavi, M. and Leidner, D., 1999]. Information on the degree of the scope of KM and KM systems in practice is the basis of any KM initiative. Three basic aspects were identified:

- information-oriented;
- technology-oriented, and
- culture-oriented perspective.

In discussing these three perspectives of a KM initiative, one sees where managers with an information-orientated perspective associate KM primarily with easily accessible information, real time information, action-relevant information and filtered information, in addition, with concrete instances or objects like enterprise-internal yellow pages, and policy repositories. The second perspective (that of a technology-oriented perspective) stresses the purely technical aspects of the KM. In this perspective it is taken that:

... participants suggested that knowledge management was about information technology infrastructure, specifically, about the integration of cross-functional systems worldwide. [Alavi, and Leidner, 1999:4]

The objects or instances which are relevant here are the knowledge infrastructure such as intranets, search engines, data warehousing and data mining, management information systems, intelligently agents and multimedia systems and so on. In the culture-oriented perspective, the last perspective has as its focal point the experiential learning as well as the mental acumen and aptitude of the organization. The question, however, remains as to the technologies to be used for developing a formal knowledge system for KM. It is arguable whether expert systems are components of KM.

### **2.7.2 The Emerging Trend of KM**

As industry experience is gained, and academics and management practitioners continue to research this field, there will be increased understanding, and, in time, alignment with other areas of management studies and practice; however, today, this is not the case [Davis and Botkin, 1994; Drucker et al. 1997]. Anyone who consults in KM needs to be flexible and sensitive to different points of view, and must look at KM as an exploratory journey rather than as a set destination. It is a frontier of great potential value, most of which is unrealised to date, and much of which is currently hard to measure. To use the terminology and perspective of the Gartner Group, “it is also quite possible that KM is currently at the peak of inflated expectations and will soon plunge into the troth of disillusionment before rising again to provide sustained benefits” [Gartner Group 1999].

An organisation’s ability to function and prosper depends, in large part, on the knowledge and skills of its people, and on the knowledge base that it collectively develops and deploys. This knowledge base includes any information, however hard or soft, that contributes to the organisation’s operations and success: ideas, know-how, personal creativity, problem-solving ability, customer information, technical expertise, competitor intelligence and so on. The agility and impact with which the knowledge base can be leveraged depends on the quality of the knowledge system in place. Knowledge has become a commanding business issue for a number of reasons, including:

1. The shift away from capital assets as the basis for market supremacy in favour of knowledge-based intangible assets (also called the shift to the ‘knowledge economy’)

and likened in significance to the last major shift, from an agrarian to an industrial economy);

2. The emergence and convergence of a number of technologies capable of capturing, managing and disseminating vast quantities of information; and
3. The move towards the virtual organisation, where boundaries become blurred through the use of alliances, strategic partnerships and outsourcing relationships and in which the organisation's relationship with its people changes through new ways of working (such as remote and mobile working), making it imperative for organisations to manage and capture vital knowledge.
4. The realisation that knowledge can transform an organisation by moving it into new areas of activity. [Stadler 1999; Havens and Knapps, 1999]

Examples include Federal Express, the courier service, which – apart from delivering parcels – now sells systems and advice to organisations with complicated distribution and logistics problems, and Schiphol Airport Amsterdam, which sells its expertise in airport design to other airports internationally.

As markets become more competitive, more fluid and less predictable, so organisations are realising that their core asset – the reason that they will be able to continue to prosper in an increasingly uncertain and risky environment – is what they know, along with their ability to deploy it quickly and effectively for competitive advantage. Leading organizations realise that there are significant risks associated with not undertaking initiatives to manage their knowledge assets and processes now. These include [Drucker et al., 1997]:

- **Productivity and opportunity loss** – a lack of knowledge where and when it is needed in a useable format;
- **Information overload** – too much unsorted and non-targeted information
- **The ‘*knowledge is power*’ mentality** – the misunderstanding that sharing of knowledge will lead to a reduction of personal power;
- **Knowledge attrition** – according to some estimates the average organisation loses half its knowledge base every five to ten years through the turnover of employees, customers and investors;
- **Reinventing the wheel** – no standard processes for capturing best practices or lessons learned.

This is also true for nation states as well. Drucker et al., (1997) argue that:

"the only comparative advantage of the developed countries is in the supply of knowledge workers ... [which is the only] way for developed countries to maintain their competitive position in the world economy. This means continual, systematic work on the productivity of knowledge and the knowledge worker, which is still neglected and abysmally low". [Drucker, Dyson, Handy, Saffo and Senge; 1997: 22]

The implications are that knowledge needs to be understood, nurtured and requires a framework through which it may be enabled. Drucker et al go on to caution that:

knowledge constantly makes itself obsolete, with the result that today's advanced knowledge is tomorrow's ignorance. [Drucker et al. 1997:22]

The fact that this is a likelihood, in the foreseeable future has implications for those organisations operating in the knowledge-based economy of the twenty-first century. Hence, the overarching concern with knowledge and knowledge-workers dictates the strategic importance of ensuring that the right knowledge is available, to the right person, at the right time, in order for that organisation to maintain its competitive advantage. This is the context in, which an effective knowledge system is being proposed in Chapter 9.

### 2.7.3 Characteristics

The characteristics most frequently used to define KM, is that it represents an integrated aspect on the one hand of different processes. These processes include, the identification, administration and common use of knowledge are representation. Whilst on the other hand, different types of knowledge resources are included, particularly, both the explicit and implicit knowledge, or unstructured knowledge and structural knowledge metrics of the organization [Kim, 1999].

It is also the nature of KM to consider the meaning of co-operation, this applies both to the co-operation of employees at one level of the organization among themselves and to co-operation and collaboration between the management and the rest of the organization, at a different level [Harty, Fenner, 1998].

KM may be considered to be a very informal discipline. However, in terms of the context of technical issues it takes on a certain degree of formality. This classification is asserted by O'Leary (1998) very succinctly as:

KM is formal in that knowledge is classified and categorized according to a pre-specified – but evolving – ontology into structured and semi-structured data and knowledge bases. [O'Leary, 1998; March: 54]

Campbell and Pellissier (2000) suggest that ten questions arise from the foregoing, which when answered, will inform the direction and objectives of future research in KM. There is nothing mythical about this, but epistemologically, managers and researchers must answer the following fundamental questions in terms of how an organisation maps its KM efforts – its knowledge strategy to key aspects of its business strategy. These are:

1. What is knowledge?
2. How does it affect business intelligence?
3. What cognitive requirements and other limits are satisfied with the use of a global electronic KM network?
4. What media, devices, and techniques have emerged in the KM systems and what new capabilities do they allow?
5. What new ways of thinking will KM systems open up for us?
6. Are the traditional processes and methods of management adequate?
7. Which are the characteristics of KM networks that support or limit different types of cognition?
8. Where can the new opportunities for dialogue within KM systems best be applied?
9. How might one determine when it would be better to use synchronous or asynchronous tools?
10. How can the knowledge sharing dialogue best be enabled, supported, managed, and rewarded?

These questions will be discussed in Chapter 9. In their paper, Campbell and Pellissier (2000), suggest that answers to the above questions may also be seen as enablers for managing the knowledge of organisations in the knowledge-based economy. Their argument is supported by Neef (1997), who identified 6 strategies and techniques, which organisations may adopt in order to retain their competitive advantage. Taking cognisance of these strategies, answers to the above questions may be seen as enablers for managing the knowledge of organisations in the knowledge-based economy. These six strategies and techniques, as articulated by Neef (1997) are set out as follows:



**Knowledge-based strategy:** Organisations must rethink global strategy, continuously re-assessing the cost effectiveness of plant and labour locations, and organising their core competencies to take advantage of the opportunities of new markets. Additionally, they must focus on creating knowledge-based products, which complement the emerging electronic marketplace. This requires that they recast their value proposition to create corporate agility, responsiveness and competency, in order to take effective decisions aimed at improved productivity, and business intelligence. The mission critical decision here is that organisations' must develop a corporate strategy for competing in the '*New Age economy*' of knowledge-based business.

**Knowledge-based process planning:** Organisations must structure their core processes around the logical sequence of what needs to be known at each step of the product life cycle, rather than around traditional tasks and outcomes. This approach will utilise the collective knowledge of the organisation's intellectual capital and create process efficiencies and knowledge sharing opportunities. At the organisational level, knowledge process mapping techniques may be used with other business process improvement and group-based learning techniques to obtain significant cost savings, and process efficiency. The competencies so developed through this approach can be replicated through out the organisation to be re-used in problem identification and problem solution. The heuristics of this epistemology is based on the business logic, which resides in the corporate portal [cf. Figure 9.8 KM-BI] and creates and distributes the BI of the organisation. This model is introduced here, Figure 2.1, for preliminary review, and will be referenced throughout this research, but greater treatment will be reserved for Chapter 9, and represented in Figure 9.8.

**A Knowledge Sharing Culture:** This is perhaps one of the most important aspects of KM, as well as one of the most difficult. Notwithstanding this, however, organisations in the knowledge-based economy must strive to establish a KM framework [cf. Figure 3.3 Organisation Model for faculty is a knowledge system.] <sup>1</sup>, based on their value proposition and strategic intent for knowledge transfer, and collaboration. This approach will require the support of all levels of employees, and the communication of the organisation's knowledge-based action plans and strategies, shared values, visionary and strong leadership, and dedicated resources. On an organisational scale, it will necessitate the establishment of communities of practice among knowledge workers, aimed at encouraging the sharing of productivity-enhancing practices, new techniques, and lessons learnt from colleagues by

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<sup>1</sup>Organisation Model for facilitating a Knowledge System

means of tools and mechanisms such as knowledge mapping, and human networks.

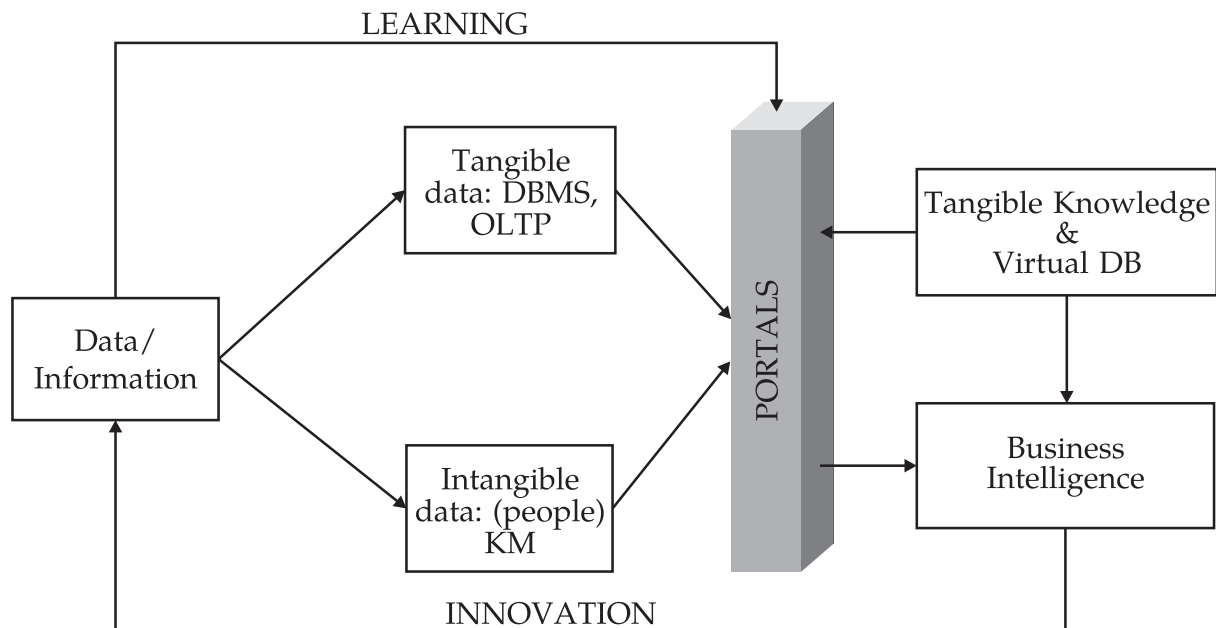


Figure 2.1: Model for KM-BI (from Campbell and Pellissier, 2000)

**A Technical Support Infrastructure:** Organisations need to take advantage of the new opportunities available in information and communication technologies in developing a technical infrastructure for transferring, creating, and organising information and knowledge. It was suggested in a recent Forester study (Neef 1997) that about 55% of all Fortune 500 companies were planning to develop knowledge webs, capable of delivering information to employees worldwide within two years. This infrastructure requires a strategic position in investment, as well as the standardisation of IT components, such as hardware, Groupware and communication equipment.

**Knowledge stewardship:** Organisations must develop techniques for organising and distributing corporate knowledge. Given the mission-critical nature of the task, as well as the opportunities for information transfer, value proposition and tools that organisations use in KM for identifying, capturing, organising, formatting and distributing information on their knowledge webs must be carefully developed. Figure 2.2 attempts to explain that in developing the value chain for a knowledge web, there must be dedicated resources and clear methodologies for submitting, organising and retrieving information electronically.

The approach can be described as a transformation process that takes the inputs (tangible and people data) and changes them into physical outputs, and virtual databases.



Figure 2.2: Value Chain for KM (from Campbell and Pellissier, 2000))

**Content and corporate memory:** Neef (1997) explains that many firms are finding out that KM entails more than just installing a knowledge web delivery system. Knowledge requirements must be identified, and properly defined and codified. Along with the development of taxonomies and delivery systems, information must be relevant and meaningful, so that it can be placed in the right context for the enrichment of the corporate memory, thus allowing the personalisation and reuse of the organisation performance information, key lessons learned, and sources of internal skills and expertise needed.

## 2.8 Summary

This approach must be seen in light of the continuing evolution of the digital society, where revolutionary progress has been made in solving several distinct knowledge capture and distribution limitations. Continued business research and analysis will help to inform and explain the complexities of the global marketplace and the use of IT in developing the global knowledge-based economy. Some have argued that the effect will be equal to or greater than that of the printing press [Provenzo, 1986]; yet, at times, it has seemed that the computer, rather than solving the problem, has only made it worse. Within this milieu, the modern discipline of KM has begun to emerge.

In general, KM may be thought of, as the effort to make the knowledge of an organization available to those within the organization who need it, where they need it, and when they need it, and in the form in which they need it, in order to improve the quality of human and organizational performance [Wah, 1999].

Organizations are now not only better able to distribute their best practices to everyone everywhere, but they can also better harvest improvements through these best practices from everyone everywhere. Two modern electronic technologies have merged to bring us the opportunities of KM systems of the present:

1. The strategic use of computer databases (which now have the capabilities to store enormous amount of information about an organisation's customers, clients, services, products, and even competitors' intelligence) aids the development of corporate Bi and
2. Networking technologies enable the movement of information, first within an office on a LAN, then across the world on WAN and through the networks that linked LANs and WANs together, including the virtually ubiquitous Internet.

The first efforts along these lines included electronic data interchange (EDI) and Electronic Mail. These were little more than the exchange of data and information. As specialists began to recognize the possibilities, new and more sophisticated software systems were developed, leading to what became known as collaborative systems and groupware, the leading current example of which is Lotus Notes. Knowledge capture and refinement capabilities, through electronic dialogue, are potentially greatly increased, along with the enhancements in knowledge distribution. Other important developments include the creation of hyperlinks and the development of the World Wide Web (WWW).

Currently, the technologies that underlie KM systems usually consist of some sort of electronic network supporting groupware or web technologies or some combination thereof along with e-mail [Lotus Development Corporation 1997].

There are two types of groupware tools. There are synchronous tools (for example, calendar and scheduling tools, electronic meeting systems, electronic whiteboards or data conferencing, and chat tools that allow two or more people to work together simultaneously, whether they are together in the same place or in different places. These tools enhance collaboration and make meetings more effective. There are also asynchronous tools that permit people to work together at different times (for example, e-mail, knowledge repositories, group writing and document editing tools, and workflow tools). In this case, it does not matter when or where a person is working. These tools replace meetings and make them unnecessary types of collaboration. Each tool has its place [Lotus Development Corporation, 1997].

These tools are the vehicles through which KM is used to empower the strategic decisions of organisations. In this regard, KM has two distinctive tasks, namely, to facilitate the creation of knowledge, and to manage the way people share and apply it. The manifestations of these tasks are found in the KM strategies that companies follow. The consulting business fraternity

generally Hanson et al., (1999) follows two very different KM strategies:

1. In some companies, the strategies are centred on the technology: knowledge is codified and stored in databases, where it can be easily accessed and used by everyone in the company. This is called the 'codification strategy'.
2. In other companies, the strategies are centred on the person - the knowledge worker; knowledge is shared through direct person-to-person interactions. Computer and the networking technologies are used to share and communicate knowledge, not to store it. This is called the personalisation strategy. The choice of strategy, is reportedly not arbitrary, but relies on the way the company serves its clients, the economies of its business, and the staff who provides the service [Hanson et al., 1999].

Whatever the strategy, there seems to be much confusion about the definition of KM. From a cursory survey of the literature it is suggested that there are four dimensions of KM:

1. The process of cognition
2. The type of knowledge (tacit or explicit)
3. The level of activity (individual, group or organisational)
4. The context in which knowledge is used.

The above are relevant where successful KM projects in organisations are achieved when information management and knowledge management are on the same continuum. The dividing line is the degree to which organisations manage their staff (people) resources and the information required by the organisation for competitive advantage. In recognition of this fact, organisations may be advised that the above dimensions may be used to define a framework on which their various key processes can be charted for current and future states of strategic momentum. This is the objective of Chapter 3.

There is much debate that KM is not feasible because it is invisible (in other words, it resides in people's heads), whereas management deals with those factors that are tangible and measurable. Larry Prusak (Davenport and Prusak, 1998) disagrees with this approach believing instead that, in general, organisations can make KM visible, and virtually tangible if they focus their strategic

intent on knowledge processes, outcomes and investments. Knowledge processes include the collaboration of knowledge workers networked in virtual teams, policy directives and information sharing by executives, and the business logic which link the automation of the business processes in a seamless infrastructure. Chapters 7, 8 and 10 corroborate these views from two different perspectives: in the case of Chapters 7 and 8, the components of KM are outlined from a process viewpoint as practised by organisations from both of the findings of the Survey Research. Whilst in Chapter 10, the findings from the Case Study (Action Research) at Directorate, and their effort in implementing a WMS of their HRM processes are reviewed and reported.

## Chapter 3

### Knowledge Management Strategies

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*Some people do not become thinkers simply because their memories are too good.*

*Anonymous*

#### 3.1 Introduction

In this chapter, some of the more important processes of KM which were found in the review of the current literature on the application of KM in industry will be presented. Since the designations are not uniform in the literature, the descriptions are to be understood not as generally accepted definitions, but as representation of typical views. There are considerable variations in the literature with regard to the applications of individual processes or activities, which may also be regarded as components of knowledge management. A working definition will suffice for now: "Knowledge Management can be described as the collection of processes that govern the creation, dissemination and utilisation of knowledge to fulfil organisation objectives" [Bawany, 2000:38]. Figure 3.1 depicts the main KM processes <sup>1</sup>:

<b>Creation:</b> (Discovery/Capture)
<b>Dissemination:</b> (Organise/Distribute)
<b>Utilisation:</b> (Share/Use)

Figure 3.1: Main Knowledge Management Processes [From Bawany, 2000:39]

This chapter begins with a review of the main KM strategies practised by most organisations by using Figure 3.1 as a template for the discussion of the KM processes of knowledge creation, dissemination and utilisation. These are discussed in section 3.2, where an outline of the definition of knowledge is given, as it is understood within the context of this thesis, and what it

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<sup>1</sup>Bawany, S. 2000:39.

means for this research in relation to the research question. The research problems are revisited, thus allowing a discussion of strategic significance of how these processes may be used to manage KM projects. This section ends with a summary of the main processes on page 84 [cf. Key considerations], where the details of the component of a Knowledge System is set out in sub-sections 3.2.1 to 3.2.15. These fifteen processes are grouped under the three main processes of knowledge creation, knowledge dissemination and knowledge utilisation, as outlined in Figure 3.1 as follows:

1. Knowledge Creation: identification, development, acquisition, sharing, and entry;
2. Knowledge Dissemination: storage, classification; location, filtering and preparation; and
3. Knowledge Utilisation: transfer, use, evaluation, retaining, and updating.

Having discussed the KM processes, and outlined the requirements for the development of a KM system, the author then will reviews the literature on the functions of KM. This is done in section 3.3. Here the researcher shall discuss the five fundamental functions for the development of a realistic KM system are discussed. These being: gather; organise; search, distribute, and deliver; collaborate; and refine. These components are the building blocks of any KM system, sub-section 3.3.1. In sub-section 3.3.2 the various KM roles in the organisation are identified and discussed. Here one shall identify nine such roles from the literature are identified: consultants, teachers, librarians, reporters, editors, oracles, critics, bards, and village gossips. The need for a properly specified KM system cannot be over-emphasized, but nevertheless, the definition of the roles of such systems must have some basic functionality. This is the brief of the section. Sub-section 3.3.3 deals briefly with the rules, and specification of a KM system. The present chapter looks at the four functional criteria for the classification of a KM system, as proposed by Jackson (1998), in sub-section 3.3.4. The chapter will then conclude by addressing the concept of the knowledge plan in section 3.4.

## 3.2 KM Processes

From Chapter 2 one may arrive at a realisation that knowledge can transform an organisation by moving it into new areas of activity [Stadler, 1999; Heavens G. Knapps, 1999]. In support of this view, is the research question of the present study, Chapter 1, section 1.1.1 which seeks



to find out “how are KM strategies enabled by the support of asynchronous groupware (AG) systems?” is against the background that KM strategies have been found to follow a process. For a clearer understanding of this process, it would seem that from the evidence at hand that any definition of the components of knowledge requires the articulation of knowledge in two ways: “the degree to which it is codified and the degree to which it is distributed.” [Hall, and Andriani, 1999:45].

The analysis to follow will use the term KM in this research to mean “... *the practice of adding actionable value to information by capturing, filtering, synthesizing, summarising, storing, retrieving and disseminating tangible and intangible knowledge. [It also covers the development] of customised profiles of knowledge for individuals so they can get at the kind of information they need when they need it. [Additionally, this includes] creating an interactive learning environment where people transfer and share what they know and apply it to create new knowledge.*” [Wah, 1999:16]

In this regard, KM is viewed as a process. It is the process through which organisations create and use their institutional or collective knowledge. It has three sub-processes:

1. Organisational learning – the process through which the organisation acquires information and/or knowledge;
2. Knowledge production – the process that transforms and integrates raw information into knowledge which in turn creates BI, and is useful to solve business problems, and;
3. Knowledge distribution – the process that allows members of the organisation to access and use the collective knowledge - corporate memory of the organisation.

The question one may ask is how does this inform the concept of a knowledge system? In the context of the present study, a ‘knowledge system’, means the web of processes, behaviour and tools which enables the organisation to develop and apply knowledge to its business processes. It includes the infrastructure for implementing the KM process. There are usually two components here:

Firstly, there is a robust IT infrastructure (database, computer networks, and software). The study is not advocating just a good or popular relational database, or a sophisticated groupware, or email system.

Secondly, there must be an organisational infrastructure. This includes the soft characteristics of the system. There are incentives schemes, organisational culture, critical people and teams which are involved in the KM sub-processes. This also accounts for, most importantly, the internal rules that govern these sub-processes.

In this framework, one should think of data as information devoid of context. Information is data in context, while knowledge is information with causal links. So within the logic of the knowledge system, the more structure that is added to a pool of information, the easier it will be for one to achieve the benefits of a knowledge system – see the portal of the model [cf. Figure 9.1 KM – BI Model].

In this regard, the definition of a meaningful KM initiative should be aligned to the enterprise strategy. This would therefore mean the development of formal KM strategies, from which realistic and concrete goals can be derived. Hall and Andriani [Hall, R. and Andriani, P., 1999:45] identified four types, or states of knowledge, which may be used in deriving such an alignment of corporate strategies with KM projects. These are:

1. Undistributed tacit knowledge: ‘personal knowledge’;
2. undistributed explicit knowledge: ‘specialising’;
3. distributed explicit knowledge: ‘protocols’;
4. distributed tacit knowledge: ‘embedded’, and
5. routines. [Hall, and Andriani 1999:45].

The secondary research question, in this thesis, is concerned with ‘how can organisations successfully implement knowledge management projects and practices?’ [cf. 1.2.3]. The formulation of a KM strategic framework, whether to a limited scope or informally, should nevertheless be made in order for the enterprise to successfully manage the processes involved in knowledge creation. Insights on how these processes may be used to manage knowledge projects and initiatives are evidenced by Hall and Andriani [1999:46]:

1. Tacit knowledge may be ‘externalised’ by maintaining a record, or inventing a code – Ravel<sup>2</sup> writing his manuscript;

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<sup>2</sup>Ravel – the 19th. Century Composer

2. Codified knowledge may be ‘distributed’ in books, by intranets and extranets, etc. – Ravel’s publisher distributing his sheet music;
3. Explicit knowledge may be ‘internalised’ by a process of learning by doing; when this has been successfully achieved the knowledge has become second nature, for example, an expert musician playing Bolero<sup>3</sup> without sheet music;
4. Tacit knowledge may be communicated and enhanced by a process of ‘socialisation’ which involves shared experiences – for example the author, who cannot read music, (my life’s goal, though, is to be able to do so) can nevertheless acquire knowledge of Bolero by hearing it many times;
5. Substitutive knowledge may replace old knowledge that has to be unlearned; this is described as ‘discontinuous learning’ – for example moving from a western musical convention to an eastern musical convention. This can be a painful process if the old knowledge that has to be discarded represents a significant personal investment [Hall, and Andriani, 1999:46]).

The understanding of these processes and how they are implemented is the basis for a knowledge definition protocol. The knowledge definition protocol sets the foundation for the formulation of the goals and strategies for the development of projects and the effective management of those projects. The knowledge definition protocols will also serve to explain varying expectations that project managers have, and differing interpretations of the procedures and scope of the knowledge management projects. Proper definition will prevent contradictory concepts from a very early stage in the KM project life cycle. During this life cycle, project managers may return to the protocols of the knowledge requirements to ascertain which methods and technologies were identified for use within the knowledge spectrum. Project evaluation and assessment are attained; in that, from time to time, the defined knowledge practices and protocols may be reviewed.

The literature differentiates between knowledge practices on the normative, the strategic and the operational level. There is a close relationship between these practices and the processes of knowledge in regard to knowledge:

Saltar Bawang asserts,

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<sup>3</sup>By Ravel, 1928.

... knowledge management is a multifaceted discipline that requires culture, process and technology to work together on a large scale. As a result, knowledge management is an evolutionary path for almost all companies. [Bawang, 2000:38]

In this knowledge process framework he, Saltar Bawang, identified five key elements of the knowledge management process, which organisations must follow in order to create a sustainable competitive advantage for the future. Our secondary research question as framed, earlier on, in this chapter and Chapter 1, section 1.2.3 was asked to seek answers as to the metrics behind these elements, with goals to:

1. Provide the firm with all the necessary knowledge regarding its industry, business, economic and competitive environment on a continuous basis;
2. assist in the formulation of competitive strategies that successfully positions them for the future;
3. assist in creating an appropriate business, organisation and information system design that integrates and complements their strategic direction;
4. assist in the implementation of their strategic and operational plans, and
5. develop a methodology to monitor and examine their progress and enable them to quickly respond to changes in the business environment [Bawang, 2000:3].

In the next fifteen sections: 3.2.1 to 3.2.15, these processes as tabulated in Table 3.1, are discussed in more detail..

Table 3.1: Relationship between Knowledge Practices

Knowledge Creation	Knowledge Dissemination	Knowledge Utilisation
<ul style="list-style-type: none"> <li>• identification</li> <li>• development</li> <li>• acquisition</li> <li>• sharing</li> <li>• entry</li> </ul>	<ul style="list-style-type: none"> <li>• transfer</li> <li>• use</li> <li>• evaluation</li> <li>• retaining</li> <li>• updating</li> </ul>	<ul style="list-style-type: none"> <li>• storage</li> <li>• classification</li> <li>• location</li> <li>• filtering</li> <li>• preparation</li> </ul>

Source: [Adapted from Bawang, 2000]

### 3.2.1 Knowledge Identification

Knowledge identification is not necessarily detecting knowledge that is already available in the firm's information inventory. This process will often require both the use of data processing

systems and will also require the assistance of people with specialised and technical expertise. In particular, statistical methods and artificial intelligence can be used to identify measure, evaluate and harvest the requisite knowledge of an organisation.

Knowledge identification differs from data mining on the one hand; identification of knowledge is not only concerned with the management of data, which are of crucial importance to organisations. On the other hand, knowledge identification does include, to a large extent, the technical aspects of classical data mining and the automated extraction of knowledge from text and other data and information sources.

### **3.2.2 Knowledge Development**

Knowledge development involves not only the functions of knowledge production in the formal sense of the concept of the development of a process or a product or service for consumption in terms of the commercial milieu, but it also includes the performance metrics of an organisation. This is in the context that KM "is a conscious strategy of getting the right knowledge to the right people at the right time and helping people share and put information into action in ways that strive to improve organisation performance and achieve the organisational objectives" [Bawang, 2000: 40].

The present investigation is not saying that the development of knowledge development and knowledge creation initiatives, in the physical sense, in the organisation's R and D department is not important. One is arguing that the processes used in the investigation and communication of that knowledge is more important than in the context of product creation and production. The generation of new ideas, abilities and products (of course) must be considered in addition to the other innovative processes of the enterprise. A central role of knowledge development is the promotion of creativity and communication among employees through the integration of enabling knowledge sharing strategies and an appropriate collaboration framework.

The presence of an appropriate organisational culture is a prerequisite for successful knowledge development. The analogy is like the role played by technological devices and tools within the spectra from telephones and whiteboards, to videoconferences and groupware, but more specifically asynchronous groupware.

Nonaka and Takeuchi (1995) argue that knowledge development is based on the interaction of

implicit and explicit knowledge as the basis for the generation of new knowledge. Also, from the literature, Ikujiro Nonaka specified a model for organisational knowledge development, which he calls the spiral of knowledge in his article in the Harvard Business Review ‘The knowledge creating company’ [Nonaka, 1991]. This model will be presented in Figure 3.5, section 3.7.

### **3.2.3 Knowledge Acquisition**

In contrast to knowledge development is the process of knowledge acquisition, which looks at the integration of external knowledge in the enterprise. This integration is by means of recruiting knowledge workers, specialists with particular value adding expertise, who usually bring relevant experience to the enterprise to assist it to meet its strategic objectives. The period over which this method of knowledge acquisition is used can be for different life cycles, ranging from permanent to project specific duration.

### **3.2.4 Knowledge Sharing**

Apart from the development of new knowledge in the enterprise and the acquisition of knowledge from external sources, the knowledge that employees already have should not be ignored. In practice it is found that most employees find it rather difficult to share their knowledge with each other. The problem is due in part to the nature of the organisational culture, or sometimes, to the modes of operation, in terms of how they synchronize with or co-ordinate with the KM efforts.

If employees espouse the “knowledge is power” mentality, then, there will be a conflict between their personal interests and the interests of the enterprise in knowledge sharing. An organisational structure, which is favourable for sharing knowledge, must develop a perspective, which does not let this conflict grow out of control. Knowledge sharing must be understood as a natural part of the organisation business (work), and strategic landscape, in the development of a KM strategy.

On the part of management, it should not only be through lip service but there should be commitment to the KM strategy. It cannot be expected that employees will share their knowledge, if, say, the time, which is needed for it, is evaluated as being unproductive. The management has to, therefore, make provisions in the organisational basic conditions of operations in order

to accommodate this cultural change. The approach will be one that begins with the basic conditions, which provides for the individual employee to have the requisite time for sharing his knowledge, and also where necessary the introduction of not-financial incentive systems as motivation for knowledge sharing.

It is to be understood that knowledge sharing is not only achieved through direct communication. It may take place over a cup of coffee or in a formal session. The concern here is when it takes place where employees enter the knowledge in an information system. A substantial aspect for the motivation of employees to use the system depends on the efficiency and the user friendliness of this system.

### **3.2.5 Knowledge Entry**

The acquisition of knowledge from external sources can be entered in a knowledge repository, in order that the organisation may have centralised access to it. A part of this work can take place without the participation of many employees through available information inventories in the repository one operates, which becomes embedded into context knowledge; that would be a direct form of integrated knowledge development and knowledge entry in the repository.

This usually requires the capturing of information and corporate memory from the knowledge within the organisation. This knowledge may be either structured or unstructured. The unstructured knowledge may take the form of the contents of discussion or idea which are generated from employees' interactions, while the structured form of knowledge may take the form of marketing reports or customer profiles. Additionally, the integration is aimed at knowledge from external sources, as soon as, it becomes accessible to the organisation.

The entry of knowledge into the enterprise may be through employees themselves in an informal manner, or it may be by way of a formal and structured process using a specially designated officer whose responsibility it is to harvest and capture organisational knowledge and BI (i.e. corporate memory).

A prerequisite for a successful knowledge harvesting programme is one which is driven by the latent barriers to knowledge sharing will be managed and co-ordinated by them. The role of the enterprise in this process is paramount to the very success of such a programme. If the enterprise does not recognise and reward the performance of employees for their participation in

this process, the input of its knowledge into the system (the knowledge responsibility) the whole process will most likely fail. The responsibility will have no future. The ideal integration process of knowledge harvesting with the other business processes of the enterprise should be one where the involvement of employees are viewed as a normal part of the business of the organisation.

The decision is to be made between the knowledge that one would like to enter, and the knowledge whose entry would in the long run be considered uneconomic, must also be considered in connection with the decisions in terms of the filter mechanisms being used. The organisations must also decide which types of knowledge provide the highest potential value in terms of measuring the degree of employees' participation in the process of knowledge harvesting. Likewise, the decision must be made to determine, which knowledge is to be harvested, if possible, in real time, and that which is not so time critical.

### **3.2.6 Knowledge Storage**

The storage of knowledge can use many different media. Explicit knowledge is held on paper. However, for some other types of knowledge, it is more suitable on different forms, models or prototypes, depending on the scope of use.

The flexibility, which computer-based systems offer and the utility of their application for storage is the challenge for most organisations. In the conventional information management system, the storage of knowledge, is still of greater importance in terms of the relations between individual objects, the advantages of computer systems and their application. Suitable hardware, software, data formats, on so on, is of course to be determined.

Knowledge storage can also be person to person motivated, that is, at a tacit level where it is stored in the heads of the employees, depending on the application of that knowledge. That involves not only the specialised knowledge of individual experts, but also all types of knowledge, which only come from the basis of the organisation culture.

### **3.2.7 Knowledge Classification**

The classification of knowledge, on the one hand, is to facilitate the subsequent application of the knowledge, which resides in the organisation. On the other hand, it is to facilitate the



development of taxonomy of the knowledge inventory, whilst on the other, it is the development of search engines for navigating and searching the knowledge repository of concepts, best practices and so on, which is the basis of such a classification.

The basis of the criteria the knowledge classification takes depends primarily on the selected applications. Nevertheless, it should be considered that the degree of classification is a factor of the amount of expenditure commitment of the organisation. It is advisable to use classification models and metrics, which are suitable for the planned applications to be used in the organisation.

### 3.2.8 Knowledge Location

The two most common forms used for locating and finding knowledge in an organisation with any computer-assisted knowledge inventory are the search and navigation archetypes. Both are very broad terms, which cover a multiplicity of different methods and technologies. They involve instances of full text, meta-data, standardised keywords, concepts and semantically used terms. Navigation can take place, for example, by hierarchies, graphs or other templates (Knowledge Maps)[Bawang, 2000].

Knowledge location can also occur directly between people. The use of the telephone was one such utility of locating knowledge, for a long time before the introduction of information systems as a natural agent for enabling organisational archiving, storage, data-mining, exchange of information, and data-warehousing. Nonaka (1991) argues that the managerial roles and responsibilities, organisational design, and business practices are paramount in the knowledge-creating organisation. He explains that the approach that puts knowledge creation “at the very center of a company’s human resources strategy” (p.97). As a consequence of this, he asserts, “...an individual’s personal knowledge is transformed into organisational knowledge valuable to the company as a whole” (p. 97). The view he takes is that “making personal knowledge available to others is the central activity of the knowledge-creating company. It takes place continuously and at all levels of the organisation” (p. 98). The coding of such information and data may facilitate the mediation between experts and other such agents. The challenge here is how to code this knowledge and replicate it for general use by everyone. The answer is found between the classification of explicit and tacit knowledge. This classification was discussed in the previous section, and will be further revisited in section 3.7 – the knowledge journey.

There is a combination of experts and information technology for the purposes of knowledge location, in the form of computer-assisted expert switching systems. These can go far beyond simple employee directories with business processes and descriptions of work. The contributions of individual employees can be analysed automatically in the enterprise knowledge repository, their electronic communication by email and discussion forum, this being one of the briefs of the Asynchronous Groupware component of this research as well as their interactions with other employees, such as cooperation and collaboration on projects and attendance at professional and technical conferences.

The quality of the knowledge location infrastructure, and the methods used for evaluation, must be judged not only by its effectiveness, but also by its efficiency. The following questions become pertinent [Zack, 1999]:

1. How long does it take to search for relevant knowledge?
2. which costs, in particular running costs, affect the individual methods?

The costs must be seen in relation to the use from the application of that knowledge, which the enterprise anticipates to derive benefit. Finally, in larger enterprises, solutions will be employed which use both computer-assisted and human components. The balance between these will be handled differently depending on the organization in question.

### **3.2.9 Knowledge Filtering**

An obvious function of KM is to protect employees from too much irrelevant knowledge, which at times overwhelm and prevent them from making the right decisions about the right kind of information. Knowledge filtering facilitates this process, which segregates irrelevant data, information and knowledge through the source of organisational knowledge catalogues. The filtering of knowledge should be both adapted to the respective employee, that is, his/her function and his/her state of training, as well as through the special context, of the knowledge needs, say of the particular organisation projects.

The prerequisite for any meaningful knowledge filtering system is the direct passing on of knowledge between people in such a way that the knowledge carrier has an intimate knowledge of the knowledge catalogue [Zack,1999].

### 3.2.10 Knowledge Preparation

The challenge here is to decide how knowledge is to be offered to employees; in terms of the best form the presentation of that knowledge should take. Information systems offer a set of possibilities for presenting knowledge objects in a context and of developing networks with other knowledge inventories, through cross references, lists of new publications, summaries and presentation of information within a reference system from which knowledge classification takes form [Zack, 1999].

The editing should take place dynamically for each user at each point in time. This can mean a significant expenditure in processing infrastructure. In order to keep this expenditure within acceptable limits it is advisable to co-ordinate knowledge storage, internal formats used in the repository with the desired output formats.

If knowledge is passed on directly from people to people, knowledge preparation, apart from expertise, requires a strategy of how to effectively communicate the need for using knowledge within the organisation. An expert should be used to develop a knowledge catalogue.

### 3.2.11 Knowledge Transfer

The term, knowledge transfer, is conceived sometimes so broadly that it also contains the concepts of the processes mentioned so far, namely, classification, location, filtering and editing of knowledge. The definition of knowledge transfer, deals with the general aspects of the process of the distribution of knowledge [Zack,1999].

The transfer of explicit knowledge proves in most cases to be easier than that of implicit (tacit) knowledge, but the occurrence of this is not widespread. Explicit knowledge can be distributed, for example, in the form of documents, which can be more easily distributed and replicated. The passing on of implicit (tacit) knowledge however requires, in the main a more complex procedure, and depends on the medium of transfer, and the attitude and receptiveness of the transferee and the transferor of that knowledge.

At the organisational level, both the transfer of specialized knowledge and the transfer of knowledge, in general, through the processes of the organisation portal, intranet and knowledge bases are of major interest.

### 3.2.12 Knowledge Use

Knowledge use deals with the actual purpose of KM in the organisation, and the application of knowledge in the everyday life of the organisation. It focuses on how to identify and overcome problems attributed to the use of organisational knowledge. A well-known barrier to knowledge use is how to ensure that good quality knowledge is available, and the perception that employees have about the quality of organisational knowledge. Approaches that may be used are that during the knowledge entry phase, the source should always be entered and integrated into the knowledge repository during the knowledge preparation phase, in order to facilitate knowledge presentation, and use [Zack,1999].

It is important to be aware of the expectation and attitude, which employees have about the knowledge to be used in the organisation. A successful ‘knowledge use’ strategy will be difficult to achieve, if the quality of that knowledge does not correspond to the expectation and attitude of employees.

The successful use of knowledge depends on the conversion of tacit knowledge into explicit knowledge. Nonaka (1991:100) calls this finding a way to express the inexpressible. He advocates that the answer lies in the use of the store of figurative language and symbolism that managers can draw from to articulate their intuition and insights. He further suggests that the metaphor was one such kind of figurative language, which could be so used. He cautioned, however, that “metaphor” in this context did not mean just a grammatical construct, structure or allegorical expression. He defines a metaphor to mean:

... a distinctive method of perception. It is a way for individuals grounded in different contexts and with different experiences to understand something intuitively through the use of imagination and symbols without the need for analysis or generalisation. Through metaphors, people put together what they know in new ways and begin to express what they know but cannot yet say. As such, metaphor is highly effective in fostering direct commitment to the creative process in the early stages of knowledge creation [Nonaka, 1991:100].

Metaphors may be used as a construct to make KM strategies practicable. The use of metaphors, can successfully be applied in making tacit knowledge explicit, by merging two different and distinct areas of experience into a single, inclusive image or symbol, according to Nonaka (1991). He asserts “... what linguistic philosopher Max Black has aptly described as ‘two ideas in one phrase’ ” [Nonaka, 991:101].

Metaphors establish a connection between two things that seem only distantly related, by setting

up a discrepancy or conflict. In the use of metaphoric images there are multiple meanings, which appear logically contradictory or even irrational at times, but in this framework lay the strength of metaphors as a construct for knowledge use. The process of resolving any ambiguity or conflicts in the metaphoric construct helps organisations to make tacit knowledge explicit. This is the role of knowledge use in enterprises.

### 3.2.13 Knowledge Evaluation

The term knowledge evaluation is used here with two different meanings.[Zack, 1999]. On the one hand, it deals with the evaluation of the success of the knowledge management initiative in the organisation; this means the comparison of the status quo with the knowledge goals and strategies defined in the first phase. Any deviations are used to modify or formulate new strategies for the future, with regard to the problems identified. On the other hand, knowledge evaluation deals with the measuring and evaluating of knowledge as it relates to IC will be discussed in greater details later on in this thesis.

### 3.2.14 Knowledge Retaining

The process of the knowledge retaining begins with the decision by management as to which knowledge is to be retained. This is the knowledge which creates value for the organisation, and which can be codified in such a way that it can be archived, and which also allows easy access. This knowledge should be retained at all cost. Regardless of the KM strategy, which the organisation is following, whether it is a personalisation or codification one, "... the framework should be one which aligns its knowledge resources and capabilities to the intellectual requirements of its strategy." [Zack, 1999:136]

Zack (1999) identifies two dimensions, reflecting the degree of aggressiveness that the organisation should follow for its knowledge strategic framework. He described these as:

*"[T]he first addresses the degree to which an organisation needs to increase its knowledge in a particular area vs. the opportunity it may have to leverage existing but under utilized knowledge resources – that is, the extent to which the firm is primarily a creator vs. user of knowledge. The second dimension addresses whether the primary sources of knowledge are internal or external. Together these characteristics help a firm to describe and evaluate its current and desired*

*knowledge strategy.*” [Zack 1999: 136]

### 3.2.15 Knowledge Updating

The relevance of any KM strategy requires that there should be a robust knowledge system in place to allow for ease of access and the archiving of knowledge. Miklos Sarvary (1999:95) supports this view by indicating that while ‘information technology has played an important role in the recent emergence of the KM concept, it is important to realise that there is much more to KM than technology alone.’

He further asserts that: KM is a business process. It is the process through which firms create and use their institutional or collective knowledge. It includes three sub-processes:

1. Organisational learning – the process through which the firm acquires information and/or knowledge;
2. Knowledge production – the process that transforms and integrates raw information into knowledge which in turn is useful to solve business problems, and
3. Knowledge distribution – the process that allows members of the organisation to access and use the collective knowledge of the firm.

A KM system is the infrastructure necessary for the organisation to implement the knowledge management process. It includes – and for large companies critically depends on – a good IT infrastructure (databases, computer networks and software)[Sarvary,1999]. However, it is not simply a good relational database or a sophisticated e-mail system. In addition to information technology, it also includes organisational infrastructure: appropriate incentive schemes, organisational culture, critical people and teams involved in the knowledge management sub-processes, and, most importantly, the internal rules that govern these sub-process [Sarvary, 1999:96].

The KM system allows for real-time updating of knowledge within the firm. The absence of a KM system can result in the firm being inefficient and employees will spend much time replicating other employees work – the rediscovery of the wheel syndrome. A robust KM system will be of the form as is outlined in Figure 3.2.

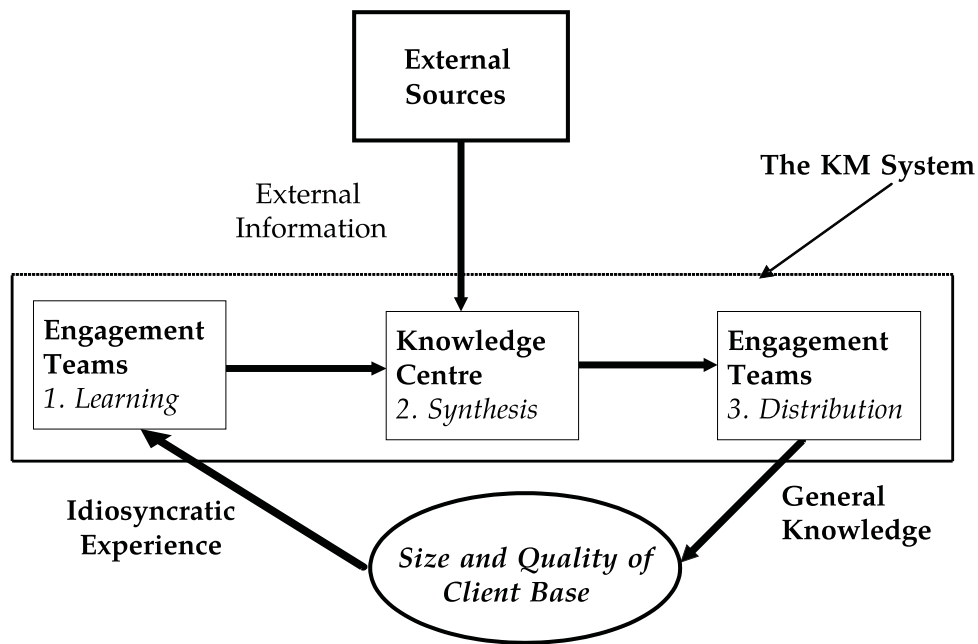


Figure 3.2: The knowledge system in the organisational context  
Source: [Sarvary, 1999:96].

### The knowledge system

A knowledge system is an “organic entity”. As such, it includes culture – in terms of values and behaviours; people – knowledge workers and the knowledge support organisational structures; processes and the content itself as well as technology-based tools - by so saying, one is here, focusing on the technology elements alone [Schwarzwalder, 1999]. The present analysis, takes the view in fact, saying that there is much more to knowledge systems than technology alone. Although it is arguable, it cannot be denied that IT has played a very important role in the recent emergence of the KM concept.

The inference seems to be that one must hasten, however, to clarify this concept, because of the plethora of mixed and varying definitions in the KM literature. The researcher concurs with the current thinking, however, that KM is indeed an oxymoron. “Knowledge Management” is a misnomer. From the evidence at hand, one is saying that knowledge cannot really be managed, neither can it be controlled. It can, however, be put to use. Karl-Erik Sveiby [Sveiby, 1997:31] acknowledges that the term suggests that knowledge is an object that can be handled like a tangible good. He further states that, that it is not, but rather that it is a human faculty. It is his belief that, the best way to change the organisational culture to one that is “knowledge-focussed” is through action. From the foregoing, one may conclude that the term “knowledge

management” is wrongly used, because it conveys the idea of control.

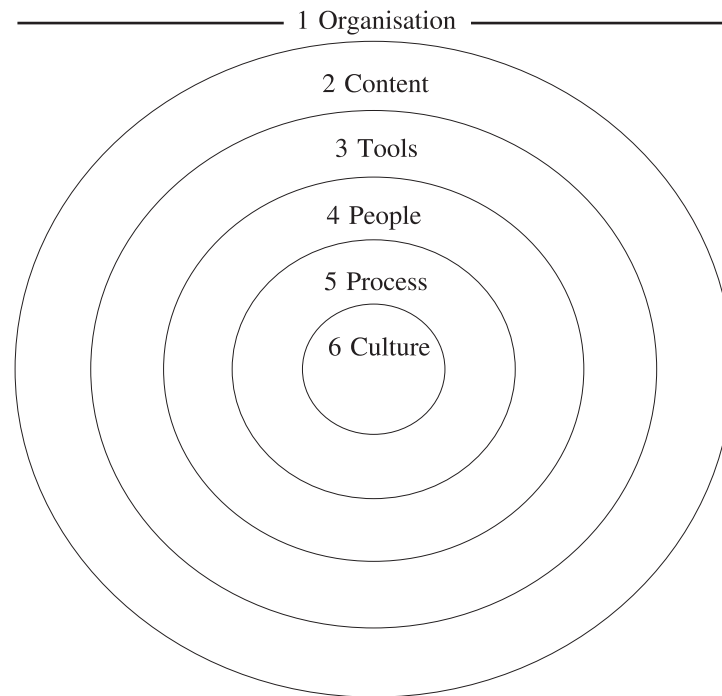


Figure 3.3: Organisation model for facilitating a knowledge system

Source: [KPMG Consulting: The knowledge journey, Business Guide to Knowledge Systems]

The reality of the “new economy” is that knowledge about one’s business is constantly evolving, and as such one cannot control it. One, however, can use it to create wealth, BI and competitive advantage. Organisations can implement systems and initiatives to assist in managing the knowledge that is important for their core business. This, of course, does not mean that they can manage the knowledge inside people’s head, but rather that, they can manage the infrastructure and work environment to facilitate exchange, flow and capture what people know [cf. Figure 3.5. Stephen Denning of the World Bank says, “The term is misleading, because you cannot manage knowledge any more than you manage love or friendship or religion. On the other hand, KM has come to me as an organic and more holistic way of sharing knowledge across organisational boundaries” [Denning, 1998]. His views have influenced the approach taken in this research.

This organic and holistic approach is the underlying theme of this research. Figure 3.3 is a representation of these views and seeks to illustrate how the main components fit together in the sharing of knowledge across organisational boundaries. The figure shows the central role of culture, how process links practice to learning, how individuals and teams work together to create and exploit knowledge into communities of practice, and where knowledge support services and repositories fit into this holistic framework.



Technology clearly plays an important role in enabling the corporate knowledge base to be available for all to access. The figure gives a simplified view of a complex picture that will, of course, differ in detail from organisation to organisation. This approach will be developed into a more robust KM and BI model in Chapter 9.

### **Key considerations**

In devising a knowledge system to suit the needs of a particular organisation the following issues must be considered [Spear and Bowen 1999; Hope and Hope, 1999; Sarvary, 1999]:

1. *A focus on key content*

What do you need by way of subject matter, from where should it be sourced, how should it be organised, how should it be managed and what form should it be in? The organisation must determine what information it needs to support its core business processes and implement business strategy. Information needs – for instance, the mix of technical, market and competitor information – will differ from organisation to organisation [Hope and Hope, 1999].

2. *Supporting and encouraging people*

What behaviours and skills does the knowledge system require of users and what benefits will it provide?

People and their responses are critical to the success of a knowledge system. Will the knowledge system improve productivity by reducing wasted time? Will it help with staff retention, for instance through reducing staff frustration, enhancing their skills and development, and providing a knowledge base that they will be unlikely to find elsewhere?

Consider the need to revise performance measurement, reward and appraisal systems in order to encourage new approaches to the collective exploitation of information, and to encourage ownership, contribution to and usage of the knowledge base.

3. *Knowledge support organisation*

An increasing number of organisations are establishing a professional team to provide knowledge support services and to develop KM initiatives. These may bring together existing functions such as the library and new functions such as ‘knowledge centres’, a subject-specific knowledge team.

#### 4. *Knowledge development*

Organisations need to develop knowledge repositories through which they can make the collective experience of the organization available to all personnel. This area is also concerned with improving the quality of the content available.

#### 5. *Knowledge application*

The knowledge system is there to support business operations, such as helping front-line staff in the field deal more effectively with customer situations. Lessons learned from applying the knowledge to these situations must be captured and fed back into the corporate knowledge base for others to access [Spear and Bowen, 1999]. Knowledge exploitation The ‘knowledge economy’ presents new opportunities for the trading of knowledge assets. For example, it is only in recent years that supermarkets have collected such large amounts of data about customer transactions (at point of sale) for marketing purposes. Capturing such information might have applications in other organizations and other industries.

#### 6. *Enabling technology support*

Many organisations have existing investments in networks, data and computing from which KM could help release added value. Technologies that are proving their worth in this field include intranet, groupware, document management, data warehousing and artificial intelligence [Sarvary, 1999:96].

#### 7. *Knowledge application*

The knowledge system is there to support business operations, such as helping front-line staff in the field deal more effectively with customer situations. Lessons learned from applying the knowledge to these situations must be captured and fed back into the corporate knowledge base for others to access [Spear and Bowen, 1999].

#### 8. *Knowledge exploitation*

The ‘knowledge economy’ presents new opportunities for the trading of knowledge assets. For example, it is only in recent years that supermarkets have collected such large amounts of data about customer transactions (at point of sale) for marketing purposes. Capturing such information might have applications in other organizations and other industries.

## Knowledge and Business Processes

The analysis to follow will be considered with how organisations compiled, stored, indexed, retrieved and maintained, their requisite knowledge and linking this knowledge into their business processes.

Processes link technology, people and applications. Even with the right technology in place, a knowledge system will not work if the organisation has failed to link the components together with the necessary processes. It is important that knowledge processes integrate tightly with business processes, and with technology processes, so that they become part of normal working practices [Spear and Bowen, 1999; Sveiby, 1996].

### 3.3 Functions

The present investigation will now focus some more on the applications of the functions of a computer-based KM system. At first the discussion, will be on the roles of such a system. Then follow with an analysis of the demands made on the organisation in building a robust knowledge center, as indicated in Figure 3.2. Finally, the discussion will focus on the categorisation of KM and how this knowledge may be efficiently distributed among engagement and work teams in the organisation.

#### 3.3.1 Functions of a KM System

Harty and Fenner [Harty and Fenner 1998] identify five fundamental functions of a knowledge management system:

- Gather,
- Organise,
- Search distribute and deliver,
- Collaborate and refine

The first component, Gather, refers to the technical aspects of the processes as set out in the processes of knowledge entry and knowledge storage. While with Organise, one is interested in

how an organisation can get employees to ‘buy-in’ to the benefits to be derived from the KM system. The functionalities of the system must be built around taxonomy that is both technical, from a knowledge classification perspective, but also incorporates the organisation’s culture. The third function corresponds to knowledge location, knowledge preparation and knowledge transfer. The technical base of a good KM system comprises knowledge sharing towards better communication efforts form the fourth component of Collaboration. The components of Refine are a factor of both the knowledge preparation and the knowledge identification.

The researcher also found that corresponding to the aforementioned components, Mentzas and Apostolou [Mentzas, and Apostolu, 1998] describe the functions of a knowledge management system

- Search, retrieval and navigation
- Indexing, mapping and classification
- Storage, analysis and metadata
- Distribution and publication, and
- Collaboration

There is much similarity between the knowledge components of a good KM system of Harty and Fenner and those of Mentzas and Apostolu. The first point, Search, retrieval and navigation, is similar to the third component of Harty and Fenner. It deals with the context of knowledge location. Total access to a KM system is based on the level of archiving, knowledge mapping which will provide a classification of a catalogue of knowledge repository. The second point deals with knowledge classification, and corresponds to the second component of Harty and Fenner. The third point addresses both knowledge storage and knowledge identification. Whilst the fourth point: distribution and publication deals with the technical components, facilities and resources of knowledge filtering and knowledge transfer, and is similar to those of Harty and Fenner’s first, third and fifth components, respectively. Finally, collaboration defines the communication components, which are also dealt with in point four of Harty and Fenner.

### 3.3.2 Roles of KM

The basic requirement of a KM system is that the system should meet the knowledge requirements of the organisation. There is however, no specific approach which can fit all industries. There are however, two different approaches that may be used in defining a generic knowledge system: bottom-up, decentralized KM systems; and top-down, centralised KM systems. Moreover, KM systems have different roles. One such example, from the literature, is that of Masterton and Watt [Masterton and Watt, 1999] who set out nine formal and informal metaphors/roles. These are Assistants, Matchmakers, Librarians, Reporter, Editors, Oracles, Critics, Bards, and Village Gossips.

The exact definition of the role of a KM system may be, at times, very abstract, and often subjective. The main issue, in this thesis is that, on the one hand, a KM system can easily fulfil several of the roles identified by Masterton and Watt (1999). On the other hand, however, it is with much difficulty, if not at all impossible that two systems, which do not fulfil the same roles on the level of their functionality to the users, can meaningfully function together.

### 3.3.3 Rules of a KM System

The rules, which a KM system must satisfy depends on several factors, for example, the intended purpose, the target user group, the available infrastructure and the organisational environment. Nevertheless, one can state some general rules, which may apply to almost all KM systems, which are recommended as best practice. Many of these rules apply also to other systems than to KM systems. There is also much difference in systems in the field of KM, where there are conflicting experiences about the context and the rules that should apply to a KM system.

The basic condition for the use of a KM system is that the system should meet the requirements of the organisation. It concerns the availability, security and backup systems. Furthermore, the system should be at the disposal of all users, be attainable and accessible. The quality of the user interface should make provision for a high degree of usability.

### 3.3.4 Classification

The classification of KM is categorised into four functional criteria by Jackson [Jackson, 1998]:

- Gathering
- Storage
- Communication
- Dissemination
- Synthesis

The concept of gathering in this classification includes search functions and all the knowledge entry mechanisms from manual inputs to optical character recognition (OCR). Under storage fall not only storage devices, but also filtering and the administration of cross-reference mechanisms, like those found in data-mining systems. Communication, in this context, defines the function of the groupware inclusive tools for collaboration and common decision-making. Under dissemination such tools and aids for the publishing of knowledge are considered, while the category of synthesis covers such systems as, those which deals with knowledge development or knowledge identification.

### **3.4 The Knowledge Plan**

The analysis to follow will focus on how organisations may go about developing a knowledge plan. The knowledge plan is a framework and the guiding philosophy of the organisation's strategy. It must review and analyse the firm's mission and objectives, organisational dynamics, knowledge assets, strategic approach, information systems and the operation plan. It must then determine and develop a knowledge plan that identifies what the critical knowledge needs of the firm are and how it should go about fulfilling that need. There are four facets to the knowledge plan. These are:

1. Knowledge of the business environment
2. knowledge of strategic thinking
3. knowledge of business design
4. implementation of KM.

The present study will now discuss these facets in detail next:

### **3.4.1 Knowledge of the Business Environment**

It must provide a solid foundation of the state of the business environment on a continuous basis to all the levels of the organisation. Its purpose is to assess and examine the competitive environment, the potential shifts in the industry structure, technology impact, and understanding of the economic forces that are shaping its business environment. It must also maintain a thorough understanding of the latest concepts, theories, models and issues on business, economics, management and strategy that may have a direct impact on their firm.

### **3.4.2 Knowledge of Strategic Thinking**

All businesses need to have strategies. The strategic model today is continuously changing. The KM group has the responsibility of assisting the firm to design and develop effective strategies. It must be able to provide a thorough but practical knowledge of the latest strategic thinking, concepts and analysis of real-world strategies of contemporary and competitive firms. It must bring the real world awareness to the organisation.

### **3.4.3 Knowledge of Business Design**

The implementation of strategy requires a complementary business design. Business design implies an appropriate organisation structure integrated with the firm's information system KM must facilitate the process of creating the right business model. It must evaluate and recommend different business models that allow the firm to create the best business model for its competitive position.

### **3.4.4 Implementation of KM**

Firms need to implement their strategies. KM must create methodologies to monitor and measure the business performance and recommend changes as and when needed. Business success depends on excellent feedback to the firm from its customer and the marketplace and transforming that feedback into knowledge that can be utilised by the firm to meet future challenges.

Every firm should have a knowledge resource library [Sveiby, 1996]. It is a reservoir of contem-

porary knowledge that serves as a foundation for knowledge acquisition. It must create its own collection of knowledge on relevant and contemporary business, management, economic, and strategic topics and issues.

Davenport et al. (1999) in their published research paper on “Successful Knowledge Management Projects” identify what might be likely success factors for an organisation wishing to build effective knowledge management projects. These are set out in Table 3.2. In conclusion, they state, “Effective knowledge management is neither panacea nor-bromide: it is one of many components of good management. However, when a business faces competitors that perform well on those other dimensions, the difference between success and failure may well turn on how effectively it managed its knowledge”[Davenport et al., 1999].

Table 3.2: Successful KM Projects

<ul style="list-style-type: none"> <li>• Link to economic performance or industry value</li> <li>• Technical and organisation infrastructure</li> <li>• Knowledge-friendly culture</li> </ul>	<ul style="list-style-type: none"> <li>• Clear purpose and language</li> <li>• Change in motivational practices</li> <li>• Multiple channels for knowledge transfer</li> <li>• Senior management support</li> </ul>
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There are other examples of known knowledge management initiatives which include Anderson Consulting’s Knowledge Xchange, Booz Allen and Hamilton’s Knowledge Online, CAP Gemini’s Knowledge Galaxy, Ernest and Young’s Center for business Knowledge and Monsanto’s Knowledge Management Architecture.

Lotus Corporation has successfully developed and implemented a KM model, which is illustrated in Figure 3.4 below.

### 3.5 Reshaping Competition KM

KM is a tall mountain to climb and may not be the right choice for many organisations. But for those who do get to the top, and for those who have to compete with them, KM will have long-term implications that will help innovative players reshape the nature of competition in their industries. Fuelling the increasing interest in KM is the continued growth of CRM, supply chain management and e-commerce, all of which leverage KM.

KM will be a critical source of acceleration for companies trying to keep pace with an ever-increasing rate of change in their business and competitive landscapes. At a time when companies



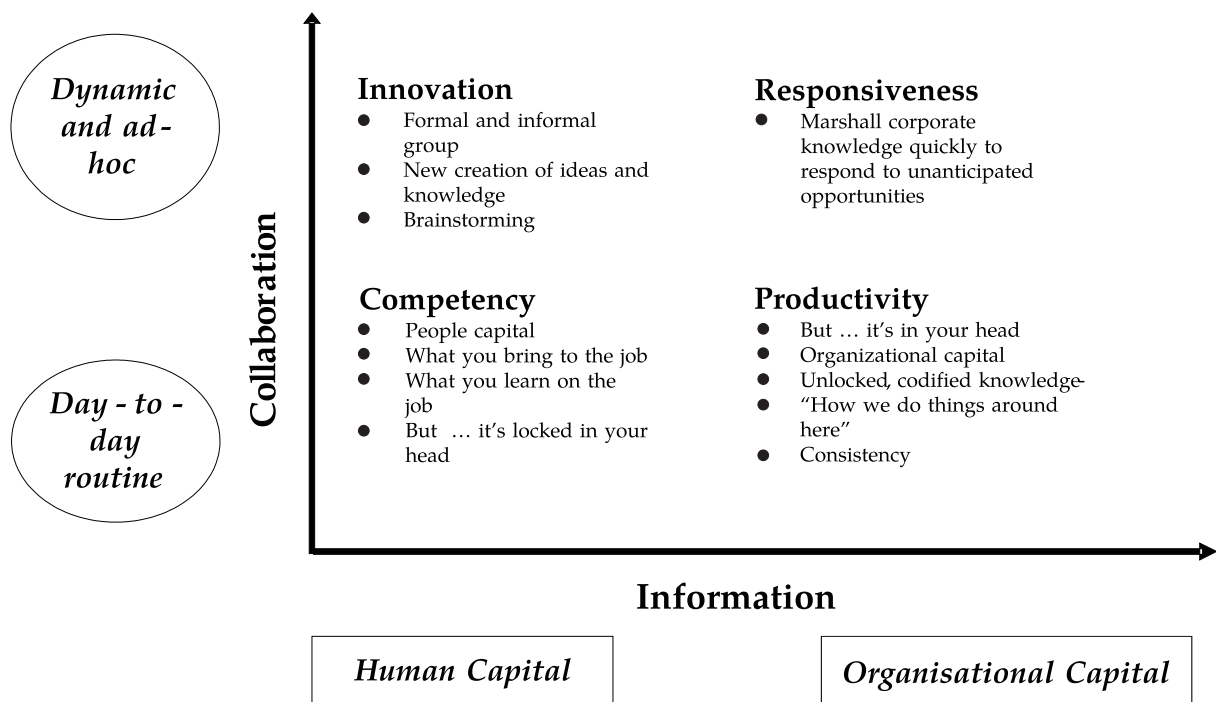


Figure 3.4: Lotus Corporation KM model for collaboration  
Source: Lotus Corporation, 1997

are creating and receiving new information in gigabytes and terabytes per second, the efficiency with which an organisation can access, assimilate and act upon change will determine its fate. KM is all about the assimilation of information on an organisation-wide basis, and therefore it can be ignored, scoffed at and misunderstood only at one's own peril.

The success of KM group depends on providing the best and the latest knowledge to the organisation on a regular and on-time basis. The benefits of KM function to the organisation are many. Some of the benefits are:[Davenport & Prusak, 2000].

1. Knowledge to successfully compete in the changing business environment;
2. ability to create and maintain competitive advantage at all times;
3. ascertain its long-term competitive position;
4. achieve meaningful and required performance results;
5. understand the contemporary knowledge to remain creative and innovative;
6. maintain a knowledgeable and skilled workforce, and
7. have the appropriate business organisation and people that can make it happen.

Every firm is responsible for its destiny [Lotus, 1997]. Davenport and Prusak (2000:17), basically support this view, from their assertion that,

Knowledge (sic), by contrast, can provide a sustainable advantage. Eventually, competitors can almost always match the quality and price of a market leader's current product or service. By the time that happens, though, the knowledge-rich, knowledge-managing company will have moved on to a new level of quality, creativity, or efficiency. The knowledge advantage is sustainable because it generates increasing returns on continuing advantages.

Hence, the evidence seems to suggest that knowledge is a key source of sustaining competitive advantage for the organisation, and as such should invest in it.

### **3.6 Technologies**

This section deals with some of the technologies, which can be used in the context of KM projects. These technologies are not necessarily characteristic of knowledge management; most of them have their roots in earlier developments. Also no claim on completeness is being made here, on the contrary the technical challenges, which occur in the context of KM, is commendable.

#### **3.6.1 Groupware**

There is no generally accepted definition of groupware. One definition, which is acceptable within the scope of this research, is provided next. This definition combines elements of three other definitions proposed by Johansen (1988), Ellis et al. (1991), and McQueen (1993), respectively.

Groupware is a generic term for computer-based systems, which are particularly used to support groups of people, engaged in common tasks in organisations. Typically, these groups are small; businesses oriented, and have relevant tasks with definite deadlines.[Johansen, 1988].

This definition is not restrictive in terms of the size of the groups that are supported by groupware. However, it states that typically these groups are small (i.e. from 5 to 20 members, for the purposes of this research). Small size is suggested in previous studies of small groups as the most appropriate for efficient and effective teamwork and collaboration [Wellins et al., 1991], who define small groups as ranging from three to twelve members in size). The improved efficiency of small groups is also supported by Shaw (1981) who has concluded that in general, regardless of task, context or group characteristics, the optimal group size is quite small, typically from

three to five members, because process losses quickly overtake any process gains from increased group size. While these assumptions reinforce the alignment of the term groupware, as defined here, with the search for optimal efficiency for group work, it is important to stress that they were generally based on the study of face-to-face groups.

The term groupware, is widely used in industry, and the emergence of a large number of software applications claiming to fall within its umbrella, has led to the development of taxonomies to classify groupware systems. In Chapter 4, the analysis will be on the applications used in groupware systems. This will include the definition of asynchronous groupware (AG), whose degree of availability to KM groups/communities of practice is the main independent variable of this research, and to proceed to a critical analysis of the pros and cons of this class of groupware over traditional non-groupware, and synchronous groupware interaction modes.

Additionally, one of the main goals of groupware systems is to facilitate collaboration and communication between groups of people over different places, space and time. This may be summarised as follows [Warner, 1996]:

1. Ease in communication between group members;
2. enabling communication between groups scattered geographically, in different places;
3. enabling new communication methods, such contact with strangers, and other people with diverse interests;
4. saving on travelling time, for meetings, conferences, etc;
5. ease of meeting in collaborating on technical papers, dialogue, etc. with colleagues and other knowledge sharing agents, and
6. ease in problem solving, and decision making.

Groupware usually provides electronic group calendars, electronic mail, and software that permit members in remote locations to have videoconferences. These functions, as will be discussed in Chapter 4, under the different taxonomies of groupware presupposed powerful electronic networks. The use of such applications as Lotus Notes, and Microsoft's workgroup, permit workers to share information and to create information sharing application [Warner, 1996].

From a technological point of view workgroup computing and workflow systems, will be discussed in Chapter 4.

### **3.6.2 Document Management**

Document management technologies support classical word processing, desktop publishing, document imaging, and workflow management. Document imaging systems store, retrieve, and manipulate digitised images of documents. The documents themselves can be discarded.

Document Management, the administration of documents is defined over its entire life cycle, and includes the creation of a document from its investigation, revision and includes the destruction of that document. As a result of this, higher productivity, shorter process times and better access to information will be achieved.

On a technical level, document management includes the entering, memory, searching, publishing and distribution of documents as well as the administration of security procedures such as restricted access, and data/information availability. Document management is akin to database systems where document management of systems deals primarily, to a large extent, with unstructured data such as files from text processing and spreadsheet analyses, pictures, audio and video, and other digitised data, et. cetera. Software solutions within the area of document management facilitate the common work of people with the same documents. In fact, two or more people can work simultaneously on the same document, work without being delayed because a file is out, and a document is in transit. Workflow systems automate processes such as routing documents to different locations, securing approvals, scheduling, and generating reports. With effective indexing, users can retrieve files based upon their contents [Warner, 1996].

### **3.6.3 Technology Options**

Many organisations already have the necessary technology in place, but are failing to use it optimally. Knowledge initiatives can help them to start realising real benefits out of their existing technology investments. The challenge to organizations is how to effectively leverage the competitive advantage that can be derived from technology and the related technological infrastructure. The three questions that are germane to this challenge are presented next:

1. Can the current technology deliver what the organisation requires in a user friendly way?
2. Can the existing technology be exploited further – are there quick wins that can be achieved?
3. What additional technology is needed and how should it be integrated?

The answers to these questions are confirmed by Miklos Sarvary [Sarvary, 1999] who argues that:

In economic terms, one might think of the KM process as a technology. The input factors of this technology would be raw information (e.g., individuals' experiences, data acquired from external sources). While the output is knowledge that is useful to solve (business) problem, KM is nothing else but a technology that transforms information into knowledge. The key difference between the inputs and output is that while the input factors are relatively devoid of structure, the output is highly structured. Knowledge is information plus the causal links that help to make sense of this information. KM might be seen as a process that establishes and clearly articulates such links. [Sarvary, 1999:96].

Knowledge technology does not necessarily have to be technically exciting or demanding, although it can be, given that advanced technologies and applications such as expert systems, intelligent agents, case-based reasoning and document summarisers are highly applicable to knowledge management needs. On the other hand, a great deal can also be achieved with more familiar technologies such as databases, data warehouses, and document management. It is the purposes to which technologies are put, and the commercial benefits that flow from them, that should really be exciting, as opposed to the technologies themselves. In other words, it's the knowledge, which results from the use of the knowledge that really matters. Sarvary further stated that, "Knowledge is critical for any firm and is often called the intellectual capital of the firm" [Sarvary, 1999: 96]. He also pointed out that this knowledge is gained from years of experience in such things as manufacturing, engineering, and sales. "This cumulative experience together with information gathered from outside sources, constitutes one of the firms' critical resources" [Sarvary, 1999: 96], he concluded. The basic concept of KM is not new. It is a generally accepted fact, that organisations have always had some process to synthesise their experience, and integrate it with the knowledge acquired from outside sources, such as inventions, purchased patents, among other things.

Given the foregoing, this is where recent developments in information technology will have an important role for the emergence of KM. It has facilitated the provision of new tools, which

organisations may use to better perform the activities of building knowledge capital. There are particularly, two important areas, which have contributed to the birth of modern KM systems. These are communication (or network technologies), and relational databases.

These tools assist organisations to think explicitly about their underlying business processes. So, as a consequence, they may start asking the following questions:

1. Where does information originate?;
2. What parts of the process can be or should be automated?;
3. Is the process as it stands today worth automating; or
4. Should a new process be built?

Answers to these questions will clearly demonstrate that what is new about KM is the act of being conscious about the existence of a KM process. Essentially, IT has a critical role in raising the consciousness about knowledge systems (KS), because its use requires the organisation to re-evaluate the entire KM process and its role within the organisation. This, of course, might lead to new business models and new ways to compete. Hence, KM and KS are perhaps the most critical processes within the organisation. What is critical is that all of these aspects should be in place and working together for a knowledge system to be successful. However, having the right technology alone, does not guarantee that an organisation has addressed the full requirements of moving to a knowledge-based strategy [Hansen et al., 1999]. Moreover, if it fails to do so, then it will fail to establish an effective knowledge system [Hiebeler, 1996], and a KM culture.

Each of these components represents a major undertaking in its own right. No organisation can achieve a perfect KS overnight. In this belief, the researcher holds that KM is a journey [McCune, 1999]. This journey is the process of learning and developing a culture of collaborative knowledge sharing, and knowledge creation [Spear and Bowen, 1999; Takeuchi and Nonaka, 1986, and Nonaka, 1991].

### 3.7 The Knowledge Journey

Building a KS is like undertaking a journey. One needs a map to plan one's path and the possible alternative routes along the way. One will also need an understanding of the tools one have at one's disposal and the resources one may need to reach one's final destination and points in between. The KS journey has five distinct stages spanning from knowledge chaotic to knowledge centric. This process is similar to that of Nonaka's knowledge spiral [Nonaka 1991], in considering the process of "...making tacit knowledge explicit" [Nonaka, 1991:101]. This is basically a journey from chaos to concept. Hence, to become a true "knowledge-creating company", an organisation must complete a "knowledge spiral", says Ikujiro Nonaka [Nonaka, 1991]. He argues that, that spiral goes from tacit to tacit, from explicit to explicit, from tacit to explicit and, finally, from explicit to tacit. Figure 3.5, therefore suggests that tacit knowledge must be articulated and then internalised to become part of each individual's knowledge base. This is a continuous process, which starts anew when completed, but each time at ever higher levels, extending the knowledge application to other functional areas of the organisation. This is usually done in a systematic manner. Thus, this "knowledge-creating principle", may be better conceptualised in the model depicted in Figure 3.6.

		Tacit knowledge	Explicit knowledge
		Future principle	
Current principle	Tacit knowledge	Share experience, discuss ideas, opinions, etc.	Articulate experience in formal models, embed experience into equipment, software, etc.
	Explicit knowledge	Convert models and formulas into tacit skills; learn/teach how to use equipment, etc.	Reformulate formal models and data, convert codes, etc.

Figure 3.5: Modes of knowledge conversion in the 'knowledge spiral'

Source: [Campbell, 2002:44]

The stages in this process, Figure 3.6, are discussed next:

### 3.7.1 Knowledge-Chaotic

The organisation is unaware of the importance of knowledge to the achievement of its goals. This stage is characterised by the storage and management of knowledge in an ad hoc manner across the organisation. The accessing and retrieval of information is difficult and time-consuming because of the difficulty of identifying sources of knowledge. Systems may be incompatible. Processes for collecting information may be ineffectual or non-existent. People may be reluctant to share information or simply lack the time or incentive to do so [Sveiby, 1996; Denning, 1998, Espejo, 1996; and Nonaka 1991].

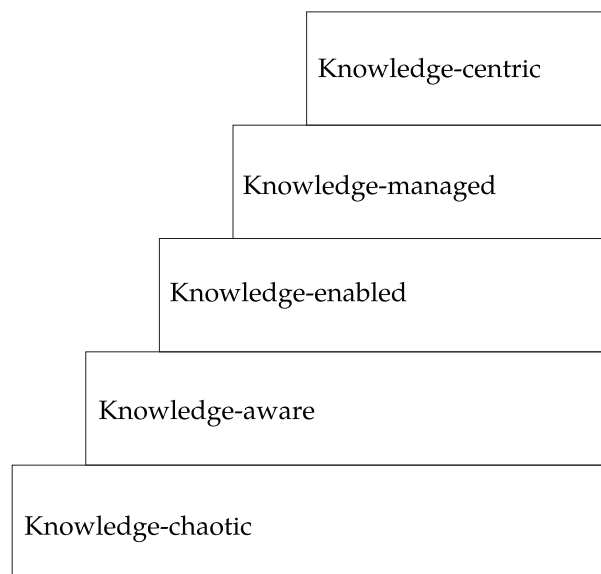


Figure 3.6: The stages of the knowledge journey in the ‘knowledge spiral’.  
Source: [Campbell and Pellissier, 2001]

### 3.7.2 Knowledge-Aware

The organisation is aware of the need to husband its knowledge and some attempt has been made to do so. Knowledge processes and sources within the organisation have been identified and documented. A catalogue of the available knowledge sources and their use within established knowledge processes facilitates the retrieval of information. However, awareness and implementation across the organisation may not be uniform. Ownership and sharing of knowledge may be an issue [Spear and Bowen, 1999, Takeuchi and Nonaka, 1986; and Nonaka, 1991].



### 3.7.3 Knowledge-Enabled

KM is beginning to benefit the business. Standard procedures and tools are utilised across the organisation to access information stores. Knowledge resources have been inventoried, evaluated and classified, and procedures have been implemented to maintain this listing. A number of the cultural and technological barriers have still to be addressed [Leonard, 1996; Hansen et al., 1999; Mc Cune 1999; Bolisani and Scario, 1999; Carayannis, 1999; and Drucker et al., 1997].

### 3.7.4 Knowledge-Managed

The organisation has an integrated framework of procedures and tools to discover, create, maintain and retrieve information. The technological and cultural issues have been overcome. The organisation's knowledge strategy is reviewed and improved on a continuing basis [Spear and Bowen, 1999; Takeuchi and Nonaka, 1986; Nonaka, 1991; Bennett, 1996; Hope and Hope, 1999; Havens and Knapp, 1999; Evans and Wurster, 1997; Baldwin and Clark, 1997; Christensen, 1997].

### 3.7.5 Knowledge-Centric

The organisation's mission is the application and enhancement of its knowledge base, which is providing it with a demonstrable sustainable competitive advantage in its markets. KM procedures are an integral part of organisational and individual processes. KM tools are highly integrated and reside on a robust technological backbone that allows knowledge to be mission-critical to the enterprise. The assessment and improvement of the knowledge environment are standard operating procedures. The value of knowledge to the organisation is being measured and reported to stakeholders, is reflected in the organisation's market value and is being managed as the organisation's intellectual capital. The questions that organisations should ask themselves include:

1. Where are we today?
2. Where do we stand relative to our customers and competitors?
3. What are the barriers to moving to the next stage and achieving its benefits?

4. What are we doing and what should we be doing to make progress?
5. What is the cost or risk of doing nothing?

The knowledge journey is not only a journey – it is a race [Spear and Bowen, 1999]. The most innovative organisations have already started on the journey. Leading organisations in virtually every sector have shown, through an ever-growing number of case study examples, that more effective use of knowledge and insight gives them a competitive edge. Business success is not about amassing assets, it is about putting them to work [Spear and Bowen, 1999; Hendriks and Vriens, 1999; Wah, 1999; Edvinsson and Sullivan, Petrash, 1996].

In concluding, the present study is informed by Davenport and Prusak [2000:153], that there are nine factors leading to knowledge project success. These are:

1. A knowledge-oriented culture
2. Technical and organisational infrastructure
3. Senior management support
4. A link to economics or industry value
5. A modicum of process orientation
6. Clarity of vision and language
7. Nontrivial motivational aids
8. Some level of knowledge structure
9. Multiple channels for knowledge transfer.

These factors will not be discussed in this chapter; rather, a more thorough discussion will be attempted in chapters 9 and 11. Suffice this to say that, it is time for those who would be in the ‘early majority’ to take action, closing the narrow, but fast-growing, gap between themselves and the innovators, and seizing the remaining opportunity to reap competitive advantage [Wah, 1999].

### 3.8 Summary

In this chapter, the researcher discussed the landscape of KM strategies in terms of the components of KM. The study explored the processes of KM and discussed how these processes may be used to answer the main research questions: “how knowledge management strategies are enabled by the support of asynchronous groupware. systems”. The study also presented the secondary research question was deemed relevant in this context.

In the definition of KM, the study examined 15 components of KM. These processes led to the understanding of the major functions of KM in section 3.2. The five fundamental functions of KM system were identified as: gather; organise; search; distribute and deliver; collaborate and refine.

These processes form the basis for devising a knowledge plan. The plan is the framework which organisations use to develop a competitive advantage. The chapter also examines the role of technology in the KM strategic framework. Groupware is the major sub-component here, and is one of the interests of this thesis.

The chapter concludes with the review of the requirements for developing a KS. The chapter also looked at some practical issues and the future use of knowledge systems.

The present investigation now turns to Chapter 4, where that chapter will explore and review asynchronous groupware, and also investigate how this is related to knowledge systems.

## Chapter 4

### Asynchronous Groupware

---

*We are drowning in information but starved of knowledge.*

*John Naisbitt, Megatrends*

#### 4.1 Introduction

The term groupware generally refers to group support systems utilised in various business contexts [Johansen, 1988; Lockwood, 1994]. This term became popular in the early 1990s, due in part to a number of articles in practitioner-oriented magazines. PC Week was one of the first among these magazines. It issued two special supplements (PC Week, Special Report on Groupware, 14 October 1991 and 26 October 1992) on groupware in 1991 [McQueen, 1993]. Shortly after, in 1992, a conference was held in the US with a strong commercial appeal, that conference was called Groupware '92 [Coleman, 1992].

In general, however, the term Computer Support Co-operated Work (CSCW) has a strong commercial appeal followed by the introduction of the term groupware. It emphasises the application of information technology to support group work in business settings such as manufacturing plants, small businesses, and distributed offices of large corporations – provides ground for distinguishing it from the pure study of technology to support group work, which seems to be the general focus of CSCW [Johansen, 1988; Wilson, 1991; Poltrack & Grudin, 1998]. In this sense, groupware can be seen as a sub-class of CSCW, more preoccupied with the impact of information technology on group work practices in organisations so that improvements on efficiency and effectiveness can be attained.

There is no generally accepted definition of groupware. One definition, which is acceptable within the scope of this research, is provided next. This definition combines elements of three other definitions proposed by Johansen (1988), Ellis, Gibbs & Rein (1991), and McQueen (1993).

*Groupware is a generic term for computer-based systems which are particularly used to support*

*groups of people engaged in common tasks in organisations. Typically, these groups are small; businesses oriented, and have relevant tasks with definite deadlines.*

This definition is not restrictive in terms of the size of the groups that are supported by groupware. However it states that typically these groups are small (i.e. from five to twenty members, for the purposes of this research). Small size is suggested in previous studies of small groups as the most appropriate for efficient and effective team work (Wellins, Byham & Wilson (1991), who define small groups as ranging from three to twelve members in size). The improved efficiency of small groups is also supported by Shaw (1981) who has concluded that in general, regardless of task, context or group characteristics, the optimal group size is quite small, typically from three to five members, because process losses quickly overtake any process gains from increased group size. While these assumptions reinforce the alignment of the term groupware, as defined here, with the search for optimal efficiency for group work, it is important to stress that they were generally based on the study of face-to-face groups.

The wide scope of application of the term groupware, and the emergence of a large number of software applications claiming to fall within its umbrella, has led to the development of taxonomies to classify groupware systems. The analysis in the next section, will discuss two of these taxonomies. This discussion allows one to define AG, whose degree of availability to KM groups/communities of practice is the main independent variable of this research, and to proceed to a critical analysis of pros and cons of this class of groupware over traditional non-groupware and synchronous groupware interaction modes.

The chapter concludes by pointing out, based on this critical analysis, that AG has the potential to be used as a tool to support KM groups/communities of practice. This potential contrasts with the limited amount of empirical research so far focusing on AG support impact on group-focused KM strategies, which calls for an increase in this type of research.

The present investigation, reported in this thesis, is an attempt to highlight the need for further research in this area of management in general, and in IT in particular.

## **4.2 Taxonomies for groupware**

There are several taxonomies for groupware. The two most commonly accepted are the application-level taxonomy, based on the main functions the system provides to its users; and the time-space

taxonomy, based on the users' temporal and physical distribution while interacting through the system [Ellis et al., 1991; Kock, 1994; Kock, McQueen and Fernandes, 1994; McQueen, 1993; Watson, Bostrom & Dennis, 1994; Wilson, 1991; Poltrack & Grudin, 1998].

#### 4.2.1 Application-level taxonomy

Among the most representative categories of the application-level taxonomy are electronic-mail, computer conferencing, workflow control, knowledge and information sharing, electronic calendaring, shared work space, and shared media space. From these, the two "oldest" and most widely utilised in organisations are electronic-mail and computer conferencing (particularly in its asynchronous form). Each of these categories is discussed separately next.

**1. E-mail** E-mail is often seen as the most successful and the most utilised groupware instance in organisations [Easterbrook, Beck, Goodlet, Plowman, Sharples & Wood, 1993]. It is also among the first computer systems to be developed with the aim of supporting communication among people. e-mail's ease of use is often attributed to its strong analogy with a system that is common to most of us: the ordinary mail system [Keen, 1994]. Several types of organisational improvements have been reported from the use of e-mail, ranging from reduction of time in processes involving intense communication, to reduction of common mail expenses. For example, it is claimed to have saved IBM millions of US dollars in expenses with envelopes and stamps, as well as having increased the efficiency of the company's communication with its customers, and between physically dispersed branches involved in cooperative projects [Stewart, 2001].

**2. Computer conferencing** Groupware systems which support computer conferencing as their main function are also called simply conferencing systems. Computer conferencing is, along with electronic-mail, considered one of the foremost instances of groupware. Its main function is to allow users to exchange messages related to a given topic [Hasted, 1994]. Computer conferencing is different from e-mail to the extent that messages are organised around single topics and are available to all members of the group engaged in the topical discussion. In some cases, electronic-mail systems are used to implement distribution lists which allow discussions around a given topic, emulating computer conferencing (e.g. Internet distribution lists). These implementations are referred to in this thesis as e-mail conferencing (EC) systems. Users typically access a conferencing system in an asynchronous way. This means that people can

participate in the conference by reading and sending messages at different times, as opposed to having to be connected to the system at the same time as the communication takes place (e.g. Usenet newsgroups). Previous research and business practice suggests that computer conferencing can support post and pre-meeting discussion quite effectively, which can generate savings in time of expensive staff such as senior executives [Cutts, 1994; Kock and McQueen, 1995a].

**3. Workflow control** This is probably one of the first instances of groupware. Workflow control systems' main function is to enable managers and group leaders to design and keep track of the execution of interrelated activities [Tagg, 1996]. The evidence seems to suggest that great importance has been given to this class of groupware as it is closely related to the concept of process. As the awareness about this concept has increased in the management community in the last few years, especially due to the business process re-engineering movement, several discussions have been taking place about technical and conceptual aspects associated with linking workflow control systems to business process improvement [White and Fischer, 1994], and consequently, to knowledge systems. These systems allow organisations to harness the various aspects or processes of knowledge creation, validation, presentation, distribution, and application. These five phases in KM enable an organisation to learn, reflect, and unlearn, and learn. They are usually considered essential for building, maintaining, and replenishing of the organisation's core-competencies. The case study, Chapter 10, discusses the use and application of a workflow management control system.

**4. Knowledge and information sharing** This function has been ignored in much of the empirical research on groupware utilisation [Ackerman, 2001], which has been reported as strongly preoccupied with the role of groupware as a tool to replace or expand face-to-face communication in groups [Serida-Nishimura, 1994]. This function has been described in previous research as the main component of groupware systems that support the sharing of information (e.g. facts describing the status of some of the organisation's core processes) and knowledge (e.g. criteria used by top management to select appropriate lines of action based on facts) concerning organisation processes, historical information about organisation learning and BPI, and organisation memory [Conklin, 1992; Hoffer and Valacich, 1993; Kock and McQueen, 1995; Schatz, 1993; Bhatt 2000; John, 1998; Lehner and Maier, 2000].

**5. Electronic calendaring** Electronic calendaring implements the concept of group calendar through the use of networked computers. Users are allowed not only to record information about their own, but also access information about other people's, time schedules. This information sharing functionality is normally extended with features that enable one person to book appointments for another, or even to find out whether a prospective meeting matches several people's own appointments [Lange, 1993]. Productivity improvements have been observed in the coordination of group activities as a result of the use of electronic calendaring, mainly when it is used to support the work of managers [McQueen, 1993]. However, those improvements are only achieved when a critical mass of users record information about their individual time schedules in the system [Grudin, 1988, Markus, 1990, Markus and Connolly, 1990].

**6. Group decision support** Three typical commercial examples of this type of groupware are GroupSystems, VisionQuest and MeetingWorks (all trademarks). Its main goal is to support group decision meetings, where the final group decision is the main outcome of the group discussion. Brainstorming, voting, ranking and classification of ideas are examples of tasks supported by a typical group decision support system. A fundamental element for its effective use is the facilitator who provides technical and procedural support to the members of the group. Some studies suggest that group decision support systems can improve the overall quality of decisions as well as reduce the time to reach them [Pietro, 1992, Sheffield and Gallupe, 1993].

**7. Collaborative writing** This class of groupware allows two or more authors of a document to write it in collaboration. The status of the document along with author's comments and identification of modifications are provided. Through collaborative writing systems one of the authors of a document is able to keep track of its evolution and identify who changed the document and to what extent. Comments associated to parts of the document can be attached by some of the authors and viewed by the others. Collaborative writing systems can be synchronous and asynchronous, respectively providing support to real-time and non-real-time interaction. One example of collaborative writing system is a text editor, designed to be used by a group of users simultaneously editing an outline document during a work session, called GROVE, which stands for Group Outline Viewing Editor. According to Ellis et al. (1991), while it presents some advantages such as group editing time reduction, GROVE was reported by some users as cutting down social interaction and making discussion of complex issues more difficult and "boring".



**8. Shared work space** The main goal of this class of groupware systems is to provide shared access with editing capabilities to software representations of real objects normally used for group work. One example is Boardnoter, an electronic whiteboard used as part of a meeting room designed and implemented at Xerox PARC [Stefik et al., 1987]. Shared work space systems are normally used together with other groupware systems such as group decision support systems to support non-structured communication among members.

**9. Event service** The CORBA [Iona, 2001], event service introduces the concept of event communications. This is a specification which defines an asynchronous model for communication between the object request broker (ORB) applications. ORB is the fundamental component of CORBA architecture. It supplements the synchronous model normally used by client/server applications. An event originates at an event supplier and is transferred to any number of event consumers. Suppliers and consumers or their identities and consumers have no knowledge of which supplier generated a given event. The asynchronous model is further supported by an architectural element, called an event channel [cf. Figure 4.1].

An event channel mediates the transfer of events between the suppliers and consumers as follows:

- The event channel allows consumers to register interest in events, and stores this registration information;
- The channel accepts incoming events from suppliers; and
- The channel forwards supplier-generated events to registered consumers.

**10. Shared media space** A shared media space can be viewed as a computer conferencing system with multimedia features. CAVECAT is an example of shared media space system which uses integrated video, audio, and computers to allow spatially and temporally distributed individuals and groups to work together [Mantei, Baecker, Sellen, Buxton, Milligan & Wellman, 1991]. Through CAVECAT, each member can see the other members through video cameras installed in their rooms and talk to them via speakers. The system was seen as a promising tool for collaborative communication in the future. At the time the study was published – 1991 – the system’s success was seen as hindered by the unavailability of communication media with wide enough bandwidth to allow for real-time transmission of large image files. The list of categories

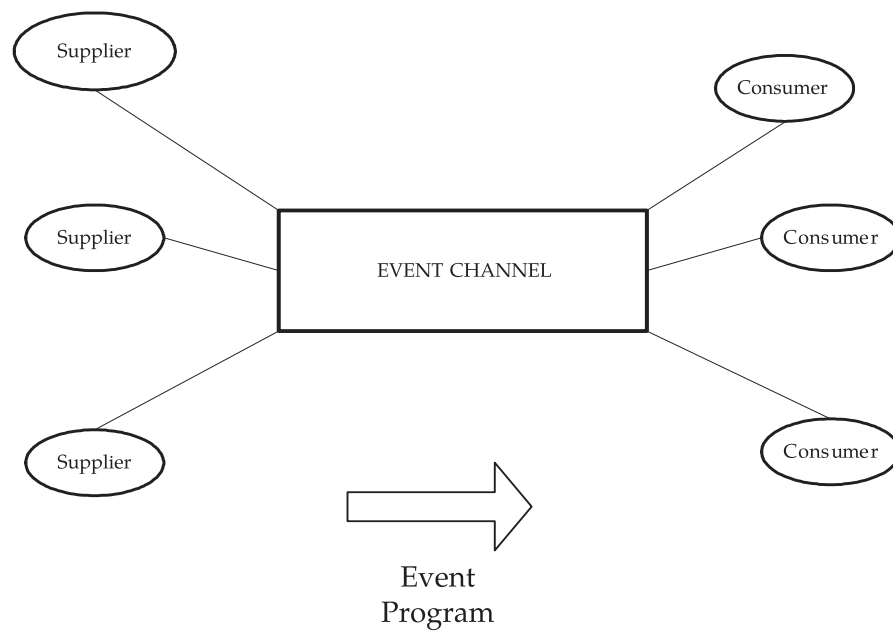


Figure 4.1: Event Channel

provided above is far from being complete and can be extended as new categories may emerge due to new features being added to the existing categories, to new categories being independently devised, or to existing categories being merged. This is in fact one of the weaknesses of the application-level taxonomy, which appears to have an unlimited scope of growth as systems with new relevant features are developed. The time-space taxonomy, discussed next, offers an alternative to the application-level taxonomy where the number of possibilities is limited to three. This can be seen as an advantage insofar as it allows for a broader categorisation of groupware systems than does the application-level taxonomy.

#### 4.2.2 Time-space taxonomy

The time-space taxonomy, like the application-level taxonomy must be viewed as a necessary part of the interaction between techniques, technologies and people, which support the groupware impacts of knowledge systems. It, however, must be viewed differently from the application-level taxonomy, which classifies groupware according to functional features offered to users, the time-space taxonomy places emphasis on the spatial and temporal distribution of the users of a groupware system while interacting as a group [Ellis et al., 1991]. According to this taxonomy groupware can be split into the following three categories, whose instances are usually found in general organisations and research centres:

**1. Same-time and same-place** Support face-to-face interaction. In this category group members typically interact in the same room and at the same time. Group decision support, shared workspace systems, and Lotus Sametime generally fall into this category.

**2. Same-time and different-places** Support synchronous distributed interaction. Group members typically interact from different rooms of the same building or in different buildings that are close to each other (e.g. the ministries in the Government enclave, in Gaborone, Botswana, collaborate through a campus network – GDN [Government Data Network]. Synchronous computer conferencing and shared media space systems generally fall into this category.

**3. Different-times and different-places** Support asynchronous and distributed interaction. Group members typically interact from different rooms in the same building or in different buildings irrespective of how far they are from each other. Group members can even be spread over different countries. Asynchronous computer conferencing, workflow control and electronic-mail generally fall into this category.

Systems belonging to the third category of the time-space taxonomy - different-times and different-places – are referred to, in this thesis, simply as asynchronous groupware systems, as suggested by Rodden and Blair (1993) and others [Markus, 1992; Baecker, 1993, Part III]. Previous studies [Johansen, 1988, Ellis et al., 1991, Gantt, 1992] suggest a fourth category – different-times and same place - which comprehends systems where group members interact in the same physical location (e.g. the same room) at different times (e.g. workers replacing each other along different shifts in an air-traffic control office).

Although this type of interaction is possible, it is also supported by the category different-times and different-places, which suggests that the category different-times and same place may be disregarded as a distinctive category in this taxonomy.

#### 4.2.3 Relationship between taxonomies

The two taxonomies described, application-level and time-space, are closely related. As the latter taxonomy has a broader scope than the former, it seems natural that the functions described in the former taxonomy typically belong to one of the categories described in the latter taxonomy.

E-mail, computer conferencing, workflow control, electronic calendaring systems, and event service described in the application-level taxonomy, can be classified as being different-times and different-places systems, according to the time-space taxonomy. Conversely, group decision support and collaborative writing systems can be classified as being same-time and same-place systems, while shared work space and shared media space systems can be classified as same-time and different-places systems, according to the time-space taxonomy. This relationship is illustrated in Figure 4.2.

The relationship between taxonomies illustrated in Figure 4.2 is based on empirical business evaluation of groupware utilisation rather than on inherent technical features of each class and sub-class of systems. This means that the systems are typically used in the way depicted in the figure by actual organisations. However, this does not mean that these systems must be used in this way due to technical constraints. In this sense, collaborative writing, for example, can be used to support asynchronous interaction, but the literature on organisational groupware applications supports the assumption that this type of groupware systems is more widely used to support synchronous interaction in the same place.

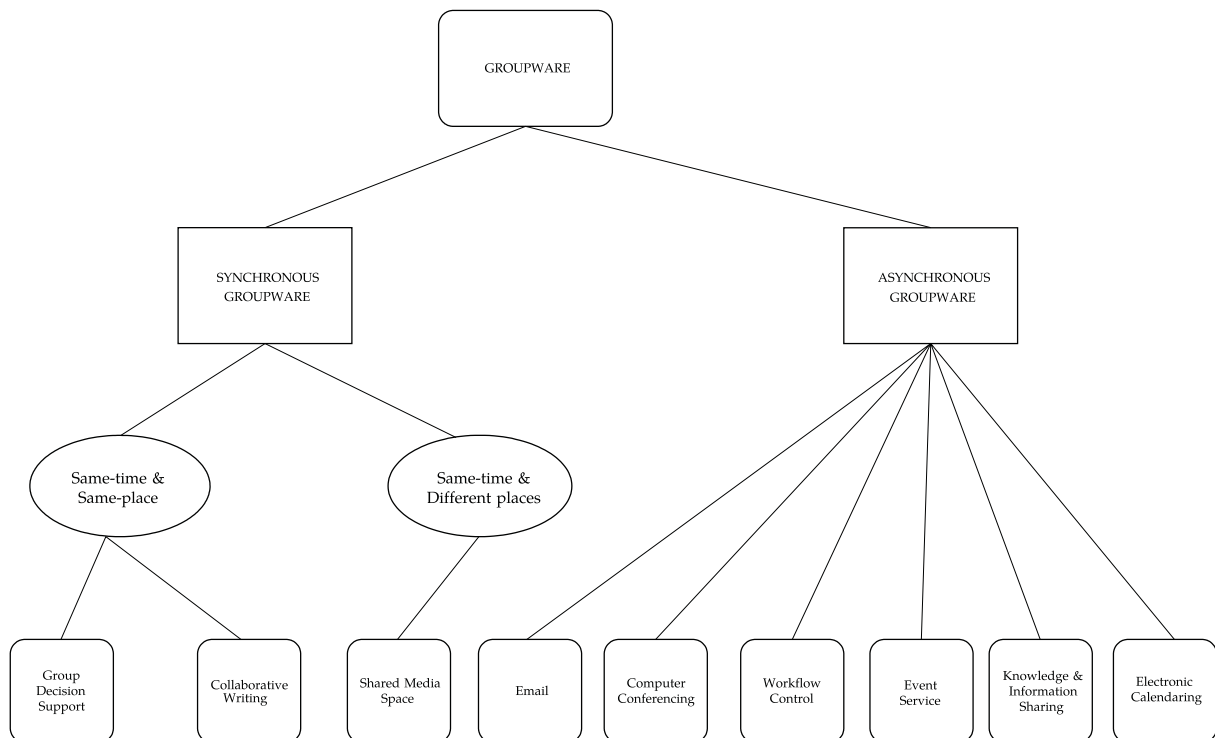


Figure 4.2: Relationship between the time-space and application level taxonomies

The relationship scheme illustrated in Figure 4.2 states that the sub-classes SG and AG belong to the general class groupware. Going down on the diagram, the class SG has two sub-classes:

same-time and same-place and same-time and different-places. Instances of these classes share the same characteristic of supporting synchronous interaction, as opposed to instances of the sister sub-class AG which comprises those groupware systems aimed at supporting asynchronous interaction.

A brief analysis of this relationship between taxonomies and related literature is provided next.

1. **Group decision support and collaborative writing** are depicted as sub-classes of the class same-time and same-place. This means that group decision support applications are typically implemented to support group work both at the same room and at the same time [Pietro, 1992; Sheffield and Gallupe, 1993; Gallupe, Cooper, Grise & Bastianutti, 1994]. The same is true for collaborative writing systems [Ellis et al., 1991; Horton and Biolsi, 1993; Irene and Chen, 1993].
2. **Shared work space and shared media space** are depicted as sub-classes of the class same-time and different-places. This means that shared work space and shared media space applications support, in most of the cases, group work carried out through simultaneous interaction between physically dispersed group members [Ishii, 1990; Watanabe, Sakata, Maeno, Fukuoka, & Ohmori, 1990; Mantei et al., 1991]; and
3. **Email, computer conferencing, workflow control and electronic calendaring** are depicted as sub-classes of the class asynchronous groupware. The meaning of this classification is that those types of groupware systems generally support work groups whose members interact at different times [Sproull and Kiesler, 1991; Turoff, Hiltz, Bahgat, & Rana, 1993; White and Fischer, 1994; Larry, 1994; Cummings, 1994].

The two taxonomies discussed here try to categorise groupware systems based on their commercial availability as products. This is aligned with the fact that groupware systems are marketed as off-the-shelf products, not design models. The current practice for the majority of information systems in organisations contrasts with this approach, being most of these systems either internally designed and implemented, or externally contracted to be developed based on models tailored to specific contexts [Grudin, 1994; Poltrack & Grudin, 1998]. Following and extending this off-the-shelf product analysis approach, Figure 4.2 provides a sense of market success for groupware by highlighting the systems with broader commercial implementation. This is done based on an analysis of the features of several commercial groupware systems done by

Stevenson (1993) and on Grudin's discussion on success and failure factors for groupware systems [Grudin, 1988; 1994]. A thick border means high success (e-mail), a normal border means moderate success (computer conferencing, workflow control, and group decision support), and a dotted border means low success (collaborative writing, shared work space, shared media space, electronic calendaring, and event service).

### 4.3 AG : An analysis of pros and cons

A critical view of AG support effects on groups can be shaped based on its comparison with other modes of interaction. The two modes of interaction chosen, for the sake of comparison, are:

1. **Non groupware-supported**, where the interaction is accomplished via face-to-face meetings and artefacts other than computerised group support systems, such as telephones and paper mail; and
2. **SG-supported**, in which interactions are supported by groupware systems where users must be connected to their computers at the same time in order to interact through the system. The discussion below focus on advantages and disadvantages of asynchronous groupware when compared with these two modes of interaction.

#### 4.3.1 Advantages over no groupware support

When compared with non groupware-supported interaction, AG supported interaction presents positive aspects from different points of view. It can be seen as typically providing better support to group activities, making communication faster and cheaper, reducing paper flow, and improving data storage and retrieval. It also seems to allow for more communication between separate departments, reduce member contribution stress, make individuals communicate more openly, cause contributions to be better distributed, separate ideas from individuals, reduce repetition of ideas, and increase commitment to group outcomes. Each of these advantages is discussed separately as follows.

**1. Ease of communication** AG support allows for a more efficient and effective mode of collaboration and communication, thus fostering faster and less expensive data exchange. Therefore, it is generally assumed that from both the individual and organisation perspective, AG support can reduce the costs of knowledge and information sharing and exchange. From a more specific point of view, the individual, according to Sproull and Kiesler (1991) observed that people connected to wide area networks tend to respond more readily to knowledge and information requests made by strangers. They posit that part of the explanation for this phenomenon is that networks make the cost of responding extremely low in terms of time and effort expended, and that respondents seem to believe that sharing knowledge and information enhances the overall electronic community and leads to a richer knowledge and information environment. They point out that the result of this is a kind of electronic altruism quite different from the fears that networks would weaken the social fabric of organisations. Specifically from the organisation point of view, advantages are seen as economy in time and expenses with paper mail [Toffler, 1991; McQueen, 1993].

**2. Reduction in paper flow** Paper flow reduction can be achieved, for example, through the use of workflow management control and document management features where the coordination and processing of activities moves away from its traditional paper-based legacy systems and forms towards electronic forms flowing through a network of computers [Sprague, 1995, Wilson, 1991]. An interactive and intelligent document management system also aids in paper flow reduction through the use of computer conferencing to structure and organize databases of manuals, specifications, and quality and performance standards. The Case Study, Chapter 10, in this thesis is such a case in point.

The use of AG as a tool to reduce paper flow, and effective better document management may be extended to nearly all activities performed with the use of documents [Oppen and Fersko-Weiss, 1992]. Memoranda, reports, letters and formal documentation can be distributed through electronic mail systems, and levels of approval and delivery options may be accommodated through features where automatic confirmation of reception and delivery can be replaced with the advantage of critical tasks such as the request for signatures acknowledgment [Flores, Graves, Hartfield & Winograd, 1988; Medina-Mora, Winograd, Flores, R., & Flores, F., 1992; Winograd, 1992].

**3. Ease of filing** AG support has the potential to considerably increase the efficiency associated to the recording, access to, and retrieval of relevant business process information. Messages exchanged between members of communities of practice can be filtered and stored in appropriate electronic folders for latter access, as exemplified by Brothers, Hollan, Nielsen, Stornetta, Abney, Furnas, & Littman's (1992) study at Bellcore.

Documents can be associated to topics of discussion for public or restricted access use, and kept on centralized databases periodically replicated [Kawell, Kawell, Beckhardt, Halvorsen & Ozzie, 1988]. Electronic journals with articles and respective appended comments can replace their printed versions [Engelbart, 1984].

**4. Increased cross-departmental communication** Today many assumptions and structures that have guided organisations in the past are being questioned and alternatives carefully considered. In particular, there are frequent initiatives on reshaping organisations along much less hierarchical and more democratic paths [Tapscott and Caston, 1993; Clement, 1994]. In this type of organisation cross-departmental groups play an important role in streamlining business processes which expand over different areas. AG systems are seen as particularly well-suited to enable effective and efficient communication between these groups, which would be difficult to attain through non groupware-supported modes of interaction [Finholt and Sproull, 1993; Malone and Rockart, 1992; Pearson, 1985; Sproull and Kiesler, 1993].

**5. Stress reduction** Previous experiences in the use of groupware to support communication in meetings indicate that individuals feel less stress when electronically contributing new ideas to the group discussion than in face-to-face meetings. This has been observed in quality improvement team meetings by Pietro (1992), where teams discussed how to improve quality in hotel service. Walther (1995), in an experimental research on relational communication (i.e. messages used to define or redefine personal relationships), has found that individuals interacting electronically were more relaxed and open in their comments than those interacting face-to-face.

The central idea seems to be that interaction through the computer is less stressful since it is perceived, to some extent, as interaction with the computer. That is, the user sees the computer as neutral to human problems such as spelling mistakes and slowness in exposing ideas. In addition, some individuals engaged in computer-mediated communication can benefit from the suppression of cues that might influence other's opinions about their ideas. Examples



are cues about the individual's cultural background, as well as social and organisational status [Sproull and Kiesler, 1986]. This can be viewed in light of the different environment in which the knowledge-based operates. Pirjo Ståhle, Chief Knowledge Officer of Sonera, Finland, asserts that "every organisation is a three-dimensional system, it has a mechanistic, organic and dynamic nature" [Ståhle, 1999]. The role of groupware, particularly asynchronous systems are particularly important here. In a mechanistic environment, as defined by Ståhle (1999), the shared knowledge is explicit, that is, it is possible to be incorporated in manuals and procedures, and easy to be handled and processes with the assistance of IT. The focus in this type of organisation is stability, and the flow of information is mainly top down, hierarchy matters here.

The role and functions of employees are clearly defined. They know what is expected of them. There is no need for improvement, customisation or innovation in their work processes. The processes are routing, and organisational objectives are set in advance.

On the other hand, the organic environment focuses on continuous and controlled developments. The objective in this climate is to understand the nature of the changing environment and to fit within the change. It is acceptable that organisations are complex entities and competition is at times very intense. The flow of information necessary to mediate the amount of dialogue and different strands of communications need to be interactive. Ståhle (1999), feels that expressions are shared, and shared meanings are sought in this organisational domain, this domain and culture of organisational realities give rise to self-assessment, interest groups, processes and co-operative quality work. He advises that "by managing and activating these information flows, it is possible to manage and change to keep the organisation in both constant motion and balance" [Ståhle, 1999].

In the environment domain, the dynamic corporate environment, work tasks and roles are continually changing, organisational structures are being renewed at short intervals say, six months or twelve months. In this domain it becomes more and more difficult to predict the future. Senior management must understand and tolerate the nuances of this hectic environment for continuous change and development. There must be an awareness that chaos functions as the source of innovation.

This view is also supported by Pellissier (2001:28-36), where she discusses the emerging paradigm of the chaos theory and goes on to discuss the emancipatory roles of chaos in the dynamic organisation domain. The challenge for managers in this domain is to be able to "jump the

curve” [Pellissier, 2001:36], this point is called the “cusp” – that is the point of transition. This point of transition is the chaotic character of the organisation which brings and matures it as a knowledge-based organisation. The chaotic metaphor must be seen as the aims for the development of a strategic competitive edge (such as creating a totally new kind of product, image or operating method).

The chaotic nature and structure of an organisation is also reflected in the breaking down of organisational barriers and in the convergence of different lines of business. This will inform the development of the KM BI model in Chapter 9. The model will be based on the dynamic nature of the knowledge-based enterprise. This type of organisation is usually global and is the only possible basis for innovations and harnessing of BI through the use of KM practices and strategies.

Ståhle (1999) hastens to caution that chaos does not refer to total disorder. There is a relationship between disorder and order – the ability of chaos to organise itself is being used. The “Portal” of the KM-BI model a case in point [cf. Figure 2.1 Model for KM-BI (from Campbell & Pellissier, 2000)].

**6. Improved communication between individuals** People in groups seem to be less likely to hide personal ideas and opinions when interacting through AG systems than otherwise, even if these ideas and opinions are antagonistic to other members’ point of views [Kiesler, Siegal and McGuire, 1988]. Sproull and Kiesler (1991) illustrated in their study on electronic-mail usage in an organisation, that uninhibited behaviour such as “flaming” was considerably higher in electronic mail than face-to-face interactions, and pointed out that: “People are less shy and more playful in electronic discussions; they also express more opinions and ideas and vent more emotion” (p. 89). One can therefore conclude that, AG interactions have the potential to positively affect the creativity of a group and consequently improve the innovativeness of its outcomes. Further, it may be argued that should an environment may lead to the creation of communities of practice, where employees will be encouraged and be willing to share the ‘know-how’, and experiences.

**7. Contributions are better distributed** In traditional non groupware-supported group meetings a phenomenon called air fragmentation is inevitable. Air fragmentation refers to the need a group has to partition available speaking time among members. Groupware systems in

general enable a better utilisation of time by allowing users to concurrently input ideas without having to compete for speaking time. This has the potential to prevent some members from exercising undue influence on the group or monopolizes the group's time [Nunamaker, Dennis, Valacich, Vogel & George, 1991].

**8. Ideas are separated from individuals** It has been observed that groupware-mediated interaction in general filters cues about certain individual characteristics such as social status, cultural background, and position in the organisational hierarchy. Group members have reported this as fostering a higher focus on the content of ideas, as opposed to the person who contribute the ideas [Dallavalle, Esposito & Lang, 1992; Chidambaram & Kautz, 1993]. Focusing on idea content, rather on “idea source”, can have the positive effect of preventing the “argument of authority” to prevail, whereby individuals ranked higher than others in certain areas have their ideas overvalued [Janis, 1972; 1982]. One of the possible results of this is the promotion of group thinking (not to be confused with groupthink – for example, see Janis, 1972), where the formation of ideas is the result of group consensus building [Napier & Gershenfeld, 1993].

**9. Repetition of old ideas is reduced** It has been noted that groupware in general can help group members avoid offering ideas that are similar or have the same content as contributions previously made by other members. The main reason for this has been identified as the more efficient recording, structuring and provision of public access to information generated by previous group discussions [Sheffield & Gallupe, 1993]. This effect can yield gains in efficiency, as recurrent discussions will be avoided, and effectiveness, insofar as a higher degree of group innovation may be fostered [Kock & McQueen, 1995b].

**10. Commitment to group outcomes is increased** Previous research involving decision-making groups whose meetings generated proposals for further action shows that, when these proposals are documented, future behaviour by group members would more likely comply with them. Much of this research has been based on the observation of the effects of SG on decision-making groups, particularly group decision support systems [Ellis et al., 1991; Pietro, 1992; Sheffield & Gallupe, 1993]. The results, however, appear to be also applicable to AG, as group discussions supported by this technology typically generate documentation that can be made available immediately after they take place [Kock & McQueen, 1995b].

### 4.3.2 Advantages over synchronous groupware support

Comparing asynchronous with SG technologies is the same as comparing two artefacts that present a few subtle differences in the impact they have on the socio-technical environments [Lyman & Trist, 1992] in which they are used. The most remarkable difference between these two technologies is in the synchronicity of interaction between group members. AG supports interaction at different times, which in consequence allows users to carry out parallel work. It also tends to be less disruptive to group members. From a technical perspective, AG systems in general tend to be less expensive than synchronous groupware systems. In addition, they seem to be typically designed by analogy to artifacts commonly used by people, which makes operational learning easier. These aspects are discussed in more detail next.

**1. A higher degree of parallel work is fostered** AG systems allow for a higher degree of parallel work in the groups supported by them than synchronous groupware systems. This seems to be especially advantageous for groups in which concurrent activities may take different times to be completed. AG support allows users to perform different activities between interactions. This is true also for traditional non groupware-supported systems and, to some extent, to synchronous groupware systems. For example, one of the characteristics observed in groups interacting through GROVE, a synchronous collaborative writing system, was that individuals executed several different tasks (e.g. reading, annotating and editing text) at the same time [Ellis et al., 1991].

However, SG systems do not typically provide appropriate support to carry out longer parallel activities, i.e. those requiring hours each to be accomplished. Longer activities are typically seen as better performed asynchronously and in distributed settings. This may prevent organisational staff, for example, from participating in Business process improvement groups (BPI) group discussions supported by SG because carrying out routine business activities is perceived by them as their number-one priority [Dennis, Daniels, Hayes & Nunamaker, 1993], whereas they might agree to participate in those discussions had they been conducted with the support of an AG system .

**2. Disruption is reduced** From a group interaction point of view, AG support has been reported as being advantageous in group processes carried out over relatively long time periods,

i.e. weeks or months [Reder and Schwab, 1990]. This is the case of non-permanent groups accomplishing BPI-related tasks, where several weeks may be needed to analyse a process and devise solutions to a specific gap in process efficiency or effectiveness. In this case the interaction can happen over time, without disruption of normal activities. On the other hand, group members have a higher degree of control over their participation than in SG -supported group discussions, as they can interact with the group through the system whenever they wish to [Quarterman & Carl-Mitchell, 1993].

The use of AG, such as group decision support systems, can be extended to support KM groups modelling and analysing business processes. However, this use is likely to increase the degree of disruption of normal activities to group members, e.g. group members must stop their normal activities to attend group discussions during a few hours every week. It also requires the support of a fully allocated and skilled facilitator, preferably with expertise on BPI techniques [Dennis et al., 1994].

**3. Expenses with technology purchase are reduced** The commercial availability and widespread usage seems to be higher for asynchronous than for SG. This brings the prices down and allows for the utilisation of AG systems with less investment per connection, especially for off-the-shelf systems [Roth, Wood, Huhm & Power, 1993, Kock, 1998]. In addition, it seems that commercial products not particularly designed to support group activities can be easily adapted to fulfil asynchronous groupware functions [Nardi and Miller, 1991], which is not as easily accomplished for the more complex synchronous groupware functions, such as voting, ranking and classification of ideas [Roth et al., 1993]. In terms of infrastructure required asynchronous groupware is also less demanding, as the communication media bandwidth required is typically narrower than for SG. This may decrease expenses with media infrastructure resources such as cabling and network connections [Kock, 1998].

**4. Resemblance to common artifacts is higher** Bullen and Bennett's (1990) interview-based study, involving 25 organisations in US suggests that electronic message communication, by means of both e-mail and computer conferencing, has been considered by far the most useful and easy to use function of computerised group support tools. Interestingly, the main success factors were seen as being related to interface design. Analyses of this phenomenon call for the advantages of analogical design approaches, in which systems are built to be very much like

commonly used non-electronic artifacts [Olson & Olson, 1991].

The analogy of commercially successful electronic message communication systems to common non-electronic artifacts like postal systems is believed to lessen rejection and make learning faster and easier [Bullen & Bennett, 1990].

This characteristic is also found in some specific types of synchronous groupware, like shared workspace systems. However, as mentioned before, these systems are generally used in combination with other types of groupware systems, including AG, which supplement the need for the exchange of unstructured information [Stefik, Foster, Botsrom, Kahn, Lanning & Suchman, 1987; Ishii, 1990].

#### **4.3.3 Disadvantages over no groupware support at all**

One of the first obstacles found when introducing AG in organisations is the need for a critical mass of willing users with access to networked computers [Galegher and Kraut, 1990, Markus, 1990]. Providing this access typically requires heavy investment, which is often difficult to justify due to the difficulty of estimating return on investment from such systems [Dolan, 1992; Dyson, 1992]. Three negative aspects directly affecting communication efficiency and effectiveness, from an individual perspective, compound this problem. The first is the information overload often reported by individuals, particularly those who are heavy users of electronic-mail systems. The second is personal dissatisfaction due to lack of personal contact with others. The third is a loss of control by managers over their subordinates, and the negative reactions that it entails particularly from those managers who are not prepared to deal with the staff “empowerment” emerging from the introduction of AG systems. These aspects are discussed as follows.

**1. Broad access to networked computers is required** Successful use of AG systems often requires a critical mass of users [Turoff et al., 1993; Grudin, 1994]. As pointed out by Markus and Connolly (1990: 376): “E-mail, like the telephone, provides no benefits to isolated users. However, when there are many other users, the benefits increase, so that the payoffs of using e-mail may significantly exceed the payoffs of using alternative media”. However, in order for a critical mass of users to be created and maintained, access to networked computers must be available on a large scale. This involves direct costs, such as the purchase of hardware and software, and indirect costs, like maintenance, training and user support [Kock, 1994]. The

investment required is often very difficult to justify on a measure of return on investment basis [Oppen, 1992].

**2. Information overload is a common complaint** Studies of electronic-mail utilisation in organisations report that it has led to new possibilities for communication that cut across time and space barriers, but, at the same time, it has created a new source of breakdowns for people who find themselves overloaded with messages demanding their attention [Flores, Graves, Hartfield, Winograd, 1998:148]

In their findings, users of the email system (ES), report that they were becoming overwhelmed with messages in their electronic mailboxes, and as such were starting to ignore these messages, which turns out to ruin their own and other's confidence in the system.

**3. Reduced social contact leads to dissatisfaction** The literature informs that the use of groupware in general to replace face-to-face interaction has two major negative effects. First, groups interacting only by means of the groupware system show less cohesiveness than face-to-face groups. They tend to have a more difficult time initiating and planning their work, as well as form weaker bonds between members. A proposed action to mitigate this effect was to combine face-to-face with electronic interactions [Galegher and Kraut, 1990]. Second, group members involved in electronic meetings with little social contact reported boredom and dissatisfaction from participating in the meetings [Ellis et al., 1991; Reinig, Briggs, Shepherd, Yen & Nunamaker, 1995].

**4. Managers lose control over subordinates** Once the volume of knowledge and information exchanged between departments in organisations is increased, which has been found to happen upon the introduction of electronic-messaging systems, management departmental control (at least in the "old" sense of the word – e.g. see Quinn, 1988 and Taylor, 1911) is made more difficult [Sproull and Kiesler, 1991; Clement, 1994]. More lateral communication may provide greater flexibility and efficiency, but may also hamper the work of managers in organisations whose structure follows a predominantly hierarchical model [Jaques, 1990; Romme, 1996]. Grudin (1994:103) observes that many employees never have face-to-face meetings which involve higher managerial levels and notes that: "...the informality of e-mail makes it easier, less imposing, and more private to bypass hierarchical levels. People who would not think of

scheduling a meeting with their manager's manager will raise an issue by e-mail, which can provide a level of informality approaching that of a chance conversation in the hall."

#### 4.3.4 Disadvantages over SG support

Some of the most successful synchronous groupware systems are always operated with the support of a group meeting facilitator. As AG traditionally does not make use of facilitators, complexity embodied by the system may encumber their proper operation and, in some cases, cause them to be relinquished. Another negative aspect of AG, when compared with SG, is the delayed feedback characteristic of the asynchronous mode of operation. Each of these aspects is discussed below.

**1. Facilitation is hindered** AG systems which present a certain degree of complexity, both at the interface and supported task levels, are more likely either to be operated in an improper way or fail to be utilised at all (e.g. the Coordinator, discussed in Flores et al., 1988). This is not often the case with some equally complex and sophisticated SG systems, such as group decision support systems for example, because of the usual presence of a facilitator, who is considered critical to assure that the consensus building process will be carried out properly and that any user queries will be solved immediately [Bostrom et al. 1993; Sheffield and Gallupe, 1993]. The lack of immediate facilitation in AG systems calls for better and more intuitive interfaces [Grudin, 1988; 1994].

**2. Feedback is delayed** AG provides a one-way "road" for communication insofar as interactions occur in a disconnected fashion. This characteristic makes it generally inappropriate as a unique medium for communication in tasks that must be accomplished with urgency, especially when there is not a clear commitment by those who interact to answer as soon as possible. One can withdraw from performing a request made via e-mail, for example, by simply not responding to it. The source of the request will be, in most of the cases, in doubt for a certain time until realising that the request was ignored either temporarily or permanently.

The lack of feedback can have negative effects both at the individual and group levels as shown by Losada, Sánchez & Noble (1990). They conducted a research on the effect of process feedback on members engaged in classification and decision tasks to be accomplished with and without the



use of a group decision support system. The results show that feedback on group process can increase socio-emotional interactive sequences, which was in turn seen as affecting individual motivation and group cohesiveness. Human facilitation in AG can be difficult to implement, mainly due to the natural delay of feedback inherent in the medium and its negative effect on group members motivation to seek facilitation. It can also be expensive to implement face-to-face, due to the usual distance separating interacting members. These obstacles suggest that it would better be replaced by system features, such as friendlier interfaces, and smooth integration with group processes [Kock & McQueen, 1995b].

Feedback delay is related to AG's own nature and appears to be unlikely to be fully overcome by means of technical advances. Partial solutions such as the provision of partial feedback – e.g. message status feedback – apparently can be of only limited help. Most of the commercial electronic-mail products, for example, embody a feature that enables the sender of a message to know whether the receiver read the message or not [Stevenson, 1993]. While this feature may be useful to replace a document receipt's acknowledgment signature, it does not fully solve the problem of delayed feedback since the receiver can still postpone her (his) reply indefinitely.

#### **4.4 Workgroup Computing**

Workgroup Computing systems serve to co-ordination the common task and activities of a group as well as, aid in the communication among the group members among themselves. These systems also assist in creating a virtual work environment, from which different functions and services of the modern organisation can be accessed by workers from virtually anywhere, and at anytime One main function of such a system is to provide different embed information and protocols to ease the communication and collaborative activities of group members. However, some group members may not have access to some of the services provided, due to security and other system's restrictions. Notwithstanding this Workgroup Computing systems provide common context and platform on which the modern groupware technologies are built and deployed throughout the modern work environment of the twenty -first century.

Some typical functions of Workgroup Computing systems are the administration of a common appointment calendar or the supply of a system for collaborative writing and publishing. One major strength of the such systems, is at the data level, in the sharing and replication of files among group members.

The obvious asynchronous communication tools are personal emails, mailing lists and discussion fora. In the case of synchronous communication, are chat rooms, and at a more formal level, videoconferences may be used. Additionally, the simultaneous application of common whiteboards or synchronised browsing may also be used. There are also a number of newer applications such as instant messaging systems, which are removing the boundaries between the various forms and types of synchronous and asynchronous communication. These are slowly creating one seamless medium of communication for the modern organisation.

#### **4.5 Workflow Systems**

WMS provide a number of logistics for business processes, planning, execution, control and automation of organisational processes. These tools assist organisations to pursue and analyse information stocks and knowledge transfer through the sharing of documents, information and functions between employees, community of practice, and organisational units. In order to make the most of these systems and the benefits to be gained from their use, formal rules are derived, for which the basis of workflow systems can be controlled and the flow of these processes, in providing support to organisational knowledge and communication, be managed and understood. This approach aid in greater, process orientation of the firm's business, and problem-solving strategies by dividing problems into smaller sub-problems, which can be solved easier and faster by different employees.

This leads to greater efficiency in managing business processes, and to develop greater value added from communities of practice, through the automation of these processes, thus eliminating unnecessary processes and routines in these business processes.

The standardised operating methods and the formalisation of the activities of workflow systems permit better process control of business processes. The consistency of the processes and the level of reliability of these systems are able to add much value to organisational competitive advantage. This is possible, through the control and management of the business processes with the help of workflow management system software.

## 4.6 The case for AG research on KM groups

The positive and negative aspects discussed above are summarised in Table 4.1. It is important to note that their identification was based on a general literature review and was not structured around any particular model or theory. Explanatory models and theories have been built to compare groupware with non groupware interaction from different perspectives, such as the group process gains and losses model [Nunamaker et al., 1991, Alavi, 1994], and the adaptive structuration theory [DeSanctis et al., 1993] – focused on media adoption patterns. Aligned with Glaser’s (1992) recommendations regarding the search for emergent patterns in the review of empirical studies, no previous model was followed in this literature review so that fresh insights could be drawn from the comparison, from an BPI-oriented perspective, between AG, SG and non groupware interaction.

One of the negative aspects of much of the previously developed models is that they do not particularly emphasise the difference between asynchronous and synchronous interaction. They also place emphasis on the analysis of gains and losses from a group communication perspective. Typically disregarding other aspects such as the effect of public and low cost access to historical information on business processes and their evolution on the BPI efficiency and effectiveness, and the effect of public sharing of written commitments on the degree of actual fulfilment of those commitments – one of the so-called social facilitation effects [Kock and McQueen, 1995b; Shaw, 1981].

The relationship between taxonomies illustrated in Figure 4.2 is based on empirical business evaluation of groupware utilisation rather than on inherent technical features of each class and sub-class of systems. This means that the systems are typically used in the way depicted in the figure by actual organisations. However, this does not mean that these systems must be used in this way due to technical constraints. In this sense, collaborative writing, for example, can be used to support asynchronous interaction, but the literature on organisational groupware applications supports the assumption that this type of groupware systems is more widely used to support synchronous interaction in the same place. A brief analysis of this relationship between taxonomies and related literature is provided next.

The discussion of advantages and disadvantages of AG can give the impression that advantages overcome disadvantages, provided that different types of advantages have similar weights. How-

ever, there is little support, even intuitive, to this assumption. For example, the perception that communication is faster and cheaper when supported by AG seems to be more important than the perception that it can reduce group member stress from participation in group discussions [Chidambaram and Jones, 1993; Sproull and Kiesler, 1991; Stevenson, 1993].

The impression that the AG advantages overcome the disadvantages conveyed by their comparison could have been caused by a biased in the literature review. For example, one may have unconsciously reviewed only those journal that discuss the main advantages of AG. Similarly, there may have been a bias in the groupware research community, in the study of AG with emphasis on the its positive rather than its negative aspects, as it relates to KM groups. The literature supports this view by saying that: "...A technological determinist vein also permeates the academic literature that focuses more narrowly on the nature of computer-mediated communication (CMC). The literature characterizes CMC as a social, more impersonal deindividuating, and ruder and more uninhibited medium than face-to-face communication. All of these studies were done in organizations or university settings and used either workers who had just been introduced to e-mail systems or student subjects who were not necessarily computer users" [Franco, Hu, Lewenstein, Piirto, Underwood, and Vidal, as cited in, Lesser, E. L., Fontaine, M. A., & Slusher, J. A., 2000:210].

Table 4.1: Advantages and disadvantages of asynchronous groupware

Over no groupware support at all	Over synchronous groupware
<b>Advantages</b> <ul style="list-style-type: none"> <li>• Communication becomes faster and cheaper</li> <li>• Paper flow is reduced</li> <li>• Filing becomes easier</li> <li>• Cross-departmental communication is increased</li> <li>• Stress is reduced</li> <li>• Individuals communicate more openly</li> <li>• Contributions are better distributed</li> <li>• Ideas are separated from individuals</li> <li>• Repetition of old ideas is reduced</li> <li>• Commitment to group outcomes is increased</li> </ul>	<ul style="list-style-type: none"> <li>• A higher degree of parallel work is fostered</li> <li>• Disruption is reduced</li> <li>• Expenses with technology purchase are reduced</li> <li>• Resemblance to common artifacts is higher</li> </ul>
<b>Disadvantages</b> <ul style="list-style-type: none"> <li>• Broad access to networked computers is required</li> <li>• Information overload is a common complaint</li> <li>• Reduced social contact leads to dissatisfaction</li> <li>• Managers lose control over subordinates</li> </ul>	<ul style="list-style-type: none"> <li>• Facilitation is hindered</li> <li>• Feedback is delayed</li> </ul>

The impression conveyed by the comparison summary, though, is consistent with conclusions of previous studies, regarding the advantages of groupware in general over traditional non

groupware-supported interaction [Johansen, 1988; Wilson, 1991]. It is also consistent with previous studies where groupware is discriminated consonantly with the application-level taxonomy, which generally highlight AG advantages over non groupware-supported interaction and synchronous groupware [Stevenson, 1993; Grudin, 1988; 1994]. Assessments based on business measures of return on investment provided by groupware-mediated interaction in general against traditional non groupware-supported modes of interaction point in the same direction.

The discussion above indicates that the general literature on empirical studies of groupware support widely acknowledges a number of potentially beneficial effects of its use as a tool for BPI groups [Matthews, 1994]. In spite of this, related empirical research has apparently been very limited. There have been some representative examples of research studies where groupware was used to support BPI groups, such as Pietro's (1992) study of quality improvement groups. Dennis & allupe 1(1993) study of one BPR group, Dennis, Daniels, Hayes & Nunamaker, (1994) and Dean & Snell (1995) studies of business process modelling groups, Vreede's (1995) study of dynamic organisational modelling and change groups, and Kock's (1999) study of the effects of asynchronous groups on BPI. However, these studies focused on SG tools, particularly group decision support systems. In the researcher's review of the groupware, BPI and KM literature, including a final review at the time of the writing of this thesis, one found no instance of empirical study of AG effects on group-based KM efforts. This review included, but was not limited to, a review of printed issues of 50 major IT, KM and IC journals; published from 1985 to date. This also include full-text and abstract-based review of articles obtained through an extensive keyword and general text searching on the ABI-Inform Global, Academic Premier, ACM Digital Library, Anbar, Emerald, ProQuest Research Library, Social Sciences, Science Direct Elsevier, et cetera, electronic databases and citation indexes.

The dearth in the literature of the impact that group-based KM projects were having on the BI of organisations, plus the comparatively strong focus on group decision support systems, seems curious since, as discussed in this chapter, these latter systems have had a very modest commercial success when compared with some instances of AG systems, such as e-mail, and are thus currently less likely to be found in organisations [Grudin, 1988; 1994]. Consequently, may reasonably argue that KM research focused on SG is less likely to lead to findings that are of direct interest to a wide range of organisations than BPI, KM and BI, or for that matter IC research on AG tools, particularly e-mail, which calls for at least a better balancing of the research focus.

## 4.7 Summary

Groupware is a generic term used to refer to computer-based systems which are particularly used to support groups of people engaged in common tasks in organisations. Typically, these groups are small, business oriented, and have relevant tasks with definite deadlines. This definition provides a basis for distinguishing groupware from CSCW systems in general, which may or may not be used by small business-oriented groups. In this sense groupware systems can be seen as a sub-class of CSCW systems whose main characteristic is a stronger commercial appeal within the business community in general.

Groupware systems can themselves be classified according to taxonomies. The two most widely accepted taxonomies appear to be the application-level and the time-space taxonomies. In the application-level taxonomy, groupware systems are classified according to the main functions provided to users. In the time-space taxonomy, groupware systems are classified according to temporal and physical distribution of the users while interacting. The most important class of groupware within the context of this research is called different-times and different-places in the time-space taxonomy, or simply asynchronous groupware. This class of groupware supports asynchronous and distributed interaction. Group members typically interact from different rooms in the same building or in different buildings irrespective of how far they are from each other - e.g. they can be in different countries. The groupware classes referred to as asynchronous computer conferencing, workflow control and electronic mail, in the application-level taxonomy, generally fall into this category in the time-space taxonomy, which indicates a close interrelation between the two taxonomies.

The comparison of AG with traditional non-groupware interaction, unveils positive aspects from three main points of view. First, it can provide better support to group activities. Second, it can change individual behaviour for better in groups. Third, it can impose a new structure for interactions, which may in turn yield positive changes in the socio-technical environment.

The comparison between AG and SG brings to light positive aspects from two perspectives. First, the characteristic of allowing communication at different times shows to be less disruptive and more suitable when parallel work is involved. Second, from a technical perspective, AG tends to resemble common (non-computerised) artefacts and are less expensive.

The negative aspects that arise from the comparison between AG and non-groupware interaction

are associated with costs and human factors. The introduction of AG in organisations, typically requires heavy investment and thus evidence of return on this investment, which is often difficult to be quantified. The human factors related to the negative aspects of AG are: (a) User inability to deal with the increased amount of information to which they are usually subjected; (b) User dissatisfaction caused by lack of social contact; and (c) The impotence of hierarchy-minded managers to handle the new communication-free work environment.

AG shows potential to be used as a support tool for KM groups. In spite of this, related empirical research has apparently been very limited. There have been some representative examples of research studies where groupware was used to support KM groups, but these studies focused on SG tools, particularly group decision support systems. This contrasts with the very modest commercial success of SG systems in general when compared with some instances of AG systems, such as e-mail, which calls for at least a better balancing of research focus. This research is in part a response to this call.

## Part II

# Research Question and Methodology



## Chapter 5

### The Research Question

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*If knowledge is the ability to act, then knowledge management should be about our ability and propensity to act*

*David Gurteen – Knowledge Consultant.*

#### 5.1 Introduction

This research is a study in the general field of MIS. It is directed towards the development of systematic knowledge concerning how KM as a component of business strategy, and AG as a component of information technology, can impact the value propositions of organisations [Lotus 1998; Davenport et al., 1997; von Krogh, Ichijo and Nonaka, 2000; Campbell and Pellissier, 2001]. In order to do this, the phenomenology research approach was combined with that of positivism. The strengths of the advantages of both positivism and phenomenology outweigh their disadvantages when they are combined in the same piece of research. The literature on research methods [Robson, 1993; Hakim, 1987; Buchanan et al., 1988:59]; as cited in Saunders, et al., (1997) in terms of the need for defining a clear research strategy identified three different research strategies. These are experiments, survey and case study. These three strategies may also be extended by either cross-sectional or longitudinal ways of approaching the three main research strategies. The present investigation has settled on the survey and case study strategies. However, the application of the case study research strategy in this research has been combined with that of AR. This modified case study (AR) strategy is discussed in greater detail in section 5.2.

#### 5.2 The research approach and strategy

At the start of this research there seemed to be a bias in groupware research in general towards experimental studies [Davison, 1995]. This was, perhaps, a consequence of the predominance of

positivist research approaches in the IS discipline in general [Orlikowski and Baroudi, 1991]. It was also observed that there was a lack of consistency in the research frameworks used [Pervan, 1994]. The present study concludes that these characteristics of groupware research may have contributed substantially to the large number of contradictory research findings regarding the impacts of groupware technologies on KM strategies and initiatives, and also the impacts these groupware systems have on group processes and task attributes [Gartner Group, 1999; DeSanctis et al., 1993; Dennis and Gallupe, 1993].

It may be argued that the groupware research bias towards experimental studies has led to difficulties in the replication of findings in organisations. It is our considered belief that one of the main reasons for these difficulties is the suppression (or artificial inclusion), even in field experiments where little control is applied, of the effects of variables present in (or absent from) actual organisational contexts. This can in turn lead to startling discrepancies in technology impact findings, as posited in Orlikowski's (1992) study of the influence of organisational culture on the adoption of groupware technology, and the contrast of its findings with those of previous experimental studies on groupware adoption and use [Lillemor and Hjelmquist, 1991; Sheffield and Gallupe, 1993].

It is our intention, here, to change the conventional research approach by adopting an approach that tries to take into account the full richness of organisational interactions and yet exert a minimal amount of artificial control on the organisational environment being studied. This research approach is a combination of AR and case study, but not AR in its strictest sense. The culture of the organisation plays a significant role in the organisation being studied; as such the nuances and characteristics of the people motivated the outcome of this research. AR for this researcher, includes participatory research, collaborative inquiry, emancipatory research, action learning, and contextual AR. These of course are all variations on a theme. The present study subscribes to the definition, which states that:

Action research . . . aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously. Thus, there is a dual commitment in action research to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and client, and thus it stresses the importance of co-learning as a primary aspect of the research process. [Winter, 1989:12]

The approach then is a hybrid of classical AR, and one which may be classified as an ethnographic approach. This ethnographic approach to intervention in the organisation takes into

consideration the culture of both the organisation and the employees within this milieu. The distinguishing feature of AR, from general management consultancy, or other professional practices involving problem-solving is the emphasis on scientific study, that is, the researcher studies the problem systematically and ensures the intervention is informed by theoretical considerations. In this scenario, the researcher's time is spent on refining the methodological tools to suit the exigencies of the situation, and on collecting, analyzing, and presenting data on an ongoing, and cyclical basis.

Several attributes separate AR from other types of research. Primary, is its focus on turning the people involved into researchers, too – people learn best, and more willingly apply what they have learned, when they do it themselves. It also has a social dimension – the research takes place in real-world situations, and aims to solve real problems. Finally, the initiating researcher, unlike in other disciplines, does not attempt to remain objective, but openly acknowledges their bias to the other participants.

### 5.2.1 Principles of AR

The literature informs us that the attributes, which give AR its unique characteristics, is the set of principles that guide the research. Winter (1989) provides a comprehensive overview of six key principles.

**1. Reflective critique** An account of a situation, such as notes, transcripts or official documents, will make implicit claims to be authoritative, i.e., it implies that it is factual and true. Truth in a social setting, however, is relative to the teller. The principle of reflective critique ensures people reflect on issues and processes and make explicit the interpretations, biases, assumptions, and concerns upon which judgments are made. In this way, practical accounts can give rise to theoretical considerations.

**2. Dialectic critique** Reality, particularly social reality, is consensually validated, which is to say it is shared through language. Phenomena are conceptualized in dialogue; therefore a dialectical critique is required to understand the set of relationships both between the phenomenon and its context, and between the elements constituting the phenomenon. The key elements to focus attention on are those constituent elements that are unstable, or in opposition to one

another. These are the ones that are most likely to create changes.

**3. Collaborative resource** Participants in an AR project are co-researchers. The principle of collaborative resource presupposes that each person's ideas are equally significant as potential resources for creating interpretive categories of analysis, negotiated among the participants. It strives to avoid the skewing of credibility stemming from the prior status of an idea-holder. It especially makes possible the insights gleaned from noting the contradictions both between many viewpoints and within a single viewpoint.

**4. Risk** The change process potentially threatens all previously established ways of doing things, thus creating psychic fears among the practitioners. One of the more prominent fears comes from the risk to ego stemming from open discussion of one's interpretations, ideas, and judgments. Initiators of AR will use this principle to allay others' fears and invite participation by pointing out that they, too, will be subject to the same process, and that whatever the outcome, learning will take place.

**5. Plural Structure** The nature of the research embodies a multiplicity of views, commentaries and critiques, leading to multiple possible actions and interpretations. This plural structure of inquiry requires a plural text for reporting. This means that there will be many accounts made explicit, with commentaries on their contradictions, and a range of options for action presented. A report, therefore, acts as a support for ongoing discussion among collaborators, rather than a final conclusion of fact.

**6. Theory, Practice, Transformation** For action researchers, theory informs practice, practice refines theory, in a continuous transformation. In any setting, people's actions are based on implicitly held assumptions, theories and hypotheses, and with every observed result, theoretical knowledge is enhanced. The two are intertwined aspects of a single change process. It is up to the researchers to make explicit the theoretical justifications for the actions, and to question the bases of those justifications. The ensuing practical applications that follow are subjected to further analysis, in a transformative cycle that continuously alternates emphasis between theory and practice.

The researcher uses these principles, as discussed above, in the iterations of the case study,

at Directorate, in Chapter 10. The choice of AR is informed in the main by the fact that AR is used in real situations, rather than in contrived, experimental studies, since its primary focus is on solving real problems. It can, however, be used by social scientists for preliminary or pilot research, especially when the situation is too ambiguous to frame a precise research question. Mostly, though, in accordance with its principles, it is chosen when circumstances require flexibility, the involvement of the people in the research, or change must take place quickly or holistically. The case of developing a workflow management system for Directorate is justified [cf. 10.1].

It is often the case that those who apply this approach are practitioners who wish to improve understanding of their practice, social change activists trying to mount an action campaign, or, more likely, academics who have been invited into an organization (or other domain) by decision-makers aware of a problem requiring action research, but lacking the requisite methodological knowledge to deal with it.

### 5.2.2 Situating AR in a research paradigm

**1. Positivist paradigm** The main research paradigm for the past several centuries has been that of logical positivism. This paradigm is based on a number of principles, including: a belief in an objective reality, knowledge of which is only gained from sense data that can be directly experienced and verified between independent observers. Phenomena are subject to natural laws that humans discover in a logical manner through empirical testing, using inductive and deductive hypotheses derived from a body of scientific theory. Its methods rely heavily on quantitative measures, with relationships among variables commonly shown by mathematical means. Positivism, used in scientific and applied research, has been considered by many to be the antithesis of the principles of AR [Susman and Evered 1978; Winter 1989].

**2. Interpretive paradigm** Over the last half century, a new research paradigm has emerged in the social sciences to break out of the constraints imposed by positivism. With its emphasis on the relationship between socially engendered concept formation and language, it can be referred to as the interpretive paradigm. Containing such qualitative methodological approaches as phenomenology, ethnography, and hermeneutics, it is characterized by a belief in a socially constructed, subjectively based reality, one that is influenced by culture and history. Nonetheless

it still retains the ideals of researcher objectivity, and researcher as passive collector and expert interpreter of data.

**3. Paradigm of praxis** Though sharing a number of perspectives with the interpretive paradigm, and making considerable use of its related qualitative methodologies, there are some researchers who feel that neither it nor the positivist paradigms are sufficient epistemological structures under which to place AR [Lather 1986; Morley 1991]. Rather, a paradigm of Praxis is seen as where the main affinities lie. Praxis, a term used by Aristotle, is the art of acting upon the conditions one faces in order to change them. It deals with the disciplines and activities predominant in the ethical and political lives of people. Aristotle contrasted this with Theoria – those sciences and activities that are concerned with knowing for its own sake. Both are equally needed he thought. That knowledge is derived from practice, and practice informed by knowledge, in an ongoing process, is a cornerstone of AR. Action researchers also reject the notion of researcher neutrality, understanding that the most active researcher is often one who has most at stake in resolving a problematic situation.

### 5.2.3 Case study

Organisational AR studies are characterised by the researcher applying positive intervention to the client organisation, while collecting field data about the organisation and the effects of the intervention [Levin, 1946; Peters and Robinson, 1984; Jonsson, 1991]. AR is a collaborative approach to inquiry or investigation that provides people with the means to take systematic action to resolve specific problems. Stringer (1999:17) asserts that:

[T]his approach to research favours consensual and participatory procedures that enable people:

- to investigate systematically their problems and issues,
- to formulate powerful and sophisticated accounts of their situations, and
- to devise plans to deal with the problems at hand.

He further suggests that

...action research focuses on methods and techniques of inquiry that take into account people's history, culture, interactional practices, and emotional lives.

This characteristic of ethnographic AR, provides a particularly solid ground for our decision to use AR in this study.

The researcher visited a number of organisations in Botswana, in order to select an appropriate organisation in which to conduct the research. In that search, only the Public Service was using AG, in a limited way, to support group-based KM efforts. This was however, still in its infancy. As a consequence of the state of the implementation of an AG management system in the Botswana Public Service, it was decided that both an on-site and an interview-based case study approach would be used with the AR methodology. The motivation here is to inform the development of a model which could be used to foster better BI through a more robust component interaction in distributed systems.

In this thesis, the researcher therefore opted for the following two alternative research approaches: Survey research, which is characterised by a certain degree of artificial control, but still permits a clear and rigorous elaboration of a logical model which clarifies the deterministic system of cause and effect; and case study (includes, both the on-site and interview-based case study approaches), which is by nature, is low in artificial control. This is a cross fertilisation of the AR approach and the case study approach. The two are merged and will be hereafter called the “case study”, this is for ease of explanation and acceptance. This research will also be validated through two exploratory surveys on the awareness of KM practices and strategies in organisations, and how these strategies are being implemented through the use of AG systems. One will now discuss how these approaches were used to achieve the intended research objectives [cf. 1.2.1].

The case study research strategy is used to attempt to explain some of the implementation challenges being faced by Directorate in its efforts to implement a human resources WMS. The findings and results from the exploratory and KMP survey research will be used as the hermeneutics for the case study in the main, and along with the AR taxonomy. These are presented in Chapter 7 and Chapter 8, respectively, whilst the findings from selected iterations of the AR cycle at Directorate are presented in Chapter 10.

Given the previous research bias towards experimental research and its likely negative consequences, the researcher naturally opted for the AR (with the interventionist case study methodology) approach. The researcher nevertheless feels that because of the scope and opportunities of KM the survey research methodology will also be used to validate the outcome of the iterations from the AR taxonomy. The client organisation of this study was Directorate, a department of the Botswana Government with offices spread throughout the country (the organisation name used here is a pseudonym).

The specific AR approach followed is described next, and is modelled on the taxonomies in [Kock, McQueen and Fernandes, 1995; Kock, McQueen and Scott, 1995]. The approach is centred on the action research cycle proposed by Susman and Evered (1978), and Susman (1983), which comprises five stages, and are illustrated in Figure 5.1:

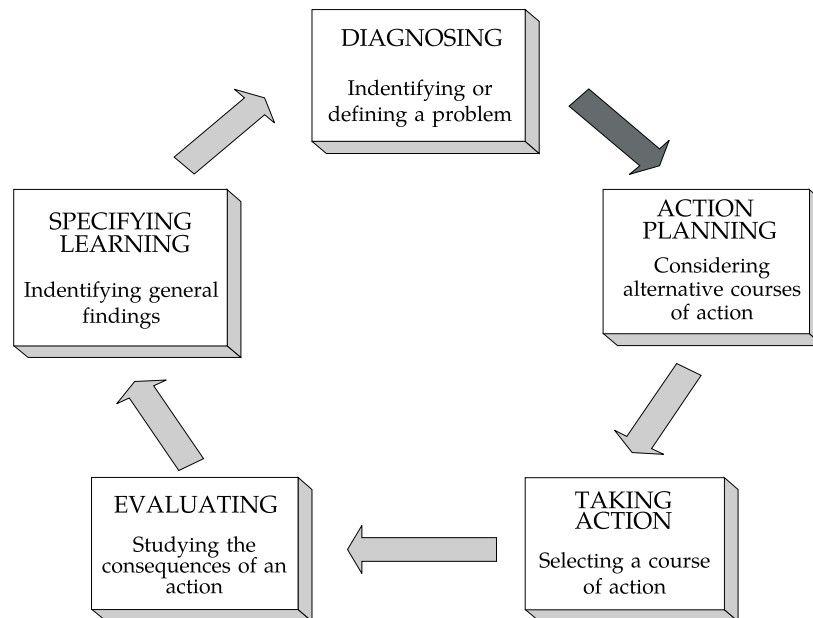


Figure 5.1: Action Research, [from Susman, 1983]

Following below are their related expected outcomes in each stage:

1. Diagnosing: The researcher and client organisation identify and specify an opportunity for organisational productivity and improvement in the client organisation and match it with the research goals;
2. Action Planning: The researcher and client organisation consider alternative courses of action to attain the improvement and change orientation identified, and devise a plan to implement one of these alternative courses of action;
3. Action Taking: The researcher and client organisation implement the devised plan;
4. Evaluating: The researcher and client organisation assess the outcomes of the plan implementation, and
5. Specifying learning: The researcher identifies and describes *general findings* based on the information generated in the previous stage.



These models are initially expected to be only descriptive, rather than predictive, since the close involvement of the researcher with the environment (Directorate) being studied leads, to the study of a small number of instances of particular events. However, as the number of AR studies carried out on a similar topic grows, their resulting descriptive models can then be integrated into more general and predictive models, and eventually lead to “grand theories” [Strauss and Corbin, 1990]. In this research, one believes that the cyclic nature of AR will increase the level of internal consistency and validity of the results. This then informs the general principles of AR. These have already been discussed in section 5.2.1.

### 5.3 Exploratory Survey

#### 5.3.1 Research objectives and design

**1. Instrument development** The research objectives and research design have already been discussed in section 1.2. They are repeated here, at the risk of redundancy, but in order to provide completeness in the evidence at hand, they are presented again.

For the survey, one was motivated in part by the role that AG systems and applications play in facilitating and enabling the implementation of KM projects and strategies. The researcher’s interest was galvanised by the ongoing debates in the literature on KM, BI, IC, and their impact on the CA of the organisation. One thread runs through all the debate in the literature [Brancheau, Janz, and Wetherbe, 1996], that of the integral role of IT, and its supportive infrastructure. These debates informed the present study conceptually. Chief among them, were, the exploratory survey of IT executives featuring the technology issues most important to them, where they indicated that the development of a flexible IT infrastructure was their number one priority [Brancheau et al., 1996:225-242].

**2. IT infrastructure** Davenport and Linder (1994: 885-899) reach the same conclusions in a similar study. They suggest that a flexible IT infrastructure is the new competitive weapon and note that it is crucial in developing sustained CA. Rockart et al [Parsons 1983:3-14], attest that an effective infrastructure is a pre-requisite for doing business globally, where the sharing of information and knowledge is vital. In a recent interview, James Cash asserts, “A relatively unheralded component of a company’s competitiveness today is the flexibility and adaptability of

its IT infrastructure. The importance of having a robust infrastructure on which the frequently changing strategy and tactics of a contemporary company can be quickly built has dramatically increased”<sup>1</sup>. The literature relates that, as the number of infrastructure services increase in an organisation, the value of that infrastructure to overall strategic objectives also increases [Broadbent, Weill, O’Brien and Neo, 1996:174-194].

The present study takes the view that while the literature supports the argument that there is a need for a degree of flexibility and adaptability in an organisation’s IT infrastructure, the supporting empirical evidence upholding this view of the value of a flexible IT infrastructure is unproven. From the research, this seems to be evident, in the case of the Commonwealth of Nations. In this thesis, an attempt will be made to examine the organizational value of an adaptive and flexible infrastructure, as it relates to asynchronous groupware, and its enabling role in KM strategies and practices. Since the empirical evidence is sparse, in terms of KM strategies and practices in the Commonwealth of Nations, this study uses an exploratory approach. Specifically, it employs bivariate correlation analysis to explore the relationship between AG and competitive advantage, as it relates to KM strategies and implementation.

The literature that relates to AG, KM, IC, BI, IT infrastructure, and CA provides the conceptual bases for this part of the thesis research [Broadbent, Weill, O’Brien and Neo, 1996:174-194; Girard, 2004:21]. The conceptual model, which illustrates the relationship between the KM nexus and CA (IT and BI), is shown below, in Figure 5.2 and is discussed next.

The capabilities of IT associated with the term “infrastructure” vary somewhat. McKay and Brockway (1989: 1-11), call the “IT infrastructure”, the enabling foundation of shared IT capabilities, upon which the entire business depends. Weill, (1993:547-572), notes that the “IT infrastructure” is a foundation for capability across business and functional units of the organisation. Davenport and Linder (1994:885-899), on the other hand, refer to the “IT infrastructure” as that part of the organisation’s information capacity intended to be shared. They conclude that an “IT infrastructure” is a firm’s institutionalised IT practice. That is to say, the specific business activities and computer applications are built on the consistent foundation. Other researchers support this view, notably Rockart, Earl and Ross (1996). They reflect on the ideal goals of an IT infrastructure as follows:

... an IT infrastructure of telecommunications, computers, software, and data that is inte-

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<sup>1</sup>Infrastructure’s importance, Information Week, Issue 713, (1998) 154-156.

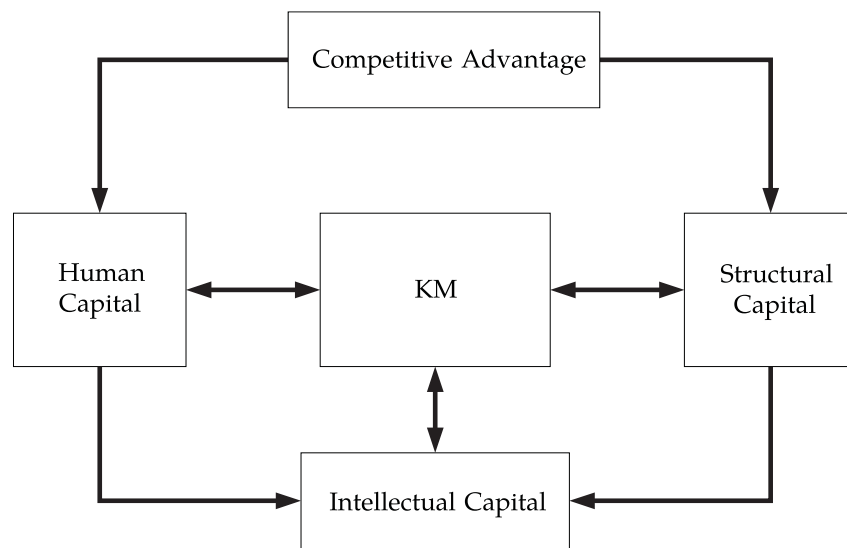


Figure 5.2: Knowledge Management Nexus

grated and interconnected so that all types of information can be expeditiously – and effortlessly, from the users viewpoint – routed through the network and redesigned processes. Because it involves fewer manual or complex computer-based interventions, a ‘seamless’ infrastructure is cheaper to operate than independent, divisional infrastructures. In addition, an effective infrastructure is a pre-requisite for doing business globally, where the sharing of information and knowledge throughout the organisation is increasingly vital. [Rochart, et.al., 1996]

Duncan (1995:37-57) describes IT infrastructure as a set of shared, tangible IT resources forming a foundation for business applications. These, composing an *IT infrastructure*, are platform technology (hardware and operating systems), network and telecommunication technologies, data, and core software applications. Keen, (1991) defines the *IT infrastructure* or the *IT platform*, in terms of reach and range.

Reach determines the locations to which the infrastructure can link from workstations and computers in the same department to domestic customers and suppliers, including international locations, to anyone anywhere. Range, on the other hand, determines the information that is shared directly and automatically across services and systems. Broadbent and Weill (1997:77-99), and Henderson and Venkatraman (1994: 203-220) separate the IT infrastructure into IT architecture and IT skills.

The study concurs with their views and take the position that the first pertains to the applications, data, and technology configurations choices as they relate to the use of AG. In this thesis, the IT infrastructure component is measured with the technological infrastructure component, which has fifteen items. It is also measured it in the AG component, which has eighteen items.

The domain of the construct, AG, is compared to the technical and human components of the “IT infrastructure” of a firm, in order to provide more clarity to the research design. These views are graphically, reproduced in Figure 5.3, for illustration purposes although they have been previously discussed,.

From the literature, the skills and HK component relate to the knowledge and capabilities required to manage the human and social capital resources within the organization, using AG. This is measured with both the HK and structural knowledge (SK) measures, using five and fourteen items, respectively.

Hypotheses 1 and 2 to further test and confirm these views.

Hypothesis 1 will test the relationship between the structural knowledge (capital) (SC), human knowledge (capital) (HC) and AG constructs.

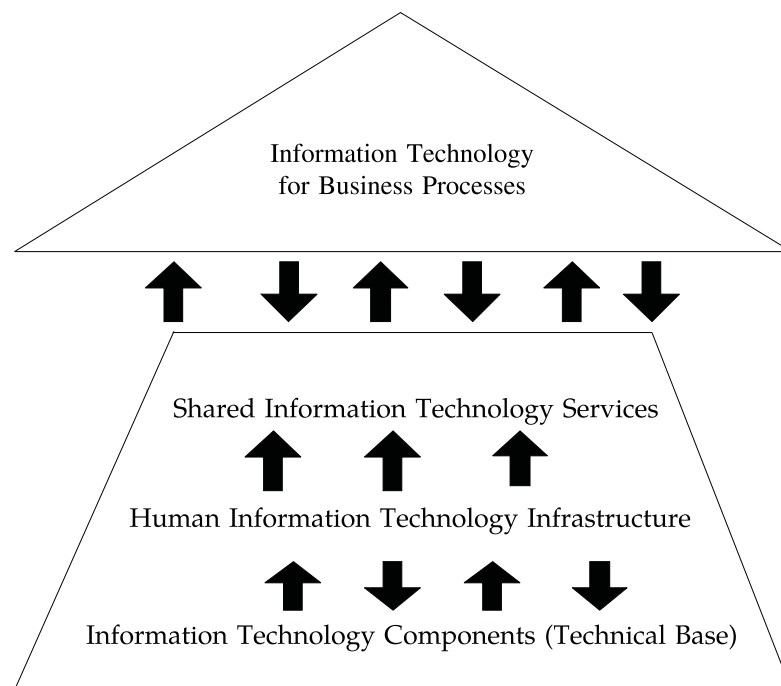


Figure 5.3: Model depicting technical and human components of IT infrastructure  
Source: [Adapted from Broadbent and Weill, 1997]

Hypothesis 2, on the other hand, will test the relationship between the BI and AG constructs, and their covariances with SC and HC. The BI and AG components have twenty five and eighteen items respectively.

The conceptual research model, which is depicted in Figure 5.4 and further supported by the

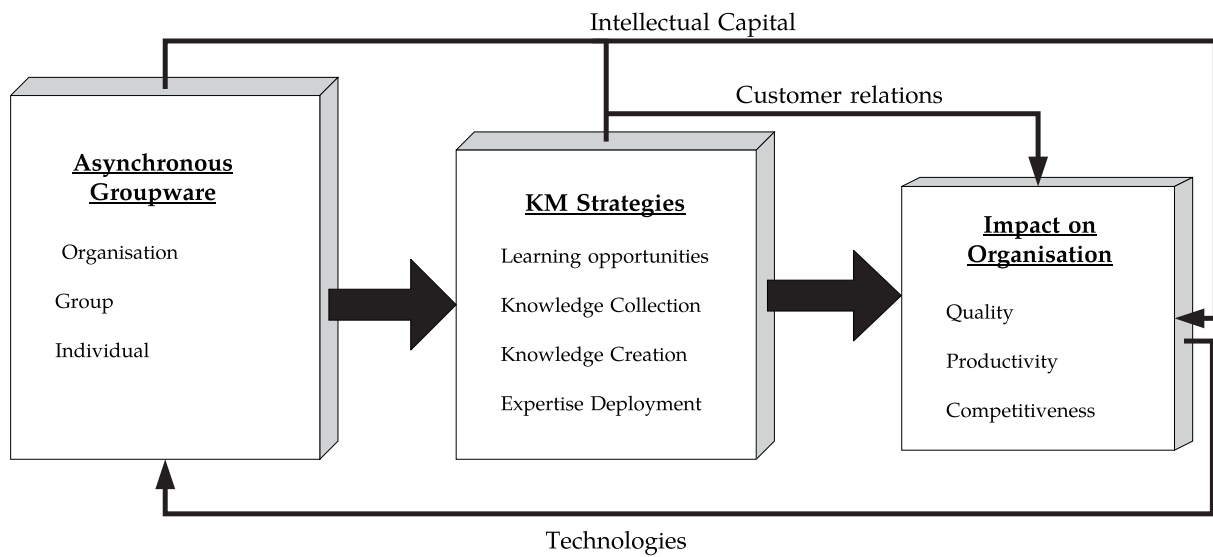


Figure 5.4: Research Model

structural framework in Figure 5.5, informs the test and validation of the research hypotheses (1 and 2): Research framework for hypotheses 1 and 2. The dimensions of CA, by extension BI is measured with both the performance analysis and business intelligence constructs, (see Table 5.1). These two constructs have twelve and twenty five items, respectively. Hypothesis 3 will test the relationship between the efforts of task-related outcomes and those of group-related outcomes, in the use of AG technology, in assessing the productivity and performance-oriented initiatives of organisations. Hypothesis 4, on the other hand, will be used to test the relationship between the efforts of the individual in task-related outcomes and those of individuals in team-related outcomes, in the use of AG technology, in assessing the productivity and performance-oriented initiatives of organisations. Whilst the test and validation of research hypotheses 3 and 4 are informed, conceptually by the research model, depicted in Figure 5.4. The structural frameworks of Figures 5.6 and 5.7, respectively are used to aid the examination of these hypotheses.

**3. Competitive advantage** Managers are constantly scanning the environment to see how they can leverage the CA of their organisations with their limited resources. Michael Porter made the concept of CA popular [Porter, 1980, 1985]. He says that CA grows from the value a firm is able to create that exceeds the firm's cost of creating the product or service.

From the foregoing, one was able to narrow one's interest and research aims and objectives, to examine those aspects of the IT infrastructure (AG) of an organisation, which allows it to

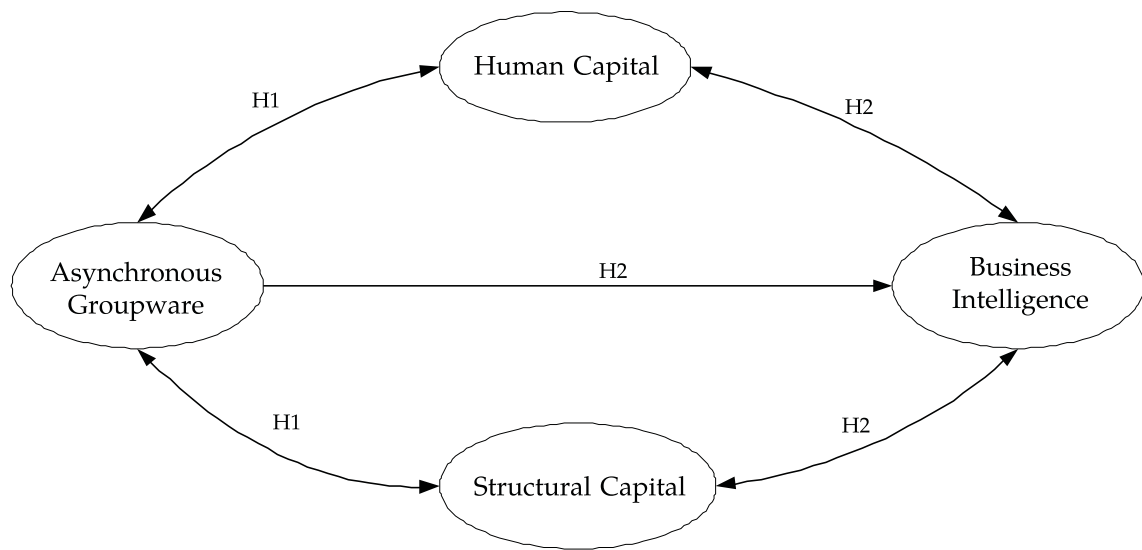


Figure 5.5: Research framework for hypotheses 1 and 2

better harness its CA through the uses and application of KM strategies and practices. The broad research aims of this study is set out next.

This research has two broad aims, which are to examine:

1. How KM strategies are enabled by the support of AG systems [cf. Figure 5.4], and
2. How organisations are successfully implementing KM projects and practices in order to improve their CA and BI [cf. Figure 5.2]

The objectives of this research, as presented earlier, in Chapter 1 [cf. 1.2.1] sought to answer the following fundamental questions in terms of how an organisation maps its KM efforts – its knowledge strategy – to the key performance aspects of its business strategy, through the support and use of AG systems [cf. Figure 5.3].

The research questions of this thesis are thus framed:

1. How are KM strategies enabled by the support of AG systems?
  - How can organisations successfully integrate AG technology into their KM efforts with a view to self-improve their quality, productivity, and overall competitiveness?
  - How are organisations assessing the productivity and performance-oriented initiatives attributed to the efforts of task-related and group-related outcomes in their use of AG technology?

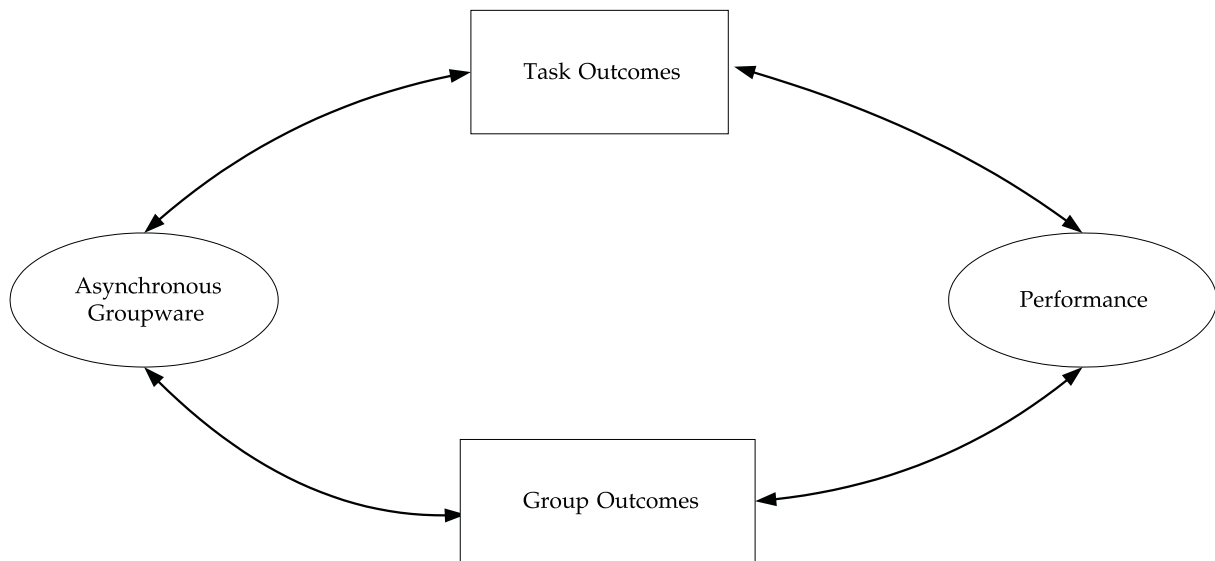


Figure 5.6: Research framework for hypothesis 3

- How are organisations assessing the productivity and performance-oriented initiatives attributed to the efforts of the individual in terms of the task-related and team-related outcomes, in their use of asynchronous technology (The customer relations efforts of the firm [cf. Figure 5.4 Research Model]).
2. If implemented successfully, KM will help organisations short-cycle internal process, cut costs, and operate more effectively. Some organisations have realized millions in cost-saving benefits from knowledge efforts. The secondary research question is therefore concerned with: how can organisations successfully implement KM projects and practices.)

Given the foregoing, four research hypotheses were conceived to investigate how organisations operating in the current knowledge economy of the twenty-first century were sustaining high performance levels and achieving their CA. As a corollary to this, the research will also investigate how organisations may successfully embark on a knowledge-focussed strategy.

The literature review informed this research motivation towards the design of the hypotheses. The survey component of this research used a nomothetic approach in attempting to compare the degree of the relationship between policies and strategies as they relate to KM, and those of AG. This is the focus of hypotheses 1 and 2. Whilst in hypotheses 3 and 4 one is interested in the productivity and performance-oriented initiatives attributed to the use of AG. The present study will also explore whether there is any evidence that KM systems and practices are creating new dialogue for the implementation of KM initiatives in organisations.

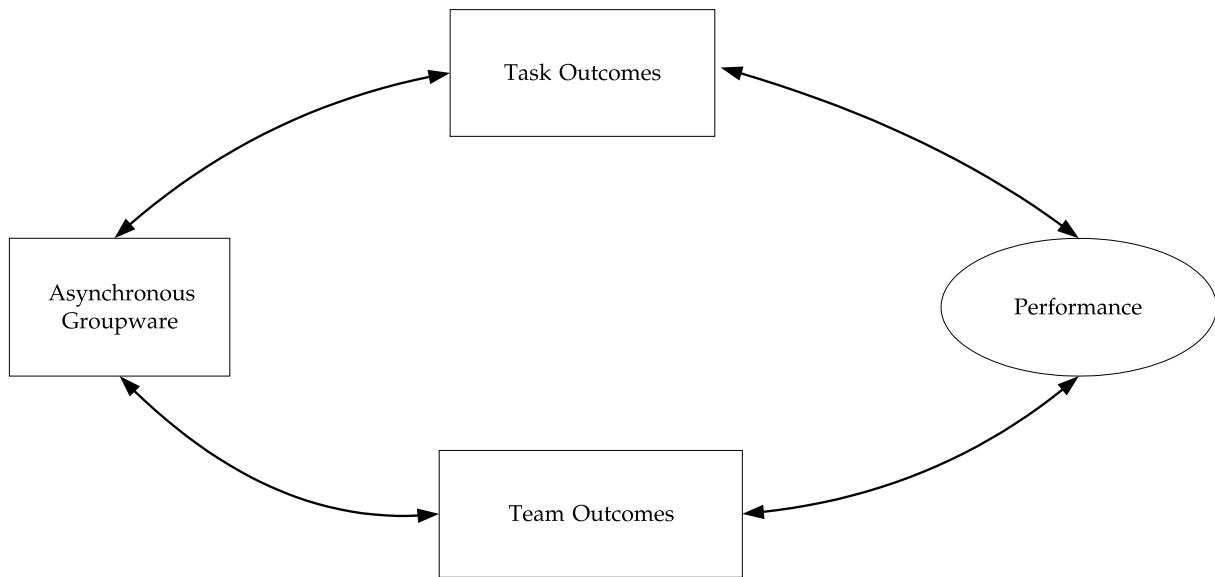


Figure 5.7: Research framework for hypothesis 4

### 5.3.2 Research hypotheses (Design)

The supporting literature for the choice of these four research hypotheses have been motivated and discussed in Chapter 1, section 1.2.4. It is felt that it is necessary, to again, present the null hypotheses here, so that the statistical models and tests that will be used to answer the research questions can become clearer, and better demonstrate how the various investigations of the research problem for the Exploratory Survey were handled. The null hypotheses is reproduced here, because there has been a detail treatment of all the hypotheses in Chapter 1

*Null Hypothesis 1* There is no statistically significant correlation or relationship between the policies and strategies used in organisations for KM practices and those of AG systems, to self-improve their quality, productivity and competitiveness.

*Null Hypothesis 2* There is no statistically significant correlation or relationship between the integration of AG technology into organisations' KM practices and their strategies to self-improve their quality, productivity, and overall competitiveness.

*Null Hypothesis 3* There is no statistically significant difference between the way organisations assess the productivity and performance-oriented initiatives attributed to the efforts of task-related outcomes, and those of group, in the use of AG technology.

*Null Hypothesis 4* There are no statistically significant differences between the ways organi-



Table 5.1: Research constructs and metrics

CONSTRUCTS	ITEMS	METRICS
1. Current state of KM	7	(1) Organise information, (2) Awareness of KM, and (3) Transferred organize business [Bawang, S. 2000:3]
2. Human Knowledge	5	(1) Loss of best practice in specific area, (2) Loss of significant income, (3) Loss of vital information and (4) Employees provided with Information. [Hall, R and Andraiani P. 1999:45 Nonaka and Takeuchi, 1995]
3. Structural Knowledge	14	Knowledge: identification, development (Nonaka and Takeuchi, 1995), Acquisition, sharing, entry, storage, classification, location, filtering, preparation, transfer, use, evaluation, retaining and updating. (Nonaka and Takeuchi; 1995, Nonaki,1991 Zack,1999, Sarvary,1999), [cf. 3.2.1 – 3.2.15]
4. Technological Infrastructure	14	(1) Internet access for KM, (2) Intranet infrastructure, (3) Document Mgmt. System, (4) Groupware system,(5) Data warehousing and data mining, (6) Decision support system, and (7) Extranet support infrastructure for KM [Spear and Bowen,1999, Sveiby.1996, Harty and Fenner, 1998, Mentzas and Apostolu,1998, Materson and Watt,1999, Jackson, 1998]
5. Business Intelligence	25	(1) Strategy is important for KM initiative, (2) Sharing best practice, (3) Dedicated KM role, (4) Dedicated budget, (5) Developing and measuring IC. [Davenport,et al, 1999, Caray annis, 1999, Drucker et al., 1999, Spear andBowen, 1999, Hendriks and Vriens, 1999; Bennett, 1996, Hope and Hope, 1996; Havens and Knapp 1999; Wah, 1999]
6. Performance Analysis	12	(1) Better decision-making, (2) Improving productivity, (3) Sharing best practice, (4) Component interaction between technologies, and (5) Overall business performance [Cune, 1999, Bolisari and Scario, 1999, Edvinsson and Sullivan, 1996; Petrash, 1996, Evans and Wurster, 1997, Baldwin and Clark, 1997, Christensen, 1997]
7.Asynchronous Groupware	18	Organisation: Knowledge and Infrastructure sharing. Group: information access. Individual: Learning. [Johansen, 1988, Ellis et. al. 1991, McQueen. 1993, Willins et. al; 1991; Warner, 1996. Sarvary, 1999, Hansen et al; 1999; Hiebeler 1996; McCune 1999, Spear and Bowen, 1999; Takeunchi and Nonaka 1986, Nonaka 1991].

sations assess the productivity and performance-oriented initiatives attributed to the efforts of the individual in task-related outcomes in their use of AG technology, and those of individuals in team-related outcomes.

In seeking to test those hypothesis, using the research model 5.4, an exploratory factor analysis (EFA) will be performed on the ninety five items of the instruments to explore the data. This is with the aim to determine the number or nature of the factors that account for the covariation between the variables used to test these hypotheses. Hence, the use of the exploratory factor analysis is due to the lack of, a priori, sufficient evidence to form any hypothesis about the number of factors underlying the data. The use of EFA may therefore be seen as a theory-generating procedure, rather than as a theory-testing procedure (Stevens, 1996).

This is achieved by using the seven hypothesized constructs of the research, as illustrated, see Table 5.1.

In addition to these constructs, the study draws direction from Figure 5.4: the research model, in order to test the four hypotheses.

The present investigation will discuss the multilevel process used in the exploratory factor analysis in section 6.4: Statistical analysis models, in more detail. However, here the study will only state that hypotheses 1 and 2 relate to the rank order correlation between AG and KM practices HK and SC, and AG technology and BI, in the case of hypothesis 2. The present study will test these hypotheses using the bivariate correlation procedure of SPSS, as follows:

(1) Hypothesis 1:

- use a two-tailed test;
- $H_0$ : KM practices and AG systems are independent;
- $H_1$ : KM practices and AG systems are directly related;
- the test statistic for hypothesis 1, will be Kendall's tau b,
- at the significance of  $\alpha = 0.01$ .

(2) Hypothesis 2 follows:

- use a two-tailed test;

- $H_0$ : Strategies of AG technology and those of BI used by organisations to self improve are independent;
- $H_1$ : Strategies of AG technology and those of BI used by organisations to self improve are directly related;
- the test statistic for hypothesis 2, will be Kendall's tau b,
- at the significance of  $\alpha = 0.01$ .

For the case of hypotheses 3 and 4, the present analysis will also use the bivariate correlation procedure of Kendall's tau b as the test statistics. The result of these hypotheses shall also be validated by Spearman's rho, at the same level of significance,  $\alpha = 0.01$

### (3) Hypothesis 3

- use a two-tailed test;
- $H_0$ : productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AG technology are independent;
- $H_1$ : productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AG technology are related;
- the test statistic for hypothesis 3, will be Kendall's tau b,
- at the significance of  $\alpha = 0.01$ .

### (4) Hypothesis 4 For Hypothesis 4, one shall also use the two-tailed test.

- use a two-tailed test;
- $H_0$ : productivity and performance initiatives attributed to the efforts of the individual in task-related outcomes and those of individuals in team-related outcomes in the use of AG technology are independent;
- $H_1$ : productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AG technology are related;
- the test statistic for hypothesis 3, will be Kendall's tau b,
- at the significant level of  $\alpha = 0.01$ .

## 5.4 Summary

The goal in this chapter was to show how the research was conducted. The chapter attempts to do this by outlining the research motivation, which had previously been set out in chapter 1, but was repeated here so as to add value to the current discourse. The concept of CA, was then discussed, since it is believed to be pivotal in the harnessing of the full potential of KM strategies. The CA and BI of organisations are inextricably linked.

The chapter discusses the four hypotheses, which will be assessed from the findings and results of Chapters seven and eight. These findings will be analysed in Chapters seven and eight. In Chapter seven the study will report on the findings of the exploratory survey. The four hypotheses will be tested here. The researcher's motivation is to answer the first research question:

*How are KM strategies enabled by the support of AG systems?;*

and the subsidiary questions, emanating from the primary research, these being:

1. How can organisations successfully integrate AG technology into their KM efforts with a view to self-improve their quality, productivity, and overall competitiveness?
2. How are organisations assessing the productivity and performance-oriented initiatives attributed to the efforts of task-related and group-related outcomes in their use of AG technology?
3. How are organisations assessing the productivity and performance-oriented initiatives attributed to the efforts of the individual in terms of the task-related and team-related outcomes, in their use of AG technology?

In Chapter six, the the research methodology is presented. The chapter discusses the approach taken to validate and measure the reliability of the research data and findings, along with the sampling techniques and statistical models used for data analysis.

In Chapter eight, the study will report on the findings and results of the KMP Survey, which was conducted in Australia, Canada, New Zealand and the United Kingdom. One will try to answer the second research question here.

The investigation will then proceed on to Chapter nine, where the researcher will report on the factor analytic procedure with path analysis and structural equation modelling. In this Chapter, the investigation will seek to confirm the validity of the research's hypothesised model [cf. Figure 9.1], which is ascertain that BI is enabled by KM practices and strategies, through the use of AG.

Chapter ten then reports on the case study, and the AR iterations at Directorate. This is to determine the use of how workflow management systems, are enabled by KM practices and strategies.

In Chapter eleven, the researcher will summarises the thinking, general findings, the conclusion and recommendation of the study, and the knowledge gained from this experience.

## Chapter 6

### The Research Methodology

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*I have no data yet. It is a capital mistake to theorise before one has data. Insensibly one begins to twist facts to suit theorise, instead to suit facts.*

*Sherlock Holmes – A Scandal in Bohemia.*

#### 6.1 Introduction

This chapter presents the research method, which takes cognisance of the credibility of the research findings, as reported in Chapters 7, 8 and 10, in designing the research methodology. The approach followed in this chapter in ensuring that the findings and conclusions could stand up to closer scrutiny, is aptly summarised by Roger (1961), cited by Raimond, (1993:55), in Saunders et al., (1997):

Scientific methodology needs to be seen for what it truly is, a way of preventing one from deceiving oneself in regard to my creatively formed subjective hunches which have developed out of the relationship between one and ones material [Saunders et al., 1997].

To the researcher, this means that in order to reduce the possibility of getting the answers being sought from the research questions, in Chapter 1, wrong, he must pay greater emphasis to the question of reliability and validity as measures of the research design.

This research is explorative, because it includes a literature review and has as its goals to gain new insights into how AG is use to impact the KM strategies of organisations, and to develop new hypotheses about the relationships and correlation that KM have on organisations. It also deals with the value propositions to be gained from BI and IC framework. This study is also descriptive, to a certain extent, because it will attempt to describe any observed correlations and relationships between the organisational, group and individual domains of the integration of asynchronous groupware and KM strategies and practices in terms of knowledge sharing and the cultural impacts caused by the implementation of KM projects. This research may also be

considered to be explanatory, because it will also seek to find and interpret relationships that lead to any causality between variables and parameters of research constructs.

This research has certain predictive characteristics. This assumption may be explained in the main that it is possible to describe and explain the impact of information technology on organisational behaviour, and as such is possible to draw valid conclusions on the future impacts of KM systems on organisations.

The empirical research has been conducted through a combined quantitative and qualitative methodology. This was with a view to make it more robust and rigorous [Alreck and Settle, 1985]; [Campbell and Stanley, 1963]; [Kerlinger, 1973]; [Patton, 1987]. A triangulation methodology was also used; it involves a multi-method or convergence of both qualitative and quantitative methodologies [Bateman and Ferris, 1984]; [Mintzberg, 1979]. The literature suggests that qualitative and quantitative methods are complements, and may be used to supplement and compensate each other, especially in the case of triangulation. The literature further suggests that triangulation has been used to integrate fieldwork and survey methods.

In this current research, a quantitative methodology (survey research) was combined with qualitative methodology (focus groups, structured individual interviews, and content analysis). The qualitative data collection made important contributions to the quantitative survey data; Mintzberg (1979: 319) supports this view in arguing:

while systematic data create the foundation for our theories, it is the anecdotal data that enable us to do the building. The current st uncover all kinds of relationships in our ‘hard’ data, but it is only through the use of this ‘soft’ data that one is able to ‘explain’ them, and explanation is, of course, the purpose of research.

The case study (AR) component of the research will be discussed in detail in Chapter 10.

## 6.2 Sampling frame

### 6.2.1 Unit of analysis

From Figure 5.5: Research framework for hypotheses 1 and 2, the study uses four latent variables to test hypotheses 1 and 2. The study shall use the principal component analytical procedure of factor analysis to extract the underlying factors hypothesised in Figure 5.5. The present study shall discuss the procedure of EFA, further in section 6.4. The study shall however, use

the factor score of each of the rotated rank order correction between AG and HC. While in hypotheses 2, investigation shall test the rank correlation of AG and BI. The study shall also compute the factor scores of these two latent variables from the principal component analysis, as set out in section 6.4. The factor score of BI takes cognisance of the relevance of KM strategies in the design of a business system. [cf Figure 7.2: IT function in the knowledge enterprise]. Conceptually, a knowledge-based business model or system must have KM playing a central role. The design of such a business system may be viewed, in the main, as consisting of a set of dynamically interrelated components or modules as set out next [Rastogi, 2002:230]:

1. Industry foresight and insight, theory of business, vision and values;
2. Business scope and ecology;
3. Customer values proposition;
4. Competitive logic
5. Integrated activity system;
6. Organisation design and governance, and
7. Knowledge Management Nexus (KMN).

The first module assumes the overall strategic position of a firm's business environment and industry. It comprises the core business position and *big picture* perspective of the organisation from an operational, strategic and tactical level. It also includes the guiding values and mission – critical vision of the organisation's future development, growth and role.

The second module, on the other hand, according to Rastogi (2002:231) delineates the specific products and services offered to the customers and markets being served. The BI index relates to this module in the particular area, in terms of the nature and degree/range of the organisation's relationships with its customers, suppliers and alliance partners. This module, in essence, deals with the location and position of the organisation within its value chain for creating value and competitive advantage within its operating industry. This is in terms of its business network, and its collaborative ecology of its organisation/business domains. These organisation/business domains are sub-components of the AG component.

The third module is akin to the structural knowledge latent factor (see Figure 7.2) of hypothesis 1, in terms of the organisation's definition and recognition of customer-valued outcomes through



which it expects to attract and retain customers. However, it is also of paramount importance in this hypothesis, hypothesis 2, as it relates to the strategies firms employ to maintain their competitive advantage through the harnessing and recognition of their IC.

The fourth module of the model outlines the nature and rationale of the organisation's logic of competitiveness through which it maintains its leading position in its operating environment. The fifth module deals with the integration of the organisation's various tasks, activities, operations and processes, in terms of their coherence, consistency and complementarities. This module mirrors the BI component of the firm, and rests on the support of the IT infrastructure that is in place. The core functions and KRA's of the firm inform it. The module is rightly termed, the IAS, because its main focus is on the organisation's knowledge, with regard to its key processes, and how these utils may be transferred, harvested, and supported. This can be done at three levels. These are operational, tactical and strategic. den Hertog and Huizenga (2000) argue that these levels at which IT can be implemented in the knowledge enterprise is through a hierarchical framework. Figure 7.2 sets out this framework.

The operational level, from this framework, is concerned with the use of IT instruments for the design of the workplace and network environment of knowledge worker for collaboration and the transfer of knowledge. The tactical level deals with organising knowledge work and facilitating knowledge flows. The latent factor which represents the structural knowledge component, shall measure this in hypothesis 1 (see Figure 7.2). Its focus is on the use of the *IT infrastructure* for the design of work processes, and for information supply (Chapter 10 – Case Study, this will be discussed in detail in that chapter). This level also conforms with the BI latent factor, which aims at aligning the primary functions in the organisation as they relate to KM. The strategic level in the framework [Figure 7.2], is concerned with how the IT infrastructure can be used to generate various degrees of differentiating value and capacity [Porter, 1985].

The application of IT in the company's primary processes or the development of core competencies in using IT, makes IT of strategic importance. A strategic role for IT is directed towards:

- The design of processes superior to the competitor's (*cost leadership*); or
- The ability to differentiate from rival firms with other products and services (*differentiation strategy*).

The sixth module, deals with the element of organisation design and governance, which delineates the nature, rationale and form of the firm's organisation design, and governance. This is the focus of the tactical level, as discussed previously, and is set out in Figure 6.1. It represents the vehicle and mechanism for the firm's value creation (IC), capture, delivery, and management of its intellectual capital and KM. This module reflects the firm's organising capability [Rastogi, 2002:230]. It incorporates the firm's knowledge about how to organise its resources, operations and processes. It also provides the coordinating mechanisms for identifying and responding to business challenges. Additionally, it deals with exploiting the firm's resources to capitalise on business opportunities in pursuit of value creation.

The seventh and final module is the core module of the business system design (BSD) framework, which deals with the overall integrating role of the KM nexus (see Figure 5.2). The KM nexus (KMN) of a firm consists of the over-arching strategic metric of its CA, which is linked with the dense, dynamic, and mutually supportive interactive constructs of HC, KM, and SC. These three constructs of the module link interactively with, and informs the IC construct of the module. levels of (Figure 6.1: - IT functions in the knowledge enterprise), operational, tactical, and strategic levels, are inextricably linked to the value creation constituents of this module, in the creation of total BI.

The IC and BI of the firm is the resultant output from this nexus. The IC and BI of a firm represent its holistic capacity or meta-capability toward meeting the challenges and exploiting the opportunities in its continual pursuit of value creation.

The dynamic nature and structure of the KMN, is both informed from the KM strategies' component of the research model [cf. Figure 5.4: Research Model], that is:

- Identifying learning opportunities,
- observing and collecting knowledge,
- creating knowledge products, and
- deploying expertise (Dixon, 2000:106).

This deals with the value chain of the firm, and is represented by the competitive advantage link in the model [cf. Figure 5.2: Knowledge Management Nexus]. It is coupled with the upstream and downstream knowledge activities of the firm's business. The model may be thought of as

the value system of the firm, which synoptically maps the knowledge flows between the business units in the firm, its customers and suppliers. This is depicted by the customer relations' link in the research model [cf. Figure 5.4: Research Model]. The expected impact on the organization is improved quality, productivity and competitiveness.

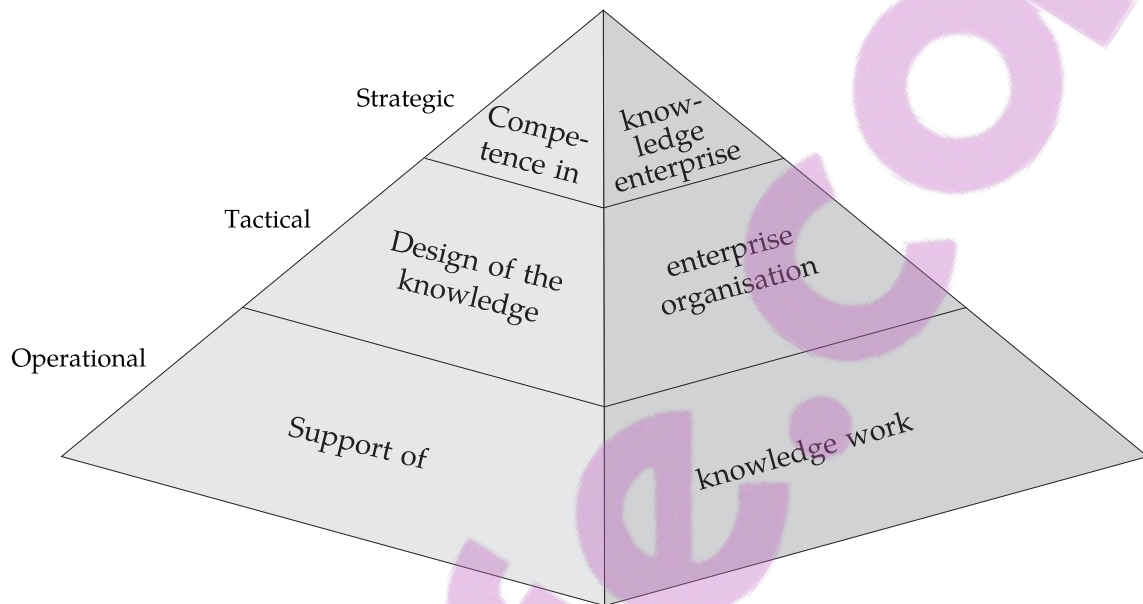


Figure 6.1: IT function in the knowledge enterprise  
Source: [Adapted from den Hertog den and Huizenga, 2000]

Hence, the KMN provides an integrated perspective/framework of the total value-creating milieu of the knowledge enterprise. Through it, SC, HC, and KM components it is possible to determine and define interrelationships of product and process technologies or logistic links. This research will want to see if the KMN framework gives the enterprising knowledge-based firm, insights into cost structures, technology flows and product flows in the value system. This is with a view that the researcher will be able to draw conclusions and make recommendations on the direction of the knowledge flows within the organizations.

### 6.2.2 Validity

#### Explanation of the inputs of the constructs, and the instrument development

The meaning of knowledge and KM continues to be open to debate. For the purposes of this survey: *knowledge* means the knowledge in the business about customers, products, processes, competitors and so on, which can be locked away in people's minds or filed on paper or in

electronic form. 'KM' means a systematic and organised attempt to use knowledge within an organisation to transform its ability to store and use knowledge to improve performance.

The survey component of this research was designed to explore the various constructs of KM, and BI, and as enablers, within the context of a conceptual model. The present study replicates and adopt many of the total design method (TDM) recommendations, suggested by Dillman (1978). Seven constructs of KM and AG based on Churchill's (1979) guidelines for developing reliable and valid measures, items measuring current state of KM, structural components of KM, knowledge and business processes, and KM integration with BI were developed.

The exploratory survey instrument was revised based on the inputs and feedback obtained from four senior management consultants, employed by the Botswana Government. It was also pilot tested with twenty-five firms at the firm level, in the following industries: three from manufacturing, four from public administration, seven from general services, five from financial services, and three from the retail and wholesale sector. This was to ensure the adequacy of the face validity. The face validity measures the appropriateness, relevance and comprehensiveness of items, which are, included in the instrument. The twenty-five questionnaires were returned completed by all the firms. Based on their comments; some items were deleted, and others reworded.

The researcher then redesigned the actual survey instrument so that respondents would take at most fifteen minutes to complete it. The researcher then sent 2500 questionnaires via e-mail (Lotus Notes) to executive level managers, some of whom the researcher met in Malaysia in February 2000 at the Commonwealth Secretariat's Conference on e-commerce.

Since this study concentrates on the firm level of analysis, each respondent was required to answer the questionnaire as a representative of the organisation. One thousand, two hundred and twenty-five (1225) of the questionnaires were returned completed. This represents a 49% response rate (see Appendix A: Countries of respondents). The researcher considers this adequate for the purposes of this survey, in terms of the representativeness of the sample. This level of response was attributed to the fact that the researcher had previously met most of the respondents, or had acquaintances with other members of the organisation who facilitated the researcher's introduction to the organisation.

The literature review provided several scales for measuring IT. Some of them were not appropri-

ate for this study, which seeks to measure KM awareness and the level of adoption of knowledge sharing initiatives. The following scales in current use were found in the literature: Teng and Grover (1992) developed a scale to measure the relationship between data integration in relation with database planning. That instrument was not, specifically concerned with KM, nor was it tested for its reliability and validity. Nath (1988) developed a scale to measure IS managers' perspectives on the value of local area networks (LANs). The instrument was, found to be inadequate because the domain of questions was too narrow, and did not address the question of groupware implementation and use. Therefore, based on the existing key literature on IS integration, the items measuring data integration and networks integration were selected (see Boar, 1993; Bradley et al., 1993; Goodhue et al., 1988, 1992; Madnick, 1991, 1995; Wyse and Higgins, 1993). The structural modelling approach used by Andrews (1984) was used to test construct validity and error components of survey measures. These were co-opted to develop the items on the use of groupware and other technologies, viewed as enablers for KM initiatives to be successful.

The researcher, also closely followed the scales used by the following researchers: Saraph, J.V., Benson, P.G., & Schroeder, R.G. (1989) developed a scale for product and service design in context of the TQM. Flynn, B.B., Schroeder, R.G., Sakakibara, S.A, (1994) developed a scale for product development to conform to customers' requirements in relation to quality management research. Powell (1995) developed a scale for zero defects, and process improvement in relation to TQM (see also Dean and Snell, 1991). For measuring the current state of KM and how it relates to the various KM initiatives being adopted, and the structural components related to structural knowledge, technological infrastructure and BI, the researcher closely follows the following scales.

All these variables were measured with 5-point interval scales. As a result, the researcher, in designing the questionnaire, used a 5-point Likert scale. Respondents were asked to mark an answer, varying from 1 to 5, where "1" is "*not at all*", "3" is "*moderate extent*", and "5" is "*very large extent*" to represent the current status of KM in their organisations. The same labels were used for items related to the cost of ignoring human knowledge and benefits gained from setting up KM initiatives. However, the remaining items in the other constructs of structural components, BI and performance analysis were measured in relative terms. Each of the five items for the two constructs were measured varying from 1 to 5: "1" is "*strongly disagree*", with obstacles to knowledge sharing in the organisation, "3" is "*neither agree nor disagree*", and "5"

is “*strongly agree*”, with obstacles to knowledge sharing in the organisation.

The researcher used questions that were of a medium length of 16 to 24 words, as suggested by Andrews (1984). A total of 99 items, designed to tap into seven constructs (three constructs relating to KM, and one relating to technological infrastructure, one relating to business intelligence, one relating to performance analysis, and one relating to AG. The demographic information, such as country, size, turnover, and so was not counted as any of the constructs. The asynchronous construct has three sub-constructs, namely: organisation, group and individual domains.). These were included in the questionnaire, to measure different concept of the hypotheses. The research model is relevant – see Figure 5.3. All the items included in the survey were developed and informed from concepts that were accentuated during the literature review phase of the study. Since this was an exploratory pilot study, no previous instruments were replicated. Appendix B. Summary of Survey Items, summarises the items that were used to develop the constructs of the pilot survey.

Regarding the validation of the measurement instrument it was concluded that the measurement instrument used to collect the quantitative data in this research is valid and reliable for use on the present sample. It furthermore shows good measurement of fit with the original Statistics Canada questionnaire, which was adapted for the KMP survey of this research.

Scatter plots of the responses on the individual items on the sub-domains and the asynchronous groupware attribute sections were done individually on each sub-construct to test for item response bias within a sub-domain. The standard deviations of the different subgroups were also analysed to investigate possible response method bias between the constructs for both surveys. There was no item response bias in the different sub-constructs of either survey.

It is important to note that, although survey research in general, and this research in particular, are designed to gather firm-level data, and although the analyses to validate the questionnaires in this research were also based on the firm-level data, these analyses are based on an independent representative sample of organisations in the, survey in question. This survey is multi-sectoral, comprising financial services, manufacturing, retail and wholesale, utilities and telecommunications, and other services. One can use the data set in an aggregated form to investigate intra-domain variances.

### 6.2.3 Reliability

The issues of reliability is generally regarded, in the main that the results obtained in one research project should be repeated in another such research project. The question then is one of repeatability of research findings. This view is held by Bowen and Bowen [Bowen and Bowen, 1999:57] who argued that the researcher is trying to get the same results on repeated tests, either by himself or if another person is trying to replicate his research. It is then, this researcher's understanding that the reliability of an instrument is the concept of being able to obtain consistency (or repeatability) of the said instrument in measuring the same phenomenon over time. This view is summarised aptly by Giannatasio [Giannatasio, 1999] who cautioned that in research one must ensure that one is measuring 'apples with apples' when it comes to the question of reliability. Davis [2000] also supports this position, where the case of consistency and stability of a score from a measurement scale is concerned. The literature reports us that there are two forms of reliability. These are:

- Inter-instrument – which deals with whether the methodology used in the same research setting will generate the same results consistently; and
- Inter-observer reliability – which deals with whether two researchers using the same methodology will obtain the same results?

There are issues here, in terms of reliability. The first is that of sampling. The selection of a representative sample of the subjects and the objective for the collection of data that can be generalised to the population are important elements of reliability issues. The present study used a representative sample, using a two-stage cluster sampling approach, in the survey, to ensure representativeness and reliability of this research study.

The second issue is that of specifying the unit of analysis, in order to provide internal validity. The literature is perused and the development of grounded theories, along with the collection and analysis of data which are then used to test the findings and the theories so developed.

Reliability refers to the accuracy and precision of a measurement procedure [Thorndike, Cunningham, Thorndike, and Hagen, 1991]. These authors advised that reliability may be viewed as an instrument's relative lack of error. In addition, to the advice from the literature, the present investigation views the question of reliability as a function of the properties of the underlying

construct being measured, the instrument itself, the groups being assessed, the research environment, and the purpose of assessment. The use of reliability analysis will answer the question, *how well does the instrument measure what it purports to measure?*

The present analysis shall accept that some degree of inconsistency is present in all measurement procedures. The variability in a set of item scores shall be due to the actual variation across individuals in the phenomenon that the scale measures, as such, made up of true score and error. Therefore, each observation of a measurement (X) is equal to true score (T) plus measurement error (e), or  $X = T + e$ . Another way to think about total variation is that it has two components:

“signal”, i.e., true differences in the latent construct, and

“noise”, i.e., differences caused by everything but true differences.

There are three main sources of measurement inconsistency, from the literature [Suhr, D. 1999], which one should consider, when discussing reliability. These are due in part to:

1. a person changing from one sampling frame to the next:
  - the amount of time between the administration of the instruments may have resulted in some change in the sampling framework, or units of analysis;
  - motivation to respond to or participate in the research may be different at each instance of administration;
  - the items may be more relevant to the respondent’s peculiar circumstance, and
  - the individual may have a priori knowledge of the sampling frame, before the administration of the instrument.
2. the task being different from one testing to the next:
  - different environment
  - different administrator
  - different test items on parallel forms.
3. the sample of behaviour resulting in an unstable or undependable score:
  - the sample of behaviour and evaluation of it are subject to chance or random influences



- a small sample of behaviour does not provide
- stable and dependable characterization of an individual
- for example, the average distance of 100 throws of a football would provide a more stable and accurate index of ability than a single throw.

Reliability may be therefore be summarily expressed:

1. as an individual's position in a group (correlation between first and second measurements; the more nearly individuals are ranked in the same order, the higher the correlation and the more reliable the test)
2. within a set of repeated measures for an individual (internal consistency, how consistency are items answered)

This study shall assess the reliability of an instrument by:

1. repeating the same test or measure (test-retest)
2. administering an equivalent form (parallel test forms)
3. using single-administration methods
  - subdividing the test into two or more equivalent parts, and
  - internal consistency – measured with Cronbach's coefficient alpha.

### Internal consistency

Internal consistency is a procedure to estimate the reliability of a test from a single administration of a single form. Internal consistency depends on the individual's performance from item to item based on the standard deviation of the test and the standard deviations of the items. Equation 6.1, below, gives the estimate of reliability for the instrument:

$$\hat{V} = \frac{n}{n-1} \times \frac{(SD_t)^2 - \sum SD_i^2}{(SD_t)^2} \quad (6.1)$$

where:

$\hat{V}$  is the estimate of reliability,

$n$  is the number of items in the test,

$SD_t$  is the standard deviation of the test scores,

$\sum$  means “take the sum” and covers the  $n$  items,

$SD_i$  is the standard deviation of the scores from a group of individuals on an item,

$(SD_t)^2$  is the variance of the test scores.

### **Factors influencing reliability**

Many factors can affect the reliability of a measurement instrument. They are the:

1. range of the group:

- pooling a wider range of grades or ages produces a reliability coefficient of higher magnitude
- take into account the sample on which the reliability coefficient is based when comparing instruments

2. level of ability in the group:

- precision of measurement can be related to ability level of the people being measured
- report the standard error of measurement for different score levels

3. methods used for estimating reliability:

- amount of time between administrations
- method of calculating reliability

4. length of the instrument:

- when reliability is moderately high, it takes a considerable increase in the Instrument length to increase reliability
- relationship of reliability to length of the instrument can be expressed with:

$$r_{kk} = \frac{kr_{tt}}{1 + (k - 1) r_{tt}} \quad (6.2)$$

Where:

$r_{kk}$  is the reliability of the instrument  $k$  times as long as the original instrument,

$r_{tt}$  is the reliability of the original instrument, and

$k$  is the factor by which the length of the instrument is changed.

For example, if the reliability were .60 for a 10-item instrument, the reliability for a 20-item instrument, would be found from applying the formula in Equation 5.2:

$$r_{kk} = \frac{2(0.60)}{1 + (2 - 1) (0.60)} = \frac{1.20}{1.60} = 0.75$$

[from Suhr, 1999]

### Levels of reliability

Acceptable levels of reliability depend on the purpose of the instrument. Acceptable reliability of instruments developed for research purposes can be as low as 0.60. An acceptable reliability level of a diagnostic instrument used for making decisions about individuals (e.g., a psychological measure) should be much higher, e.g., 0.95.

### Comparisons

The reliability coefficient provides a basis for assessment instrument comparison when measurement is expressed in different scales. The assessment with the higher reliability coefficient could provide a more consistent measurement of individuals.

### Statistical power

An often overlooked benefit of more reliable scales is that they increase statistical power for a given sample size (or allow smaller sample size to yield equivalent power), relative to less

reliable measures. A reliable measure, like a larger sample, contributes relatively less error to the statistical analysis.

The power gained from improving reliability depends on a number of factors including:

- the initial sample size
- the probability level set for detecting a Type I error
- the effect size (e.g., mean difference) that is considered significant
- the proportion of error variance that is attributable to measure unreliability rather than sample heterogeneity or other sources.

A solution to this problem is to raise the power. This is often achieved through substituting a highly reliable scale for a substantially poorer one. For example, when  $n = 50$ , two scales with reliabilities of 0.38 have a correlation of 0.24,  $p < 0.10$ , and would be significant at  $p < 0.01$  if their reliabilities were increased to 0.90 or if the sample was more than twice as large ( $n > 100$ ) [Suhr,1999]

Cronbach's alpha was used for testing the reliability of the instrument. This is illustrated in Appendix C (C1 to C8). The resulting reliability coefficients for each construct in terms of their alpha and standardised item alpha are discussed in Chapter 7.

## 6.3 Sampling technique

### 6.3.1 Population, sample and sample size

This survey was conducted in February and March 2000. It was conducted at the firm level among chief executives, finance directors, marketing directors, and those with specific responsibility for KM in their organisations.

The principal aims of this survey were to pre-test several aspects of the research design. These include the sample design, the research instrument, the data collection methodology, the data processing procedures, and the analysis, of the research. The selected organisations were the 2500 leading organisations of 26 countries (See Appendix A) of the member states of the Common-

wealth (former British Colonies), with turnover exceeding 1.5 billion Rands (£1.0 = ZAR12.00)<sup>1</sup> per year.

This sample was chosen because organisations of this size have the greatest need to implement KM initiatives, have possibly the greatest capability and resources to do so and potentially can reap the greatest benefits. The subject focus was the collective knowledge of their organisations' employees and their own use of information. In this survey, 'largest organisations' means those with annual turnover of ZAR4.0 billion or above, more than 1500 employees or more than five sites. 'Other Services' includes business services, communications, holding companies, and miscellaneous corporate bodies.

The objectives were, therefore, to establish the extent to which organisations are aware of knowledge management, take it seriously, and are pursuing initiatives to implement it, and benefit from it. The questionnaire questioned respondents about their current implementation, awareness and future plans for KM.

Table 6.1: Industry Sector

Industry Sectors	Proportion
Financial Services	375
Manufacturing	800
Other Services	675
Retail and wholesale	325
Utilities and telecoms	250
Not stated	75
<b>Total</b>	<b>2500</b>

base: all respondents (2500)

These aims seek to address all of the research hypotheses of this research on KM practices.

### 6.3.2 Data collection methodology

For this study, an e-mail survey was considered appropriate for data collection. The use of the survey method offers many advantages over anecdotal experiences, and case studies. First, a survey study is replicable, testable, and thus allows researchers opportunities to extend the scope of the initial models. Second, the study allows researchers to test the validity of the data for different sets of sample, thus allows generalisability, and cross study comparability (Kerlinger,

<sup>1</sup>Forex Rate: Reuters [March 2000]

1973).

### 6.3.3 Data computerisation process

The results were coded in Statistical Package for the Social Science (SPSS) for Windows, version 12. The following items were reverse coded: business intelligence (BI09R, BI10R, BI11R, BI11R, BI12R, BI13R, BI13R and BI17R) and performance analysis (PA03R and PA08R). Of the total 121, 275 data cells (99 items \* 1225 respondents), there were no missing values. The 1225 observations represented a variety of organizations in numerous industries. See Chapter 7, Tables 7.1 – 7.15, and Figure 7.1 – 7.8, for highlights of the profile of the data with some descriptive statistics.

The research also uses SAS/SAT version 8, the Proc Calis procedure to perform the various confirmatory factor analytical procedures, to fit the data to the hypothesised model, derived from the results of the exploratory factor analytical procedure.

## 6.4 Statistical analysis models

Descriptive and exploratory statistical analyses were conducted (using univariate and bivariate analyses involving frequencies, cumulative frequencies, percentages, histograms, and cross-tabs) on the seven constructs in the questionnaire. The goal was to describe the sample in terms of the relevance of the constructs to the organisations/firms. The researcher also wanted to obtain preliminary results on the item responses on the KM practices/strategies being used by the organisations in question. The selection of the organisations/firms in the sample is independent, and the population distribution is normal.

Bivariate correlation analysis was used to examine the relationship between the AG factors and the measures of CA. Additionally, Kendal's tau b was used to perform pairwise correlation between each of the seven constructs.

Kendall's  $\tau$  b is a nonparametric measure of association based on the number of concordances and discordances in paired observations. Concordance occurs when paired observations vary together, and discordance occurs when paired observations vary differently. It is a measure of correlation between two ordinal-level (rankable) variables. It is most appropriate for square

tables, to compute this statistic, in general one first compute two values, P and Q, which represent the number of concordant and discordant pairs, respectively. The formula for Kendall's  $\tau$  is:

$$\tau = \frac{\sum_{i < j} \text{sgn}(x_i - x_j) \text{sgn}(y_i - y_j)}{\sqrt{(T_0 - T_1)(T_0 - T_2)}} \quad (6.3)$$

where

$$T_0 = n(n - 1)/2$$

$$T_1 = \sum t_i(t_i - 1)/2$$

$$T_2 = \sum u_i(u_i - 1)/2$$

and where  $t_i$  is the number of tied  $x$  values in the  $i^{th}$  group of tied values,  $u_i$  is the number of tied  $y$  values in the  $i^{th}$  group of tied values,  $z$  is the number of observations, and  $\text{sgn}(z)$  is defined as

$$\text{sgn}(z) = \begin{cases} 1 & \text{if } z > 0 \\ 0 & \text{if } z = 0 \\ -1 & \text{if } z < 0 \end{cases}$$

This formula is used in SPSS for Windows, version 12, and SAS/SAT, version 8.2, to compute Kendall's correlation by ranking the data and using a method similar to Knight (1966). The data are double sorted by ranking observations according to values of the first variable and re-ranking the observations according to values of the second variable. The formula computes Kendall's tau-b from the number of interchanges of the first variable and corrects for tied pairs (pairs of observations with equal values of X or equal values of Y).

The procedure used also allowed for tied pairs. The approach used in Kendall's tau-b with correction for ties, is the same as that previously discussed above, except a correction is made for the case when ties are found in the data.

The statistical programme (SPSS for Windows, and SAS/SAT) calculates Pearsonian and Spearman-rank correlation matrices. It allows missing values to be deleted in a pair-wise or row-wise fashion. These are presented in Appendix D. Normally when one speaks of a correlation matrix, one

usually mean a matrix of Pearson-type correlations. Unfortunately, in this study, it was found that outliers, unequal variances, non-normality, and nonlinearities unduly influence these correlations. One of the chief competitors of the Pearson correlation coefficient is the Spearman-rank correlation coefficient. This latter correlation is calculated by applying the Pearson correlation formulas to the ranks of the data rather than to the actual data values themselves. In so doing, many of the distortions that infect the Pearson correlation are reduced considerably.

To allow one to compare the two types of correlation matrices, a matrix of differences can be displayed. This allows one to determine which pairs of variables require further investigation. It is informative to present the formula for Spearman's correlation. Spearman rank-order correlation is a nonparametric measure of association based on the rank of the data values. The formula is:

$$\theta = \frac{\sum (R_i - \bar{R})(S_i - \bar{S})}{\sqrt{\sum (R_i - \bar{R})^2 \sum (S_i - \bar{S})^2}} \quad (6.4)$$

where

$R_i$  is the rank of the  $i^{th}$   $x$  value,

$S_i$  is the rank of the  $i^{th}$   $y$  value,

$\bar{R}$  is the mean of the  $R_i$  values,

and  $\bar{S}$  is the mean of the  $S_i$  values.

The Spearman's correlation was computed by ranking the data and using the ranks in the Pearson product-moment correlation formula. In case of ties, the averaged ranks are used.

The statistical package lets one specify a set of partial variables. The linear influence of these variables is removed by sweeping them out of the matrix. This provides a statistical adjustment to the remaining variables using multiple regression analysis. It is important to note that in the case of Spearman correlations, this sweeping occurs after the complete correlation matrix has been formed.



## 6.5 Other Considerations

It is important to note that, although survey research in general, and this research in particular, are designed to gather firm-level data, and although the analyses to validate the questionnaires in this research were also based on the firm-level data, these analyses are based on two independent representative samples of organisations in the:

1. **Exploratory survey:** a multi-sectoral, comprising financial services, manufacturing, retail and wholesale, utilities and telecommunications, and other services;
2. **The KM practices (KMP) survey:** a single sector was selected, which is the information communication technologies (ICT) sector in Australia, Canada, New Zealand, and the United Kingdom. The data may also be used in an aggregated form to investigate intra-domain variances.

## 6.6 The KMP survey

### 6.6.1 Research hypothesis

For the KMP survey, the second research question shall be the focus of attention: If implemented successfully, KM will help organisations short-cycle internal process, cut costs, and operate more effectively. Some organisations have realized millions in cost-saving benefits from knowledge efforts. The secondary research question is therefore concerned with, *how organisations can successfully implement KM projects and practices*.

The supporting literature for both research questions and all four research hypotheses have been motivated and discussed in Chapter 1, section 1.2.4, and elsewhere in this chapter. The research question is reproduced here, so that the statistical models and test that shall be used to answer this research questions can become clearer, and better demonstrate how the various investigations of the research problem for the KMP Survey will be handled.

Table 6.2: Selected OECD ICT in 1997 – 1999

Country	No. of Enterprises	Employment	Value Added*	R and R*
Australia	18,469	195,580	14,402	717
Canada	30,769	429,946	34,965	2892
New Zealand	763	31,151	N/A	N/A
United Kingdom	95,520	1,111,630	81,919	3339
<b>Total</b>	<b>145,521</b>	<b>1,768,307</b>	<b>131,286</b>	<b>6,948</b>

\*Figures are in Million of USD. Source: Measuring the ICT Sector (OECD, 1999)

### 6.6.2 Sampling technique

1. **Population, sample and sample size:** Because of the influence of organisational contingency variables (Kerlinger 1986), the researcher elected to confine this investigation to one sub-sector (management, scientific and technical consulting services) in one industry (ICT)) that has consistent macro-environmental influences (political, economic and technological uncertainty). Because of the specific nature of management consulting, process, task, structural and technological variables are to a great extent similar in all the different organisations. These firms are also considered progressive organisations, in terms of knowledge use and application, in the Organisation for Economic Co-operation and Development (OECD) business context. To maximise functional equivalence, the sample was controlled for the organisational-independent variable of size of the enterprise (10-49, 50-199, 200 and more employees) and revenue (revenue of 250, 000 (Dollars) or more), this was done through a matching process.
2. **Sampling, data collection methods, and analysis:** Four countries were selected from the fifteen, which responded in the pilot survey. They are Australia, Canada, New Zealand, and the United Kingdom. These were chosen from the OECD report on ICT (OECD, 1999). A two-stage approach was used to select the sample for the KMP survey. The researcher used the sample stratification, allocation and selection process from the OECD report. The firm data obtained from that report is shown in Table 6.2:

It should be noted that the statistical unit of that survey was the establishment. The actual sample size was 478 firms/enterprises. The distribution of these 478 enterprises was done in such a way that the Coefficients of Variation (CVs) are similar for all strata. A simple random sampling was carried out for each of them, in each country. The approach used is discussed next.

The initial sample size for Australia and Canada were 0.25 per cent (46.17 and 76.92) each, that of New Zealand and the United Kingdom 4% and 0.125% (30.52 and 119.4) respectively. A sample size adjustment of 75% was made because of the type of collection method (email survey). This adjustment was made in order to improve the response rate, as suggested by Edward Balian (Balian, E. 1987) for postal survey, where the adjustment range of 70% to 300% is acceptable. The upward adjustment of 75% of the initial sample sizes resulted in sample sizes of : 81 for Australia, 135 for Canada, 53 for New Zealand, and 209 for the United Kingdom.

The overall return rate of the questionnaires was 25.31%. The actual sample comprised a 20% response rate from Australia (16 out of 81 firms), 30% response rate from Canada (41 out of 135 firms), 26% response rate from New Zealand (14 out of 53 firms), and a 24% response rate from the United Kingdom (50 out of 209 firms). This results in a total actual sample frame of 121 firms.

### 6.6.3 Instrument development and data collection methodology

The quantitative data collection method was used to collect the data, along with a goal-specific questionnaire for the data collection measure purposes. The questionnaire was developed over a four months period from using SPSS Data Entry Builder. The questionnaire was then published on the World Wide Web (the internet) on the Africa Informatix *website*: <http://www.gobotswana.com>. The questionnaire form was password secured, and respondents were contacted via emails, and asked to complete the questionnaires. Upon completion the respondents would submit the form (the questionnaire by clicking on a button at the bottom of the form, and the form would be sent as an e-mail to the researcher. A master file was created to convert the responses into cases as they were received. Respondents did not seem to have any difficulty in completing and understanding the items on the questionnaire because the instrument was replicated from Statistics Canada's questionnaire on Knowledge Management Practices (Statistic Canada, 2001), and that the language of all respondents was English.

The first unit of analysis was the aggregate responses of the firms/enterprises of the whole sample on the in-use / planned-use identification of a series of business practices related to knowledge management. These practices were grouped/categorised as follows: policies and strategies; leadership; incentives; knowledge capture and acquisition; training and mentoring; and communications. Respondents that indicated that any practice listed in the first question

was *In Use* (In Use Before 1999 or Used Since 1999) continued to the next section. Respondents not using any of the practices moved (skipped) to question 10 – *Incentives to Use*.

The second unit of analysis (*Questions 3-9*) was aggregate responses of the opinions of the firms/enterprises to capture the reasons, results, effectiveness and responsibility for using KM practices. Also included in this section were questions on the sources of KM practices, spending dedicated to KM and resistance to using KM practices? T-tests were used for this analysis.

The third unit of analysis was aggregate responses of the opinions of firms/enterprises on questions 10-11. Question 10 related to incentives to use KM practices. Question 11 provided employment structure information for the firm.

The fourth unit of analysis was aggregate responses of the opinions of firms/enterprises on (*Question 12*). This was the asynchronous groupware (AG) items for measuring the integration of asynchronous technology and group-based KM efforts. Specifying dealing with assessing those productivity and performance-oriented initiatives attributed to the efforts of work improvement teams, communities of practice, and focus groups as they relate to task and team outcomes in the use of KM practices/strategies. More generally it deals with also assessing those productivity and performance - oriented initiatives attributed to the efforts of the individuals as they relate to task and team outcomes in the use of KM practices/strategies.

#### 6.6.4 Statistical analysis models – The KMP survey

The research used the following statistical tests in this portion of the research: Internal consistency measures and confirmatory factor analysis. The SPSS for Windows, version 12, and SAS/SAT version 8.2 structural equation modelling procedures were performed on the asynchronous groupware section of the instrument. The objective was to investigate the inter-correlation and reliability (derived from the Cronbach's alpha values) of the measuring instrument on the sample in this study. Furthermore, one wanted to ascertain the goodness of fit between the existing underlying factorial structures of the measuring instrument. The intention was also to check on the degree of unidimensionality. Overall the model fit indices indicated that unidimensionality was replicated for all the asynchronous groupware dimensions. Three AG dimensions are identified in this research.

Internal consistency measures were carried out on the current state of KM practices in-use

attribute of the research instrument, and four first-order sub-categories showed lack of convergence. For the most part, dropping one or two items or conflating some scales handled these problems. The six second-order KM strategies could not be replicated, and it was therefore necessary to analyse the specific interrelationships among the first-order KM strategy dimensions of the present sample in terms of their underlying second-order dimensions, by means of exploratory or common factor analysis (Hair et al., 1992:223-257). The research carried out a principal components analysis on the data, and four essentially similar second-order factors were derived by means of a VARIMAX rotations procedure.

Firstly, the means, standard deviations, and standard errors of the means for the sub-domain of AG support dimensions and the knowledge management projects implementation constructs were computed for the whole sample. Independent T tests were also used to assess whether there were any significant differences between the mean scores of the three AG domains and the six KM strategy constructs on the sub-domains of AG support dimensions and the KM projects implementation constructs.

Levene's test for equality of variance [Wolfinger and Chang, 1995; Searle, Casella and McCulloch, 1992], was used to test for significant differences, at a 0.05 significance level; between the ways, organisations assess the productivity and performance-oriented initiatives attributed to the efforts of task-related outcomes, and those of group-related outcomes in the use of asynchronous groupware technology. The researcher also conducted bivariate analyses on the above four units of analyses, but much attention was placed on unit four, where the survey sought to measure and assess the extent of the significance and strength of the relationships as hypothesized in hypotheses 3 and 4. The researcher tested the strength of the association between the integration of asynchronous groupware technology in the use of these KM practices. One uses Cramer V and Kendall's tau b to do this. These components are grouped as follows: *organisation domain, group domain and individual domain*.

This then leads into the exploration of how groupware in general, and AG, in particular affect KM strategies. This exploration requires an understanding of the nature of the non-positivistic research strategy. Figure 5.4: The research model [cf. Figure 5.4: Research Model] is relevant.

## 6.7 Summary

The chapter sets out the research methodology. The chapter takes cognizance of the approach used to validate and test the reliability of the data, and the findings.

The chapter discusses the seven components of a knowledge-based system [Rastogi, 2001], which are used to inform the inputs of the constructs, and the instrument development for the exploratory survey. The sampling frame is presented in Section 7.2.

Here, the unit of analysis used is informed by the research framework, as set out in Figure 5.5. The section discusses the justification for using the principal component analytical procedure of factor analysis to extract the underlying factors hypothesized in Figure 5.5.

In Section 6.3, the sampling technique is presented. Here, the population and the sample, and sample size are discussed in much detail. Section 6.4, discusses the statistical analysis used in this work, Equation 6.3, and Equation 6.4, are relevant. The section sets out the rationale for using Kendall's tau-b [cf. Equation 6.3], as a nonparametric measure of association/correlation between two ordinal-level (rankable) variables.

It also discusses the rationale for using Spearman's rank-order correlation [cf. Equation 6.4]

Section 6.5, outlines the considerations of the two representative sampling of organisations in the exploratory survey; and the KM practices survey.

The chapter concludes with a discussion of the motivation for the second level survey: The KMP survey. It sets out the relevant research hypotheses. It justifies the need for this survey, in that it seeks to answer the secondary research question: *how organisations can successfully implement KM projects and practices*. Table 6.2 is relevant, and is presented to frame the scope of this subsidiary survey, along with the firm data used for data analysis. A total of 478 enterprises were used in this survey. The statistical unit of analysis of this survey was the establishment.

The investigation now turns to Chapter 7, where the study will report on the findings and results of the exploratory survey, which was conducted in 21 countries of the British Commonwealth of Nations.

## Part III

### Research Results

## Chapter 7

### Findings and Results I

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*God placed man in the centre of the universe so that he might be conscious of where he stands, and therefore free to decide where to turn*

*Pico della Mirandola*

#### 7.1 Introduction

In chapter 1, the research stated that the goal of this research is to examine how KM strategies are enabled by the support of AG systems, and to examine how organizations are successfully implementing KM projects and practices in order to improve their CA. In order to do this, it was found necessary to survey the literature on the implementation and application of KM strategies and AG systems in organizations. This was done in chapters two, three, and four, where the study reported on much of the work that has been done to date. In an effort to summarize and compare that work, it was found that, the IT infrastructure play an integral role in facilitating the use of KM practices. In the case of groupware technologies, these systems and tools are used as enablers for creating, sharing, and transferring knowledge. These views are supported by Pellissier (2001:17) who posits the concept of a critical mass, as it relates to the general adoption of groupware software products in assisting users to do a common task in a shared document environment. den Hertog and Huizenga [den Hertog and Huizenga, 2000:242] also support the facilitating role of groupware technologies, by arguing that IT is the ‘glue’ in the working environment of the knowledge enterprise. They caution that, “...the function of IT is not primarily to generate knowledge. At the operational level, IT creates an environment for the knowledge worker in which (s)he can operate far more effectively. It is an environment in which:

- routine operations are taken over by systems;
- the supply of information is booming;



- explicit knowledge can be better stored and transferred, and
- communication is better and faster.” [den Hertog and Huizenga, 2000:242]

In this scenario, the knowledge worker is pivotal for the successful development of the knowledge system and bases. It, therefore, goes without question that better tools are needed to allow the knowledge worker to develop and use knowledge, and make it accessible to share with others. Thus, creating better BI and CA for the organisation [cf. Figure 5.4 Research Model], to realise its strategic objectives.

den Hertog and Huizenga (2000) also argue that at the tactical level, IT makes a valuable contribution in facilitating knowledge flows throughout the organization. In the main this is done through the groupware systems and IT infrastructure that are in place. Specifically, this is achieved through the AG applications, which are used by the organization. This usually leads to improved knowledge development and knowledge transfer within and between organizational units. The value to the organization is greater value added to service delivery and products through better BI and CA.

In this chapter, the research shall present the findings and results of an exploratory survey that was conducted in twenty-six countries of the Commonwealth of Nations, as described in chapter 5. The main findings here is that the strategic relevance of groupware systems <sup>1</sup> for the knowledge enterprise takes shape particularly in organizations in which groupware systems are inextricably linked to the primary processes of those organisations. It was also found that organisations were using different groupware applications in their IT infrastructure, particularly, AG. Some examples are databases, information systems, collaboration network, expert systems, task-supporting systems (e.g. generic groupware systems), and knowledge banks (AG system platforms). Additionally, it was also found that the knowledge enterprise benefits from AG, particularly when the applications are part of a coherent system. Namely, at the organisation level, AG configurations, (organisation domain), lateral connections at the workgroup level (group domain), and configurations and application at the individual level (individual domain) for knowledge workers. These three levels are illustrated in Figure 5.4.

The objective of the analyses, in the introduction [cf. 1.2.1] and Capters 5 [cf. 5.3], now being advanced here, in this chapter, was to use all seven constructs, along with their attendant

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<sup>1</sup>The specialised use of the IT infrastructure.

measures, of the survey instruments, as input data. These constructs are set illustrated here in Table 7.1. They were also shown in detail with their variables in Table 5.1, and Appendix B: As the evidence stated in chapter 5, the researcher now proffer the findings, results, and analyses in this chapter. This shall be done in three parts.

Table 7.1: Constructs used in KM survey

Constuct	The Constructs for KM
1. CS	Current State of KM
2. HK	Human Knowledge
3. SK	Structural Knowledge
4. TI	Technological Infrastructure
5. BI	Business Intelligence
6. PA	Performance Analysis
7. AG	Asynchronous Groupware

In part one, the researcher shall perform an EFA into order to examine the inter-relationship of the measure in the present research model. Our main reason here, is to explore the possible underlying structure of the hypothesised inter-related manifest variables of the research. It is the researcher's firm conviction that the use of EFA will assist one to identify the appropriate number of constructs and the underlying factor structure in the research data. The researcher shall then report on the internal consistency of the data by checking the reliability of the items in the instrument, and the hypothesised constructs of the research, using Cronbach's alpha (Cronbach, 1951). The researcher performs a principal component analysis using the EFA procedure of SPSS for Windows, version 12, to check the unidimensionality of the seven hypothesised constructs, see Table 7.1: The objective here was to reduce the 95 indicator variables to latent variables, and hypothesised factors of the research framework, see Figures 5.5 - 5.7. This will prepare the framework for testing and establishing a fit for the hypothesised KM-BI model [cf. Figure 2.1 Model for KM-BI (from Campbell and Pellissier, 2000)]. This shall be aided by the other three hypothesised models [cf. Figure 5.5 Research framework for hypotheses 1 and 2, Figure 5.6 Research framework for hypothesis 3 and Figure 5.7 Research framework for hypothesis 4]. In testing the four research hypotheses; the KM Nexus [cf. Figure 5.2], and the research model [cf. Figure 5.4] will be given due consideration.

In part two, the study shall present the general findings and results on KM practices using univariate analyses from the transformed data set of the retained and rotated factors (latent variables), obtained from the results of the EFA, in part one, in the form of frequency distributions, tables, cross-tabulations, and pie and bar charts.

In part three, the study shall discuss the testing of the four research hypotheses; and shall perform non-parametric pairwise correlation using Kendall's tau-b correlation coefficients, as a measure of association between the pairs of composite variables. The framework hypothesised in Figure 5.5, will be used as the measurement model to examine the relationship between the AG factors, and the measures of BI, as it relates to competitive advantage. Spearman's rho shall also be used to validate the correction coefficient in hypothesis 3 and 4.

In the case of hypotheses three and four, the study will use bivariate correlation to examine the relationship between the AG factors and the measures of performance, as it relates to competitive advantage. This is with a view to see how they relate to KM strategies and BI. The measurement models in Figures 5.6 and 5.7, respectively, are relevant. The researcher shall use a linear regression model to further test the relationship of task-related outcomes team-related outcomes in hypothesis 4.

## 7.2 Exploratory factor analysis

### 7.2.1 Reliability analysis

Scale reliability was assessed by calculating coefficient alpha (Cronbach, 1951), and the standardised alpha, (Cronbach's alpha based on standardised items). Reliability estimates were .979 for Alpha, and standardised .981 for the seven [cf. Table 7.1 Constructs used in KM survey] hypothesised variables, respectively. The study uses N=95 items, being the number of relevant variables on KM in the instrument. Table C1 [Appendix C: C1] illustrates the reliability analysis syntax code, and the reliability statistics for Cronbach's alpha and Cronbach's alpha based on standardised items.

In Table 7.2, the researcher presents a correlation matrix, where the results of some descriptive statistics are reported, such as the means, standard deviations, and inter-correlations. In this table, the coefficient alpha reliability estimates are reported on the diagonal, with parentheses. The coefficient alpha reliability estimates (Cronbach, 1951) all exceed .80, except that of "current states of KM" at (-2.57). The value is negative due to a negative average covariance among the seven items. This violates the assumptions of Cronbach's reliability models. From the present investigation it was realised that further analysis was required to re-evaluate the coding of the items. This was done by recoding the reversed coded items of CS03, CS04, and

CS05. Here, a “1” became a “5”, and a “5” became a “1”, in that order, where a “1” – represents strongly disagree, and a “5”, represents strongly agree. Consequently, the reliability coefficient improved from (-2.57) to .678 for Cronbach’s alpha, and .798 for the standardised alpha.

A reliability coefficient of 0.80 or higher is more “accepted” in most Social Science applications.<sup>2</sup> The high alphas point to the fact that the data is unidimensional according to the initial research assumptions. The alphas therefore suggest that items in this survey instrument were reliable measures of the seven hypothesised constructs of Table 7.1.

Conceptually, Cronbach’s alpha can be written as a function of the number of test items and the average inter-correlation among the items. Below, for conceptual purposes, one shows the formula for the standardized Cronbach’s alpha [Equation 7.1]:

$$\alpha = \frac{N \cdot \bar{r}}{1 + (N - 1) \cdot \bar{r}} \quad (7.1)$$

Here  $N$  is equal to the number of items and  $\bar{r}$  is the average inter-item correlation among the items. One can see from this formula that if one increases the number of items, one also increases, proportionally, Cronbach’s alpha.

Additionally, if the average inter-item correlation is low, alpha will be low. As the average inter-item correlation increases, Cronbach’s alpha increases as well. This makes sense intuitively - if the inter-item correlations are high, and there is evidence that the items are measuring the same underlying constructs – see Table 7.2. This is really what is meant when the literature says there is “high” or “good” reliability [Nunnally, 1978:191]. It is referring to how well the items measure a single unidimensional latent construct.

Thus, if one data is multi-dimensional, Cronbach’s alpha will generally be low for all items. Where this is the case, one should run a principal component analysis, to see which items load highest on which dimensions, and then take the alpha of each subset of items separately. The fact that the alphas are reasonably high for all seven constructs of the instrument is illustrated in Table 7.2. The overall results of the reliability analyses for each of the seven constructs are illustrated in Appendix C: Tables C1 – C7.

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<sup>2</sup><http://www.ats.ucla.edu/stat/spss/faq/alpha.html>

Table 7.2: Mean, standard deviations, intercorrelation, and coefficients alpha – reliability estimates for exploratory survey

Variable	Mean	Std. Dev	V1	V2	V3	V4	V5	V6	V7
CS (V1)	31.38	3.22	(.68)	.	.	.	.	.	.
HK(V2)	22.06	3.34	.58	(.96)	.	.	.	.	.
SK(V3)	54.24	7.84	.51	.69	(.95)	.	.	.	.
TI(V4)	57.41	7.93	.53	.57	.73	(.93)	.	.	.
BI(V5)	99.56	9.28	.55	.50	.76	.77	(.91)	.	.
PA(V6)	49.98	4.44	.64	.42	.64	.73	.75	(.80)	.
AG(V7)	81.38	8.0	.39	.53	.76	.84	.82	.74	(.95)

Note: N = 1225. Reliability estimates appear on the diagonal.

### 7.2.2 Initial solution

Although the reliability coefficients are reasonably high for all of the seven constructs, these are still hypothesised constructs. The researcher's interest, here is to identify the underlying structure of the models, proposed in Figure 5.4 which is informed by both Figure 5.2 and 5.3, and from which the research framework of Figures 5.5, 5.6 and 5.7, respectively, were developed. One therefore, used the EFA statistical technique to examine the underlying structure of the research model [Child, 1990]. The researcher uses the research constructs and metrics, which are set out in Table 5.1, for this analysis.

**1. Factor extraction** The literature advises [Suhr, 1999] that factor analysis seeks to discover common factors among the data set. The technique for extracting factors attempts to take out as much common variance as possible in the first factor. Subsequent factors are, in turn, intended to account for the maximum amount of the remaining common variance until, hopefully, no common variance remains.

Direct extraction methods obtain the factor matrix directly from the correlation matrix by application of specified mathematical models. Most factor analysts agree that direct solutions are not sufficient. Adjustment to the frames of reference by rotation methods improves the interpretation of factor loadings by reducing some of the ambiguities, which accompany the preliminary analysis [Child, 1990]. The process of manipulating the reference axes is known as rotation. The results of rotation methods are sometimes referred to as derived solution because they are obtained as a second stage from the results of direct solutions.

Rotation applied to the reference axes, which means that the axes are turned about the origin until some alternative position has been reached. The simplest case is when the axes are held at 90 degrees to each other. This is referred to as orthogonal rotation. Rotating the axes through different angles gives an oblique rotation (not at 90 degrees to each other).

**2. Criteria for extracting factors** Determining the number of factors to extract in a factor analytic procedure is dependent on meeting appropriate criteria. There are four such criteria in common usage [Suhr, 1999]. These are:

- the eigenvalue-one criterion,
- the scree test,
- the proportion of variance accounted for , and
- the interpretability criterion.

The researcher will now discuss these four criteria in more detail below:

- Kaiser’s [Kaiser (1960)] criterion, suggested by Guttman and adapted by Kaiser, considers factors with an eigenvalue greater than one as common factors (Nunnally, 1978).
- Cattell’s (1966) scree test: The name is based on an analogy between the debris, called scree, that collects at the bottom of a hill after a landslide, and the relatively meaningless factors that result from over extraction. On a scree plot, because each factor explains less variance than the preceding factors, an imaginary line connecting the markers for successive factors generally runs from top left of the graph to the bottom right. If there is a point below which factors explain relatively little variance and above which they explain substantially more, this usually appears as an “elbow” in the plot. This plot bears some physical resemblance to the profile of a hillside. The portion beyond the elbow corresponds to the rubble, or scree, that gathers. Cattell’s guidelines call for retaining factors above the elbow and rejecting those below it. This amounts to keeping the factors that contribute most to the variance
- Proportion of variance accounted for: keeps a factor if it accounts for a predetermined amount of the variance (e.g., 5%, 10%, etc.).

- Interpretability criteria:
  - Are there at least three items with significant loadings ( $\geq 0.30$ )?
  - Do the variables that load on a factor share some conceptual meaning?
  - Do the variables that load on different factors seem to measure different constructs?
  - Does the rotated factor pattern demonstrate simple structure? Are there relatively:
    - \* high loadings on one factor?, and
    - \* low loadings on other factors?

The foregoing forms the set of criteria one shall use to retain factors in the application of factor analysis in this research.

**3. Initial factor solution (7 factor)** From the evidence at hand, the Cronbach alpha for the seven constructs in Table 7.2, is now presented. The first step in the procedure is to perform a factor analysis on the data set by using the principal component analysis, extracting only seven factors. These factors and their reliability coefficients are illustrated in Table 7.3: The related SAS/SAT, version 8, correlation procedure for each of the seven factors is illustrated in Appendix C, Tables C2 to C8. A CFA is then performed on the seven-factor solution of Table 7.3.

### 7.2.3 Confirmatory factor analysis (7 factor)

Factor scores (S1-S7) were created with the MEAN function, SAS/SAT. The approach followed is as set out below in Table D.7.1.

These factors were then subjected to a CFA with PROC CALIS. Figure 7.1 illustrates the CFA model. The SAS code in Table D.7.2 tests the underlying factor structure.

Results from the CFA analysis indicted lack-of-fit of the hypothesised model (chi-square = 612.1560, df = 14,  $p < 0.0001$ , RMSEA = 0.1868, CFI = 0.8793, NNFI = 0.8189). Good fit is indicated by a chi-square close to zero, an RMSEA  $< 0.06$ , CFI and NNFI  $> 0.90$  [Hu and Bentler, 1999].

Table D1 illustrated the goodness of fit indices, and the analysis of the initial measurement model. Another step that could be taken in the confirmatory approach is to test the structure

Table 7.3: Initial 7-factor structure and reliability coefficients

Factor	Items	Alpha
<i>Factor 1:</i> KM strategy created for promoting IC	bi11, bi10, cs06, pa02, pa05, bi02b, cs04, bi02d, bi02a, gd01b, bi02c, bi03, bi13, bi05, od01e, gd01g, bi06, sk01c, cs03, bi12, pa08, pa04, sk02g, bi08, bi09, bi15, bi16 (27 items)	Raw: 0.941712 Standardised: 0.944962
<i>Factor 2:</i> Groupware technologies used to support structural capital	ti01g, ti01f, pa11, od01a, bi07, ti02f, pa10, od01b, ti02g, od01d, pa12, ti02e, ti01c, od01f, ti01d, pa09, od01c, gd01c, bi17 (19 items)	Raw: 0.939854 Standardised: 0.953541
<i>Factor 3:</i> Formal networks for KM strategy	bi02e, bi02g, ti01b, gd01h, bi02f, bi02h, ti01a (7 items)	Raw: 0.939854 Standardised: 0.943929
<i>Factor 4:</i> Value of human capital	hk03, hk02, cs07, cs02, hk04, sk01b, sk01a, pa06, bi14, bi01, sk02e (11 items)	Raw : 0.936513 Standardised: 0.947210
<i>Factor 5:</i> Learning from KM initiatives	sk02d, sk02c, id01c, id01b, ti02d, id01a, ti02b, gd01f (8 items)	Raw :0.903392 Standardised: 0.933088
<i>Factor 6:</i> Effectiveness	gd01i, gd01e, pa07 (3 items)	Raw: 0.316967 Standardised: 0.45920
<i>Factor 7:</i> Benefits from setting up KM initiatives	pa01, sk02f, pa03 (3 items)	Raw: -0.876178 Standardised: -1.21147
<b>Total Scale</b>	<b>No. of Items = 78</b>	Raw: 0.972767 Standardised: 0.975327

for each of the seven factors. The SAS code in Equation 7.4 would test a model for the “KM strategy created for promoting IC”, IC factor. The covariance structure in Table D2 shows that one cannot reliably confirm the factor.

#### 7.2.4 Exploratory factor analysis

The next step in the analysis is to perform EFA because the original factor structure could not be confirmed. The SPSS code, in illustrated in Table D.7.4, provides a method of factor extraction, using principal component analysis.

The researcher presents the full output and results from this code in Table D3.



Table 7.4: Initial 7-factor structure and reliability coefficients

Factor	Factor label	Coefficient Alpha	
Factor 1	KM strategy created for promoting IC	.940	.954
Factor 2	Groupware technologies used ...	.940	.944
Factor 3	Formal networks for KM strategy	.940	.944
Factor 4	Value of human capital	.937	.947
Factor 5	Learning from KM initiative	.903	.933
Factor 6	Effectiveness	.317	.459
Factor 7	Benefits from setting up KM initiatives	.876	-1.211
Total scale	No. of items = 78	.973	.975

Note: The coefficient alpha represents both the raw and standardised alpha. The first column is the raw coefficient.

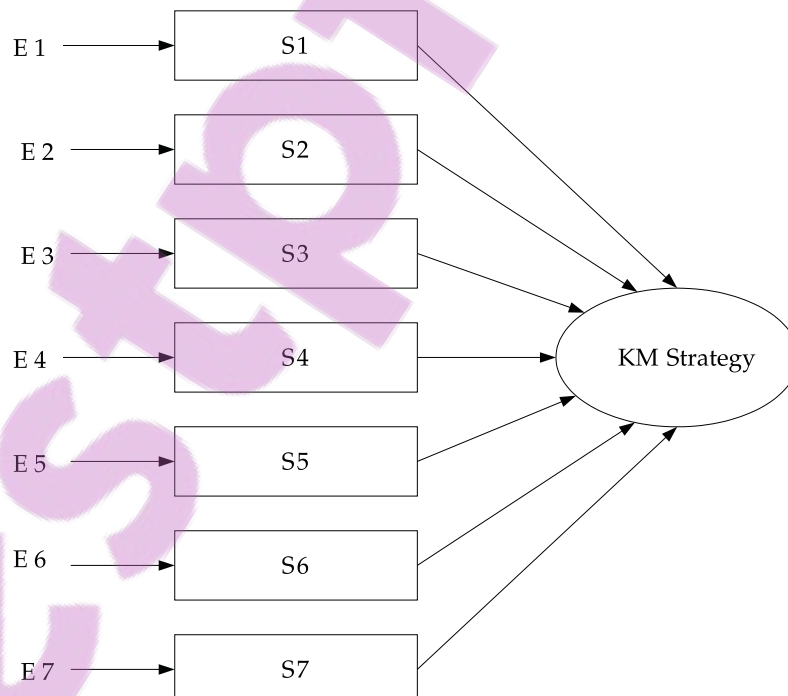


Figure 7.1: KM strategy factor structure

### 7.2.5 Principal component analysis

This statistical procedure is referred to as factor analysis, one must hasten, however, to point out that conceptually one did not use “factor analysis”, one used “principal component analysis”, instead. Both procedures can be performed with SPSS, or any other statistical package, and at times, they sometimes even provide very similar results.

Notwithstanding this, there are some important conceptual differences between principal component analysis and factor analysis. For this research, the first, and may be the most important deals with the assumption of an underlying casual structure: factor analysis assumes that the covariation in the observed variables is due to the presence of one or more latent variables (factors) that exert casual influence on these observed variables. Principal component analysis, on the other hand, makes no assumptions about the underlying casual model. It is simply a variable reduction procedure. It (typically) results in the retraction of a relatively small number of components (factors). These factors account for most of the variance in the set of observed variables [Hatcher, 1996:9].

The researcher now presents the findings and results from the principal components analysis output. Appendix D, gives the resulting output. Following is a discussion of the various sections of the output. For convenience, the values from the Appendix reported in the text are rounded to three significant digits. Any discrepancies between the numbers reported in the text and the output in the appendix are due to rounding errors.

#### Steps in conducting principal component analysis

In this research one conducted the principal component analysis in a sequence of steps, as advocated in some of the literature on principal components and its close relative, factor analysis, Hatcher (1996), Kim and Mueller (1978a; 1978b), Rummel (1970), Stevens (1986), Kerlinger (1986) and Lattin, Carroll and Green (2003), are relevant in this context. The researcher makes a number of subjective decisions and conclusions in one’s discussion throughout the process. This is against the background that this research is not an exercise in applied statistics, so comprehensive discussions of all of the options available in the principal component analysis procedure have not been covered. One, however, tried to make some specific recommendations, consistent with those practices, which are often followed in applied research, to facilitate the

discussions of the study's findings and results on KM strategies.

The researcher now presents these findings in the next four steps.

**1. Step 1: Initial extraction of the components** In principal component analysis, the number of components extracted is equal to the number of the variables being analyzed. The fact that 95 variables are analyzed in the present exploratory survey, 95 components will be extracted. The first component can be expected to account for a large amount of the total variance (44.969% in this case). Each succeeding component will account for progressively smaller amounts of variance (from 9.796% [second component] to 1.000 [fourteenth component]). Although a large number of components may be extracted in this way, only the first few components (14 in this case) will be important enough to be retained for interpretation [cf. D 8 Total variance explained].

The initial communalities are estimates of the variance in each variable accounted for by all components or factors. In terms of principal components extraction, this is always equal to 1.0 for correlation analyses. The extraction communalities, in general, are estimates of the variance in each variable accounted for by the components. These communalities are all high, and are illustrated in Table D3. The communalities for the Business Intelligence construct are reproduced here, in Table 7.5. Thus, indicating that the covariances of the variables are high and as such points to the possible relationship and representativeness of the variables with each other.

The exceptions are variables (BI08): "Employees learn from each other"; which is loaded at 0.638, and BI09. "Culture does not encourage learning"; which is loaded at 0.652. All the other variables, in this table [cf. Table 7.5 Communalities: Business Intelligence] and the related Table D3, range between a low of 0.715 to a high of 0.991, which indicates that the extracted components represent the variables, (KM strategies and policies), well. In general, those communalities that are very low in a principal components extraction should not be retained. This is evident in the rotated component matrix; see Table 7.11, Matrix of (Rotated Component) Loadings and Cross Loadings.

**2. Step 2: Determining the number of "meaningful" components to retain** Earlier it stated that the number of components extracted is equal to the number of variables being

analyzed, necessitating that one decides on the appropriate number of components that are truly meaningful and worthy of being retained for rotation and interpretation. From the present evidence, the research objectives hypothesised seven constructs, see Table 7.1. In general, it explained that only the first few components will tend to account for only trivial variance. The next step in the analysis, therefore, is to determine how many meaningful components should be retained for interpretation, in explaining the use of KM strategies in organisations.

This was done by using the four criteria previously discussed. These being:

- the eigenvalue-one criterion,
- the scree test,
- the proportion of variance accounted for, and
- the interpretability criterion.

**i). The eigenvalue-one criterion** In principal component analysis, one of the most commonly used criteria for solving the number-of-components problem is the eigenvalue-one criterion, also known as the Kaiser criterion [Kaiser, 1960]. With this approach, one retains and interpret only components with an eigenvalue greater than 1.00. This was present in Table 7.6 [cf. D 8 Total variance explained], where 14 components have been retained, using the eigenvalue-one criterion.

On the other hand, a component with an eigenvalue less than 1.00 is accounting for less variance than had been contributed by one variable. The purpose of principal component analysis is to reduce a number of observed variables into a relatively smaller number of components. This cannot be effectively achieved if one retains components that account for less variance than had been contributed by individual variables. For this reason, components with eigenvalues less than 1.00 are viewed as trivial, and are not retained, see Table D4.

The eigenvalue-one criterion has a number of positive features that have contributed to its popularity. Perhaps the most important reason for its widespread use is its simplicity. One does not have to make any subjective decisions, but merely retain components with eigenvalue greater than one.

On the positive side, it has been shown that this criterion very often results in retaining the

Table 7.5: Communalities: Business Intelligence

Variables (Questionnaire items)	Initial	Extraction
Strategy is important or KM initiative (BI01)	1.000	.917
Current state of KM initiative (BI02A)	1.000	.935
KM strategy is being created (BI02B)	1.000	.959
Planning benchmarking and audit exercise (BI02C)	1.000	.973
Developing and measuring intellectual capital (BI02D)	1.000	.955
Planning job and process redesign of core processes (BI02E)	1.000	.969
Establishing of informal KM networks (BI0F)	1.000	.990
Establishing of formal networks (BI02G)	1.000	.990
Provided incentives and rewards for KM (BI02H)	1.000	.944
KM strategy enhanced value-added services (BI03)	1.000	.953
KM strategy resulted in problem solving time (BI04)	1.000	.923
Dedicated KM role (BI05)	1.000	.894
Importance of dedicated budget (BI06)	1.000	.954
Willingness to share knowledge (BI07)	1.000	.854
Employees learn from each other (BI08)	1.000	.638
Culture does not encourage knowledge sharing (BI09)	1.000	.652
Lack of funding for km initiatives (BI10)	1.000	.991
Lack of understanding of km initiatives (BI11)	1.000	.991
Lack of appropriate technology BI12)	1.000	.982
Individuals don't have time to share information (BI13)	1.000	.972
No rewards for knowledge sharing (BI14)	1.000	.923
Knowledge is difficult to locate (BI15)	1.000	.969
Individuals do not share best practice (BI16)	1.000	.988
There is too much knowledge (BI17)	1.000	.805
Much impetus from outside (BI18)	1.000	.852

Extraction Method: Principal Component Analysis. Extracted from Table D3

correct number of components. This is, particularly true, when a small to moderate number of variables, in this case, 95 variables, are being analysed.

The case is also valid when the variable communalities are high, see Table D3. Stevens (1986), reviews studies that have investigated the accuracy of the eigenvalue-one criterion, and recommends its use when less than 30 variables are being analysed and communalities are greater than 0.70. He also recommends it when the analysis is based on over 250 observations and the mean communality is greater than or equal to 0.60. This view is supported in Table 7.5, and Table D3, where the average communality is greater than 0.80.

There are a number of problems associated with the eigenvalue-one criterion, however. As was suggested in the preceding paragraph, it can lead to retaining the wrong number of components under circumstances that are often encountered in research, for example, when many variables

are analyzed, and when the represented communalities are small. This is not the case in this research. Although the study has analysed 95 variables, which may be considered as being many, the communalities of this research are all over 0.60, as recommended by Stevens (1986) for observations over 250. The number of observations here is 1225.

Additionally, the application of this criterion, without proper thought and logic can sometimes lead the researcher in retaining a certain number of components when, in fact, the actual difference in the eigenvalues of successive components is of insignificant value to the component's structure and theme

For example, where component 14 displays an eigenvalue of 1.027 and component 15 displays an eigenvalue of 0.919, then component 14 will be retained but component 15 will not; this may mislead one at first into believing that component 15 was meaningless when, in fact, it accounted for nearly the same amount of variance as component 14. The difference here, see Table 6.5, is 0.108 [1.027-0.919]. In other words, the eigenvalue-one criterion can be helpful when used judiciously, but the thoughtless application of this approach can lead to serious errors of interpretation.

Additionally, the application of this criterion, without proper thought and logic can sometimes lead the researcher in retaining a certain number of components when, in fact, the actual difference in the eigenvalues of successive components is of insignificant value to the component's structure and theme. For example; where component 14 displays an eigenvalue of 1.027 and component 15 displays an eigenvalue of 0.919, then component 14 will be retained but component 15 will not; this may mislead one at first into believing that component 15 was meaningless when, in fact, it accounted for nearly the same amount of variance as component 14. The difference here, see Table 7.6, is 0.108 [1.027-0.919]. In other words, the eigenvalue-one criterion can be helpful when used judiciously, but the thoughtless application of this approach can lead to serious errors of interpretation. The eigenvalue table for the current analysis appears in Table D4: Total variance Explained - Initial Eigenvalues. The eigenvalues for the first 20 components are shown in Table 7.6. The first 14 components, which have eigenvalues greater than 1.000, have been retained and used for interpretation based on the criterion-one decision rule.

Fortunately, the application of the criterion is straightforward in this case: the last component retained (14), actually displays an eigenvalue of 1.027, whilst the next component (15) displays an eigenvalue of 0.919, which is clearly lower than 1.00, albeit only by 0.108. One is not

therefore, in this analysis, faced with the difficult decision of whether to retain a component that demonstrates an eigenvalue that is close to 1.00, but not quite 1.000. One therefore, uses the eigenvalue-one criterion with much confidence.

**Total variance explained** The researcher now turns attention to the Table 7.6 – Total variance explained – Initial Eigenvalues, where the initial solution, is based on the fact that there are as many components as variables, and in a correlation analysis, the sum of the eigenvalues equals the number of components. The study requested that the extracted eigenvalues be greater than one; so the first 14 principal components form the extracted solution (see the first column of Table 7.6).

Table 7.6: Total variance explained: initial eigenvalues

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	42.721	44.969	44.969
2	9.306	9.796	54.765
3	8.177	8.607	63.372
4	5.864	6.173	69.545
5	4.048	4.261	73.807
6	3.081	3.243	77.050
7	2.862	3.013	80.062
8	2.197	2.313	82.376
9	1.864	1.962	84.337
10	1.649	1.736	86.073
11	1.417	1.492	87.565
12	1.255	1.321	88.886
13	1.117	1.175	90.061
14	1.027	1.081	91.142
15	.919	.968	92.110
16	.823	.866	92.976
17	.728	.766	93.742
18	.643	.677	94.419
19	.581	.611	95.030
20	.528	.556	95.586

Extraction Method: Principal Component Analysis. Extracted from Appendix D4.

In Table 7.6, the column labelled Total is the eigenvalues for the multivariate space of the original variables, which are ordered by size. They are also plotted in the scree plot in Figure 7.2. Each value here: 42.721, 9.306, 8.177 to 1.027 (the first 14 components), is the total variance explained by the factor (component), say factor 1 to 14. The total variance is the sum of the diagonal elements of the correlation matrix or in this case, for principal components, the number

of variables (95 variables). Interestingly, the percentage of the total variance attributed to each factor is displayed in the column labelled % of Variance (Table 7.6).

Here, the first factor (component) accounts for 44.969% of the variance and the second accounts for 9.796 %, the third – 8.607 %, fourth – 6.173 %, fifth – 4.261 %, and so on until the fourteenth at 1.081 %, respectively. Together, the 14 factors account for 91.142% of the variability of the original 95 variables. It is worth noting that by default, SPSS computes, as many components as there are eigenvalues greater than 1.

If the 95 variables were independent of each other, there would be 95 components, each with a variance of 1, see Table D4. One acceptable criterion, from the literature, for determining the number of useful factors for extraction, which were used throughout this research, is to exclude factors with variances less than 1, because one feels that they do no better than a single, independent variable.

Table 7.7: Extraction Sums of Squared Loadings

Components	Total	% of Variance	Cumulative %
1	42.721	44.969	44.969
2	9.306	9.796	54.765
3	8.177	8.607	63.372
4	5.864	6.173	69.545
5	4.048	4.261	73.807
6	3.081	3.243	77.050
7	2.862	3.013	80.062
8	2.197	2.313	82.376
9	1.864	1.962	84.337
10	1.649	1.736	86.073
11	1.417	1.492	87.565
12	1.255	1.321	88.886
13	1.117	1.175	90.061
14	1.027	1.081	91.142

Extraction Method: Principal Component Analysis. Extracted from table D4.

Table 7.7 shows the extracted components. They explain 91.142% of the variability in the original 95 variables, so one can considerably reduce the complexity of the data set by using these 14 components, with only an 8.858% loss of information.

In Table 7.8, the rotation maintains the cumulative percentage of variation explained by the extracted components, but that variation is now spread more evenly over the components. The large changes in the individual totals suggest that the rotated component matrix will be easier



Table 7.8: Rotation Sums of Squared Loadings

Components	Total	% of Variance	Cumulative %
1	18.520	19.495	19.495
2	14.796	15.575	35.070
3	14.691	15.464	50.533
4	12.657	13.323	63.856
5	5.667	5.966	69.822
6	3.092	3.254	73.076
7	2.856	3.006	76.083
8	2.769	2.914	78.997
9	2.386	2.512	81.509
10	2.064	2.173	83.682
11	1.917	2.018	85.700
12	1.899	1.999	87.699
13	1.785	1.879	89.578
14	1.486	1.564	91.142

Extraction Method: Principal Component Analysis. Extracted from Table D4.

to interpret than the unrotated matrix.

**ii). Scree Plot** With the scree test [Cattell, 1966], one plots the eigenvalues listed in Tables 7.6 against their order (or associated component), and look for a “break” between the components with relatively large eigenvalues and those with small eigenvalues. The components that appear before the break are assumed to be meaningful and are retained for rotation; those appearing after the break are assumed to be unimportant and are not retained, see Figure 7.2.

The present study used the display of the curve to identify a useful number of factors to retain by looking for large values that separate well from the smaller eigenvalues. The scree plot in Figure 7.2, shows that one may safely, retain the 14 factors, which one identified in Table 7.6. The criteria for retaining these 14 factors have been discussed previously.

The use of the “breaks” in a scree plot as the decision criterion is at times difficult to make. This is so, because, in some studies, the scree plot displays several large breaks. Whenever this occurs, the researcher should use the last “big” break before the eigenvalues begin to level off. In this case, on the advice of the literature [Hatcher, 1996], one retained only, the components that appear before the last “big” breaks, for further analysis.

One is not faced with the dilemma of multiple breaks, in this research as illustrated in the scree plot, in Figure 7.2. Here, the component numbers are listed on the horizontal axis, while

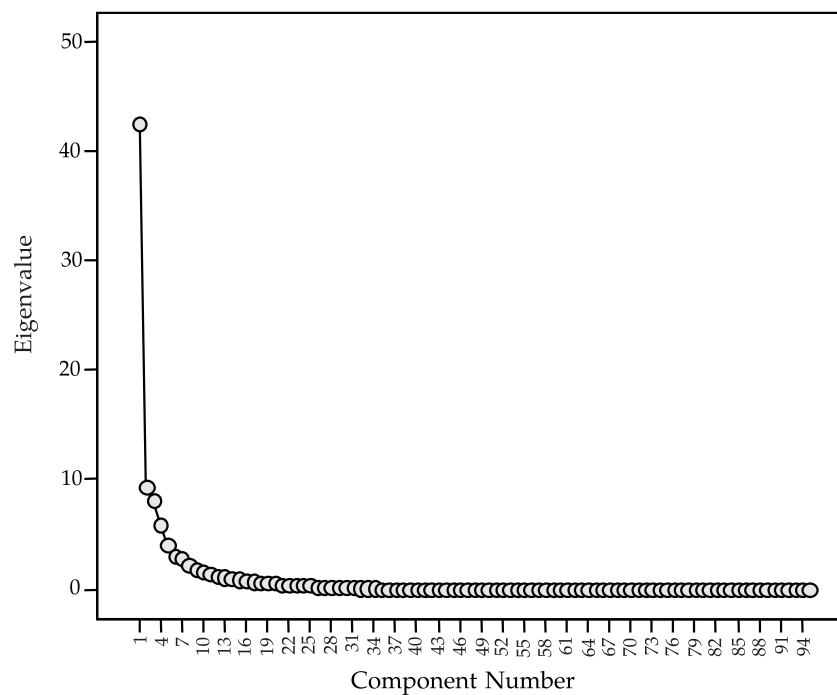


Figure 7.2: Scree plot of extracted factors for KM

eigenvalues are listed on the vertical axis. In this plot, one can see that there is a relatively large break before component 1 and 2. The break between component 2 and 3 is indeterminate, and may be considered as being negligible. The breaks between four, five and six with seven are all relatively small. Using the “breaks” in the scree test would lead one to retain only components 1, 2, 3, 4 and 5. However, the breaks between components 6 to 14 are negligible. As such, one regards them as trivial for the purposes of determining a factor structure. The results extracted from the rotated component matrix [cf. D 10 Rotated Component Matrix(a)], are illustrated in Tables 7.9 to Table 7.13: Rotated component matrix – cross loadings of components, support the researcher’s decision.

The scree plot<sup>3</sup>, which one obtains from the 95 items/variables of the questionnaire, seems to suggest that 14 factors are the optimal number of components which can be reasonably extracted from the data. They explain 91.142% of the variability of the original 95 variables. Here, one extracted the first 14 components on the steep slope. The components on the shallow slope contribute little to the solution of this research, as they apply to the hypothesised constructs of KM.

<sup>3</sup>Scree Plot: The name scree plot arises because scree is the rubble at the bottom of a cliff; so the large (retained) eigenvalues are the cliff, and the deleted ones the rubble. *SPSS Base 10.0 Application Guide*, 1999 SPSS INC. pp.330.

In general, the scree test can be expected to provide reasonably accurate results, if the sample is large (over 200) and most of the variable communalities are large (Stevens, 1986). However, this criterion has its own set of weaknesses as well, most notably the ambiguity that is often displayed by scree plots under typical research conditions: Very often, it is difficult to determine exactly where in the scree plot a break exists, or even if a break exists at all. This is the case between component 6 and 7. The breaks in the scree plot in Figure 7.2 are for components 1, 2, 3, 4 and 5 are reasonably obvious. One also retained components 6 and, 14 although they initially were of some concerns and one had to resort to other methods to resolve whether they should be indeed retained. These methods shall be discussed later, when one examine the other two criteria, namely “the proportion of variance accounted for criterion”, and “the interpretability criterion”.

**iii). Proportion of variance accounted for** A third criterion in deciding on the number of factors to retain involves retaining a component if it accounts for a specified proportion (or percentage) of variance in the data set. For example, one could decide to retain any component that accounts for at least 5% or 10% of the total variance. This proportion can be calculated with a simple formula:

$$\text{Proportion} = \frac{\text{Eigenvalue for the component of interest}}{\text{Total eigenvalue of the correlation matrix}} \quad (7.2)$$

In principal component analysis, the “total eigenvalues of the correlation matrix” is equal to the total number of variables being analyzed (because each variable contributes one unit of variance to the analysis).

The eigenvalue table for the current analysis appears in Table 6.5 – Total variance explained. From the second column (% of variance) in this eigenvalue table, one can see that the first component alone accounts for 44.969% of the total variance, the second component alone accounts for 9.796%, the third component accounts for 8.607%, the fourth component accounts for 6.173%, and the fifth component accounts for only 4.261%. If one had decided to retain only components that account for at least 5% of the total variance in the data set prior to performing the analysis. This criterion would cause one to retain components 1, 2, 3, and 4. One would therefore, have retained fewer components than would have been retained with the two preceding criteria.

An alternative criterion to this is to retain enough components so that the cumulative percent of variance accounted for is equal to some agreed minimal value. For this research, components 1, 2, 3, 4 and 5 accounted for approximately 44.969%, 9.796%, 8.607%, 6.173% and 4.261% of the variance, respectively. The sum of these percentages is 73.807%. This means that the cumulative percent of variance accounted for by components 1, 2, 3, 4 and 5 is 73.807%, while it is 91.142% for the first 14 components, using the eigenvalues greater 1 criterion, as discussed previously (see Table 6.5). In general, when researchers use the “cumulative percent of variance accounted for”, as the criterion for solving “the number of components retained”, they usually retain enough components so that the cumulative percent of variance accounted for at least 70% (and sometimes 80%).

The proportion of variance criterion has a number of positive features. For example, in most cases, one would not want to retain a group of components that, combined, account for only a minority of the variance in the data set (say 30%). Nonetheless, the critical values discussed earlier 5 – 10% for individual components and 70-80% for the cumulative (combined) components are obviously arbitrary. The literature has criticized this approach because of its subjectivity [Kim and Mueller, 1978b], and the related problems discussed previously.

**iv). The interpretability criteria** One of the most widely used criterion for solving the “number-of-components” problem is the interpretability criterion (Hatcher, 1996): “interpreting the substantive meaning of the retained components and verifying that the interpretation makes sense in terms of what is known about the constructs under investigation” (p:26).

Larry Hatcher (1996:26-27) proffers the following four rules to do this:

1. Are there at least three variables (items) with significant loadings on each retained component? A solution is less satisfactory if a given component is measured by less than three variables. In Table 6.8 one sees that component 1, has 13 of the 95 variables under consideration. While in Table 7.10 component 2, has 10 variables. In Table 7.11, component 3 has 16 variables. In Tables 7.12, component 4 has 10 variables. Component 5, from Table 7.13, has 7 variables represented. However, from Table D6, one sees that components 7, 10 and 11 have 2 variables each, components 6, 8, 9, 12, and 13 each has 1 variable, while component 14 has none.
2. Do the variables that load on a given component share the same conceptual meaning?

For example, if three questions on a survey all load on component 1 do all three of these questions (items) seem to be measuring the same construct. This is the case of component 1, given the study's seven hypothesised constructs. Here, one sees that a significant number of the variables seem to be measuring the business intelligence (BI) construct. This is illustrated in Table 7.9. Component 2, on the other hand, in Table 7.10, seems to be measuring the asynchronous groupware (AG) infrastructure, with ten uniquely loaded variables. Table 7.11 represents component 3, and measures the human knowledge (HK) construct, with 16 uniquely loaded variables. Organisational learning is uniquely measured in Table 7.12, component 4 with ten variables. Component 5 also has seven variables, which is uniquely measuring the SC construct, in Table 7.13.

3. Do the variables that load on different components seem to be measuring different components? For example, if three questions loads on component 1, and three other questions load on component 2, do the first three questions seem to be measuring a construct that is conceptually different from the construct measured by the last three questions. This is the case in Tables 7.9 – Tables 7.13, as explained above in (ii).
4. Does the rotated factor pattern demonstrate “simple structure”? Simple structure means that the pattern possesses two characteristics: (a) Most of the variables have relatively high factor loadings on only one component, and near zero loadings on the other components, and (b) most components have relatively high factor loadings for some variables, and near-zero loadings for the remaining variables. This concept of simple structure will be explained in more detail in the section titled *Step 4: Interpreting the Rotated Solution*.

The component matrix is presented in Table D5. It displays the coefficient (or Loadings) that relate the variables to the 14 unrotated factors (components). Unrotated loadings and orthogonally rotated loadings are the correlations of the variables with the components. The correlation between “value knowledge about customers (SK01A)” and component 1 is 0.741, while the correlation between SK01A and component 2 is 0.554. One may reasonably draw the conclusion that SK01A is associated with both components 1 and 2. In the case of the results for “Value knowledge on regulatory environment (SK01F)”, it loads very high on component 1 at 0.885. Thus, suggesting that SK01F is associated with component 1.

Some variables do not show any loadings against their components. This was due to the request that loading be sorted by size and those values less than 0.30 be replaced with blanks. In this

Table 7.9: Rotated component matrix – BI

Factor 1			
Item No.	Variables	Item label	Loading
1	BI16	INDIVIDUALS DO NOT SHARE BEST PRACTICE	-.923
2	BI11	LACK OF UNDERSTANDING OF KM INITIATIVES	.875
3	BI10	LACK OF FUNDING FOR KM INITIATIVES	.875
4	BI15	KNOWLEDGE IS DIFFICULT TO LOCATE	-.801
5	PA02	BETTER DECISION MAKING	.784
6	BI02D	DEVELOPING and MEASURING INTELLECTUAL CAPITAL	.758
7	BI02B	KM STRATEGY IS BEING CREATED	.754
8	PA05	CREATING NEW/ADDITIONAL BUSINESS OPPORTUNITIES	.737
9	GD01B	PROCESS ADOPTION	.735
10	BI02A	CURRENT STATE OF KM INITIATIVE	.730
11	BI05	DEDICATED KM ROLE	.722
12	CS04	NO KNOWLEDGE OF KM	.712
13	BI06	IMPORTANCE OF DEDICATED BUDGET	.696

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Extracted from Table D6.

table, Table D5, the initial component (factor) extraction does not give interpretable factors. One shall not attempt to name the resulting components, until they have been rotated, see Table D5. Hence, in this research, one interprets the first unrotated component with high loadings for the 95 variables as a general factor. Only one variable is not included in this component from the overall survey.

### 3. Step 3: Rotation to a final solution

**Rotated component matrix** The process of identifying the factors to keep is achieved with the rotated component matrix. These factors/components are represented in the Table D6.

The rotated component matrix helps one to determine what the components represent. The main objective of rotation is to make larger loadings larger and smaller loadings smaller than their unrotated values (see Tables 7.9 – 7.13 Rotated component matrices, for the matrices of Loadings and Cross-Loadings).

**i). Factor 1 – BI** One can see from Table 7.9: Rotated component matrix – BI, that factor 1 has 13 uniquely loaded variables.

ii). **Factor 2 – AG** Factor 2 is illustrated in Table 7.10: Rotated component matrix – AG infrastructure, and has 10 uniquely loaded variables.

Table 7.10: Rotated Component Matrix – AG infrastructure

Factor 2			
Item No.	Variables	Item label	Loading
1	PA11	FORMALISING THE KNOWLEDGE DEVELOPMENT CYCLE	.868
2	PA10	COMPONENT INTERACTION BETWEEN TECHNOLOGIES	.820
3	TI02G	EXTRANET SUPPORT INFRASTRUCTURE IMPLEMENTED FOR KM	.800
4	TI01F	DECISION SUPPORT USED	.783
5	BI07	WILLINGNESS TO SHARE KNOWLEDGE	.753
6	TIO2F	DECISION SUPPORT SYSTEMS USED TO SUPORT KM INITIATIVE	.749
7	OD01D	INTER-LEVEL and INTERDEPARTMENTAL COMMUNICATION	.746
8	OD01F	ALIGNMENT OF KM WITH ORGANISATIONAL GOALS	.685
9	OD01C	OPENNESS	.652
10	SK01D	VALUE KNOWLEDGE ABOUT COMPETITORS' MARKETS	.315

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Extracted from Table D6.

iii). **Factor 3 – HK** Factor 3 is illustrated in Table 7.11: Rotated component matrix – Human knowledge, and has 16 uniquely loaded variables.

Factor 4 is illustrated in Table 7.12: Rotated component matrix – Organisational learning, and has ten uniquely loaded variables.

Factor 5 is illustrated in Table 7.13: Rotated component matrix – Structural capital, and has seven uniquely loaded variables.

In applying the interpretability rules to Tables 7.9 – 7.13, The researcher found that:

1. There are 13 variables with significant loadings on component 1 [cf. Table 7.9 Rotated component matrix – BI], ten on component 2 [cf. Table 7.10 Rotated Component Matrix – AG infrastructure], 16 on component 3 [cf. Table 7.11 Rotated Component Matrix – HK] 10 on component 4 [cf. Table 7.12 Rotated Component Matrix - OL ] on component 5 [cf. Table 7.13 Rotated Component Matrix – SC]. The loadings on the other components were not retained because of Rule 2, see Table D.6.: Rotated Component Matrix [Rule 1: Significant loadings on at least a minimum of 3 variables].
2. The factor loadings for component 1 (Factor 1) are presented in Table 7.9. The factor loadings for the 30 variables were not retained although their loadings were over 0.300,

Table 7.11: Rotated Component Matrix – HK

<b>Factor 3</b>			
Item No.	Variables	Item label	Loading
1	HK03	LOSS OF SIGNIFICANT INCOME	.915
2	HK02	DAMAGE TO KEY CLIENT/SUPPLIER RELATIONSHIP	.897
3	HK01	LOST OF BEST PRACTICE IN SPECIFIC AREA	.885
4	HK04	LOSS OF VITAL INFORMATION	.836
5	HK05	EMPLOYEES PROVIDED WITH RESOURCES	.818
6	SK01B	VALUE KNOWLEDGE ABOUT OWN MARKET	.810
7	CS07	AWARENESS OF KM	.809
8	SK01A	VALUE KNOWLEDGE ABOUT OWN CUSTOMERS	.786
9	SK01E	VALUE KNOWLEDGE ON EMPLOYEES SKILLS	.705
10	CS02	TRANSFORMS ORGANISATION'S BUSINESS	.651
11	SK01G	VALUE KNOWLEDGE ON METHODS and PROCESSES	.645
12	ID01A	SATISFACTION	.546
13	BI01	STRATEGY IS IMPORTANT FOR KM INITIATIVE	.538
14	PA06	SHARING BEST PRACTICE	.507
15	TI02B	INTRANET INFRASTRUCTURE IMPLEMENTED FOR KM SUPPORT	.506
16	SK01D	VALUE KNOWLEDGE ABOUT COMPETITORS' MARKETS	.577

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Extracted from Table D6.

Table 7.12: Rotated Component Matrix – OL

<b>Factor 4</b>			
Item No.	Variables	Item label	Loading
1	BI02D	DEVELOPING AND MEASURING INTELLECTUAL CAPITAL	.910
2	GD01H	COST	.770
3	TI01B	INTRANET INFRASTRUCTURE IMPLEMENTED IN ORGANISATION	.740
4	GD01A	REUSE OF PREVIOUS KM INFORMATION	.636
5	TI01A	INTERNET ACCESS IMPLEMENTED IN ORGANISATION	.636
6	TI01E	DATA WAREHOUSING AND DATA MINING USED	.592
7	SK01D	VALUE KNOWLEDGE ABOUT COMPETITORS' MARKETS	.585
8	TI02A	INTERNET ACCESS FOR KM SUPPORT	.569
9	BI04	KM STRATEGY RESULTED IN PROBLEM SOLVING TIME	.552
10	GD01F	INFORMATION ACCESS	.518

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Extracted from Table D6.



because they also loaded on other components, see Table D.6. The variables on Factor 1 all seem to be conceptually measuring the characteristics of BI. Component 2 (Factor 2) on the other hand, has cross-loadings as shown in Table D.6. The ten variables which loaded uniquely on this factor seem to be conceptually measuring the same metrics, those of knowledge management which deals with innovation and the asynchronous groupware infrastructure. This is illustrated in Table 7.10. The researcher did not retain 27 variables for this factor, because they had significant cross-loadings on other factors.

Table 7.13: Rotated Component Matrix – SC

Factor 5			
Item No.	Variables	Item label	Loading
1	SK02A	STORE KNOWLEDGE ON CUSTOMERS	.776
2	SK02C	STORE KNOWLEDGE ON OWN PRODUCTS	.776
3	SK01B	STORE KNOWLEDGE ON OWN MARKETS	.776
4	SK02D	STORE KNOWLEDGE ON COMPETITORS' MARKETS	.729
5	SK02G	STORE KNOWLEDGE ON METHODS AND PROCESSES	.694
6	SK02E	STORE KNOWLEDGE ON EMPLOYEES SKILLS	.661

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

**v). Factor 5 – SC** In Table 7.11, one sees that the 16 variables seem to be all measuring those metrics dealing with the human knowledge constructs of the research. This is represented by the cross-loadings of component 3 (Factor 3). This factor did not retain 23 variables. The ten variables which load significantly on component 4 (Factor 4) are illustrated in Table 7.12. They are clearly measuring the construct dealing with OL, although 31 of these variables were not retained. Component 5 (Factor 5), Table 7.13 has six variables which all measure the SC construct of the research. Another seven variables were not retained [Rule 2: Do variables which load on a component share the same conceptual meaning?]

3. The evidence would seem to suggest that Rule 3 has been met, for the five components. The study found this to be acceptable, although one had initially hypothesised seven constructs. The researcher will discuss the reasons for this later on in Step 4 of the next section [Rule 3: Do variables which load on different components, measure different construct?]
4. Rule 4 [Does the rotated factor pattern demonstrate “simple structure”] is satisfied in the five retained components (factors). There is indeed “evidence of simple structure” as shown in Tables 7.9 – 7.13. The pattern characteristics of: a) high factor loading on one

component, and near zero on the other components; and b) components/factors having high factor loadings for some variables, and near zero loadings for the remaining variables [D 10 Rotated Component Matrix(a)] One now turns one's attention to the interpretation of the factors.

**4. Step 4: Interpreting the rotated solution** The first factor is most highly correlated with BI16, BI11, BI10, BI15, BI02D, BI05, BI02B, BI02A, and BI06 respectively [cf. Table 7.9 Rotated component matrix – BI]. These variables are highly interrelated with each other; see Table 7.9 BI. This represents almost 70% of the variables of the BI construct. The underling theme of the construct may be adequately explained by these nine [9 of 13 variables] variables, and thus naming the factor as BI shows that the variables of BI are highly correlated with each other. The overall correlation of this factor is significant at the 0.01 level (2-tailed).

The second factor is most highly correlated with PA11, PA16, TI02G, TI01F, BI07, OD01G, TI02F, OD01D, OD01F, OD01C, and SK01D, respectively [cf. Table 7.10 Rotated Component Matrix – AG infrastructure]. This is using the criteria discussed previously in this chapter for selecting variables that load uniquely on components. One may safely name this factor as Innovation and AG infrastructure. The variables are highly inter-correlated with each other; see Table 7.10 – AG infrastructure. This represents almost 90% [9 of 10 variables] of the variables of the constructs on IT Infrastructure which are used to measure innovation to fit within the study's hypothesised model for KM-BI. The remaining variable: SK01D, reflects the characteristics of structural capital, as it relates to IT infrastructures and KM networks.

The third component/factor is most highly correlated with all the items of Table 7.11, but specifically with HK03, HK02, HK01, HK04, HK05, SK01B, CS07, SK01A, SK01E, CS02, SK01G, ID01A, BI01, PA06 TI02B and SK01D (cf. Table 7.11 Rotated Component Matrix – HK] respectively. This seems to suggest that the factor is focused on HC, which is knowledge sharing strategy, as it relates to HC. The correlation matrix of these 16 variables of this factor is positively inter-related with each other. The coefficients are all significantly correlated. The overall correlation in this table is significant at the 0.01 level (2-tailed).

The fourth component is illustrated in Table 7.12 are highly correlated with all of the 10 variables dealing with those characteristics of the organizational learning systems. From the present findings it would seems reasonable to name the factor as OL.

The final component/factor is most highly correlated with the seven variables in Table 7.13. This representing 100% of the variables of the construct: SK/SC. The underlying theme of the construct may be adequately explained by these seven variables, and thus naming the factor as SC, seems to be reasonable.

This concludes the exploratory factor analysis of the data set using principal components. One found that there is a simple structure from the seven factor solution of the data set. The five extracted factors are:

1. Business intelligence (BI),
2. Asynchronous groupware (AG),
3. Human capital (HC),
4. Organisational learning (OL), and
5. Structural knowledge (SK or SC).

These five factors are not significant different from the seven original hypothesised constructs used in the survey.

The present investigation will now examine the descriptive statistics associated with the survey in the form of frequency distribution, cross-tabulations, and interactive graphs and charts. This is with a view to explore the general findings on the status and attitudes of KM practices in the respondents organizations, within the 26 countries from the Commonwealth of Nations (formerly British colonies) that were sampled. The researcher performs this analysis on the seven original hypothesised constructs.

### 7.3 Findings on KM Practices

#### 7.3.1 Current state of KM

This construct (Current State of KM) uses seven items. Here one tested the level of awareness of KM in organisation, whether there was a business case for KM, and the status of the KM initiative that was in place. The items have been scaled from: (1) not at all, to (5) very large extent; and from (1) strongly disagree, to (5) strongly agree, respectively. The variables are:

- organise information (CS01),
- transforms organisation's business (CS02),
- being done but has no name (CS03),
- no knowledge of KM (CS04),
- KM is just a management fad (CS05),
- KM initiative not in place (CS06), and
- awareness of KM (CS07).

The reliability coefficient of the Cronbach's alpha is computed for the Current State of KM, construct in Table 6.2 at 0.68. This alpha suggests that items in this construct are reasonable reliable measure of the "Current State of KM" in the sampled organisations.

In Part Three of this chapter, the researcher shall present the positive correlation coefficients for the seven measures of the state of KM awareness and usage at a significant level of 0.01 (two-tailed), using Kendall's tau<sub>b</sub>.

Given the strength of the association between these measures, one now reports the findings emanating from this investigation, using frequencies tables, of these measures/variables in the sampled organizations [cf. Table 7.14 Attitudes towards KM].

### **Awareness of knowledge management**

Attitudes [cf. Table 7.14 Attitudes towards KM] to KM have changed over the past three years. Only 20% of respondents considered KM to be a fad that would soon be forgotten. This contrasts with the results of a survey by the Information Systems Research Centre of Cranfield School of Management (September 1997) in which almost a third of the respondents thought KM was a fad. KM is growing rapidly in importance and has gained great impetus in these four years since that study was conducted. 100% of respondents said KM was clearly transforming the way their organisation did business. This is a high proportion given the significance of any organisational transformation.

Table 7.14: Attitudes towards KM

Attitudes to KM	Rating
It could help my company organise information sources better	98
It is transforming the way my organisation does business	100
Something we do but we don't have a name for it	12
Just a management fad, which will be soon be forgotten	20

base: all respondents (1225)

### KM initiative in place

At most 97% of respondents considered their organisation to have a KM initiative in place [cf. Figure 7.2 Existence of a KM initiative].

This compares well with the results of a survey by the Management Review (Wah, 1999), where 53% of the organisations studied either has a KM initiative in place or expects to implement one in the short-run. At most nine out of ten (89%) of the largest organisations had a KM initiative in place against just over 11% of the rest [cf. Figure 7.4].

While this is encouraging the study will, however show that few organisations are reaping the full benefits of KM in terms of:

- providing employees with the necessary resources to contribute to the organisation's knowledge,
- establishing a strategy for KM,
- identifying the expected benefits and managing their realisation, and
- making the most of existing technology to store and disseminate information which is most critical to an organisation's success.

Given the requirements of the framework depicted in Figure 5.4, particularly the KM strategies component, it may be argued that all these changes would suggest that knowledge -based enterprise needs to have a good change management programme in place to engender support from employees. This fact may be borne out by the framework – The KMN in Figure 5.2 along with the supporting and attendant arguments.

These arguments lead naturally into the next component, HK, of the KMN framework.

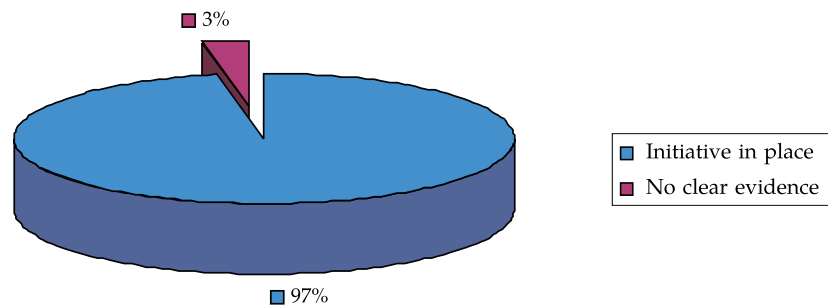


Figure 7.3: Existence of a KM initiative

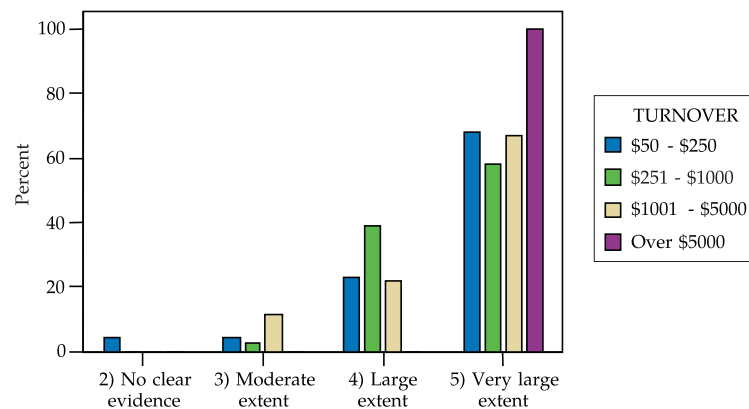


Figure 7.4: KM initiative by turnover

### 7.3.2 Human knowledge

This construct HK, uses five items. Here the study tested the level of personal knowledge in organisations and, its impact on the income of the business when this knowledge is lost, displaced, underutilized among other things. The items were scaled from: (1) not at all, to (5) very large extent, and (1) strongly disagree, to (5) strongly agree, respectively. The variables are presented next, along with their factor loading from Figure 7.10.

- Loss of best practice in specific area (HK01) .885
- Damage to key client/support relations (HK02) .897
- Loss of significant income (HK03) n/a,
- Loss of vital information (HK04) n/a, and
- Employees provided with resources. (HK05) n/a.

The reliability coefficient of the Cronbach's alpha was computed for this construct, at 0.96 in Table 7.2. The alpha suggests that the five items used in this construct were reliable measures of the level of personal knowledge (human capital) [cf. Table 7.2 Means, standard deviations, intercorrelations, and coefficients alpha- reliability estimates for the exploratory survey] in organisations. Here, the internal consistency based on the five inter-item correlations, are also shown, which shows the strong association between the items/measures, and that the resultant responses are due to the differences in the opinions of the respondents and not to any misinterpretation of the items/measures of the construct.

This coefficient supports the view that, HC (IC) is an important strategy for achieving sustainable competitive advantage. The foregoing model, suggests that firms are in general agreement that they lose best practice (BI) in a specific area due to the departure of a key employee (IC) (HK01). The alphas also support the view that firms are of the opinion that they suffer damage in some client and supplier relationship caused from the departure of a key employee (HK02). The model also shows that firms also lose both significant income and mission critical and vital information due to the departure of a key employee (HK03 and HK04). Hence, one sees that the HC and IC are requisite strategic initiatives that firms need to manage. This measure of a key employee's departure is strongly related to the other four measures in this construct. Part of this strategy, as supported by the data, is that employees should be provided with requisite resources in order to delivery the firm's competitive advantage (HK05). This measure correlates strongly and positively with the other four measures. The findings here is also cross validated with loadings in Factor 3 [cf. Table 7.11 Rotated Component Matrix – HK].

Table 7.15: The effect of a key employee leaving the organisation

Effect of a key employee leaving	Rating
Lost knowledge of best practice in specific area	88
Damaged relationship with key client/supplier	88
Lost information vital to the running of the business	92
Lost significant income	82

base: all respondents (1225)

Having, accepted that the items are sound and reasonably reliable, and will measure what one expects; one will now turn to the results emanating from this construct – HK. The researcher presents the findings on these variables next [cf. Table 7.15 The effect of a key employee leaving the organisation]:

(1) Cost of ignoring human knowledge



Much of an organisation's knowledge is personal. It is tacit knowledge, which resides in employees' minds. This survey showed there is little provision for capturing, sharing and disseminating it, which is, converting it into explicit knowledge. When individuals leave, their knowledge is lost to the organisation. Respondents confirmed they realise the value of this human knowledge, in that their organisations had suffered in various ways when individuals left, from loss of knowledge of best practice through to damage to key client and supplier relationships and, ultimately, significant financial loss. Respondents acknowledged the cost of failing to look after their organisation's intellectual capital – in other words, of failing to convert individual knowledge and expertise into corporate knowledge. However, those organisations, which had suffered damaged relationships with key clients and suppliers, were more likely, as a result, to have heard of KM (100%). They had also put a KM initiative in place (73% against 27% whose organisations had suffered damage but not pursued a KM initiative), although they were aware of the benefits of having a KM strategy.

## (2) Loss of knowledge of best practice

Approximately nine-tenths (88%) of all respondents said that they had lost knowledge of best practice in a specific area of operations because of a key employee's departure.

## (3) Damage to a key client or supplier relationship

All respondents (100%) said that a relationship with a key client or supplier had been damaged by the departure of a key individual. The researcher also observed this fact in the largest organisations [cf. Figure 7.5].

The present study observed that this phenomenon was mixed within the sectors sampled. Those respondents who agreed with the view that their firms were affected from the departure of a key employee, particularly to key client and supplier relationship, were predominantly from the utilities and telecommunications sector.

The general profile for these respondents who agree with the question: Damage to a key client/supplier relationship has resulted due to the departure of a key employee (HK02), follows:

- Utilities and Telecommunications 60%,
- Other Services 47%,
- Manufacturing 43%,



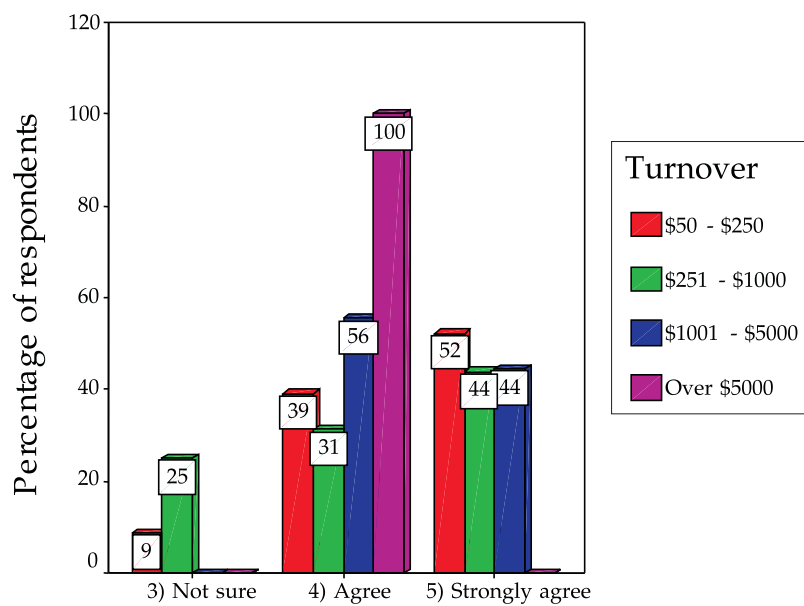


Figure 7.5: Damage to key client/supplier relationship by size

- Retail and Wholesalers 40%, and
- Financial Services 20%.

This profile is reversed for those respondents who indicated that they were in strong agreement with the question (HK02). One was not overly surprised by these findings. The utilities in most of the sampled countries are State Corporations and are monopolistic in their markets, so it would seem that there is not much pressure on them to improve their knowledge retention, and as such damaged to their clients and support relationships ensue. The observations are reflected in Figure 6.6 [cf. Figure 7.6], and an aggregate view of this figure is reflected below:

- Retail and Wholesale 60%,
- Manufacturing 57%,
- Financial Services 50%,
- Other Services 40%, and
- Utilities and Telecommunications 20%.

(4) Loss of significant income

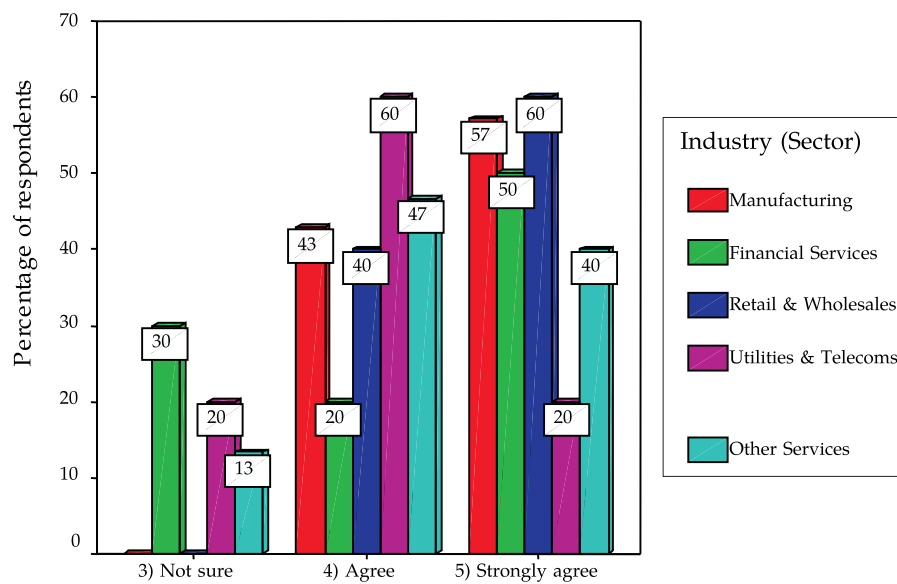


Figure 7.6: Damage to key client/supplier relationship by sector

Responses to the question: The organisation has suffered significant loss of income as a result of a key employee's departure (HK03). All the respondents, 100%, from organisations whose turnover was over five hundred million dollars, who agree with this, said their organisation had lost significant income because of a key employee's departure. Figure 7.7 illustrates this profile. On the converse, 52% of the smaller firms experienced the same phenomenon, while only 44% of the other categories were so affected.

### 7.3.3 Structural Knowledge

The construct, SK uses 14 items, which is divided, into two parts: "Value of knowledge" with seven items, and "Storage of knowledge", represented by another seven items.

Here the researcher tested the various areas of knowledge people considered as been important to their organisation.

In so doing, the Research Model [cf. Figure 5.4] is repeated here for completeness and easy reference.

The KM Strategies component has four metrics [cf. 1.2.4]:

- (i) Learning opportunities

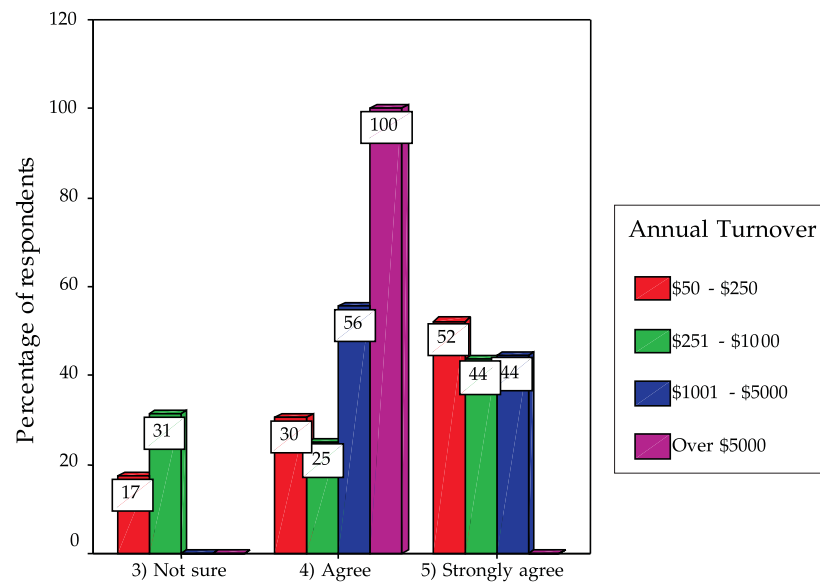


Figure 7.7: Loss of significant income by use

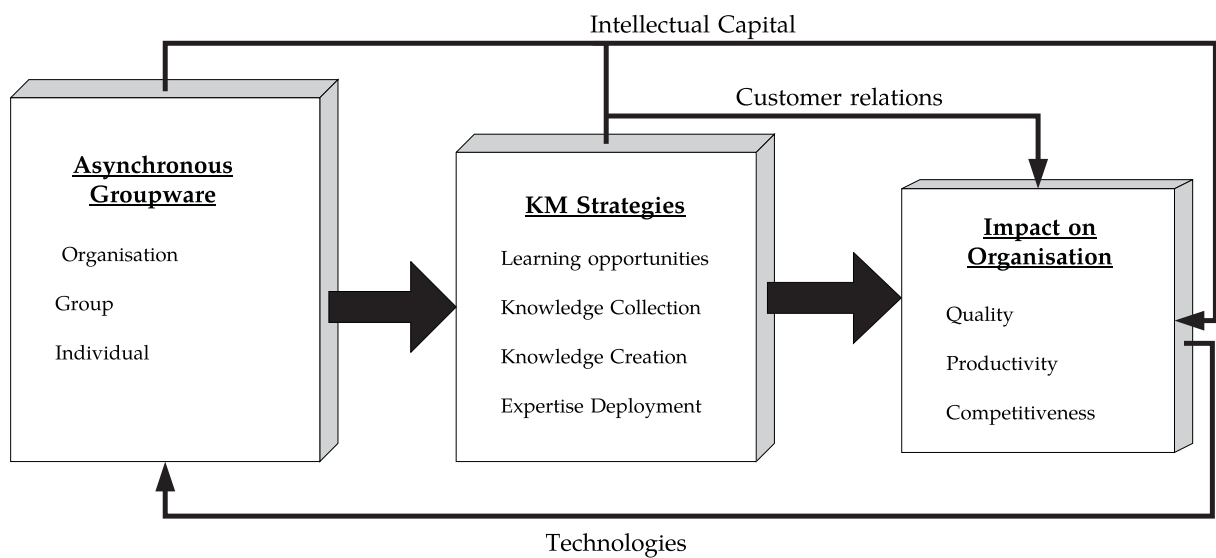


Figure 7.8: Research Model [reproduced from Figure 5.4 Research Model]

- (ii) Knowledge collection
- (iii) Knowledge creation, and
- (iv) Expertise development.

The focus here was to test the various aspects of knowledge organisation considered important and the degree of value they attached to that aspect of knowledge. This is represented in the research model by the knowledge collection (ii) component. The indicative responses were scaled from: (1) don't know/not stated, to (5) very important.

The variables are:

Value knowledge about:

- customers (SK01A) .786,
- own market (SK01B) .776,
- own products/services (SK01C) .577,
- competitors' market (SK01D) n/a,
- (on) employees skills (SK01E) n/a,
- (on) regulatory environments (SK01F) n/a, and
- (on) methods and processes (SK01G) .615.

Store knowledge on (these variables have been recoded in table 7.13):

- customers (SK02RA) .776,
- own market (SK2RB) n/a,
- own products/services (SK02RC) .776,
- competitors' market (SK02RD) .729,
- (on) employees skills (SK02RE) .661,
- (on) regulatory environments (SK02RF) n/a, and

- (on) methods and processes (SK02RG) .694.

The reliability coefficient of the Cronbach's alpha is computed for the structural knowledge, construct in Table 7.2 at 0.95. This alpha suggests that items in this construct are reasonable reliable measure of the "structural knowledge" in the sampled organisations. The evidence showed in section 7.2, that reliability coefficient of 0.80 or higher are considered "accepted" in most Social Science applications.<sup>4</sup>

Given that Cronbach's alpha measures how well a set of items (or variables) measures a single unidimensional latent construct – structural knowledge, in this case, the alpha is high, which suggest that the coefficient of reliability is strong (consistency). The literature supports this view, particularly by Nunnally (1978), who indicated that a coefficient of 0.70 is an acceptable reliability coefficient; however, lower thresholds are sometimes used in the literature.

In Part Three of this chapter, the researcher shall present the positive correlation coefficients for the 14 measures of both the "Value of knowledge" and the "Storage of knowledge". The researcher shall do this at a significant level of 0.01 (two-tailed), using Kendall's tau b.

Given the strength of the association between these measures, the investigation shall now report the findings, using frequencies tables, of these measures/variables in the sampled organizations [cf. Table 7.16 The importance of various areas of knowledge]

The alpha suggests that the 14 items used in this construct are reliable measures of the level of SK [cf. Figure 5.2 KMN] in organisations. Here, the internal consistency is based on the 14 inter-item correlations of the construct, which one will discuss in Part 3 of this chapter. The researcher shall demonstrate that there is a strong association between the items/measures, and that the resultant responses are due to the differences in the opinions of the respondents and not to any misinterpretation of the items/measures of the construct. These findings are presented in Table 7.16.

#### (1) Failure to store critical knowledge effectively

The study tested whether organisations were able to identify which types of knowledge are important to their business. The researcher found that organisations are very good at identifying which types of knowledge are important to their business.

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<sup>4</sup><http://www.ats.ucla.edu/stat/spss/faq/alpha.html>

Table 7.16: The importance of various areas of knowledge

Importance of various areas of knowledge	Rating
Customers	100
Company's own markets	90
Company's own products and services	80
Competitors	80
Employee skills	70
Regulatory environments	50
Methods and processes	70

base: all respondents (1225)

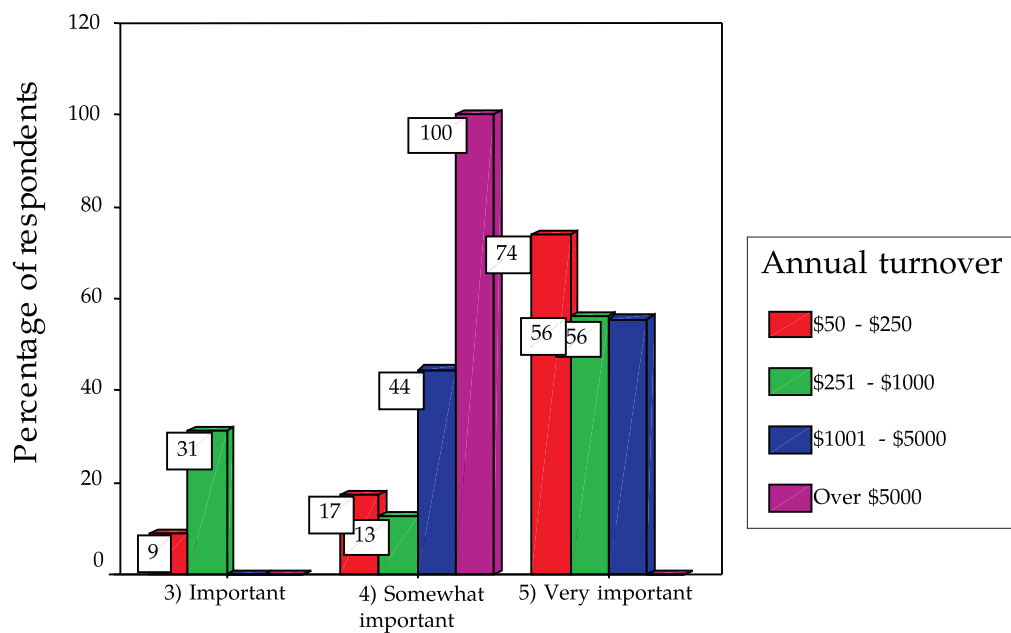


Figure 7.9: Value of knowledge about own customers

But, as this section and the next will demonstrate, they are less effective at using appropriate formats to store and share it, even if they already have such facilities and the infrastructure in place.

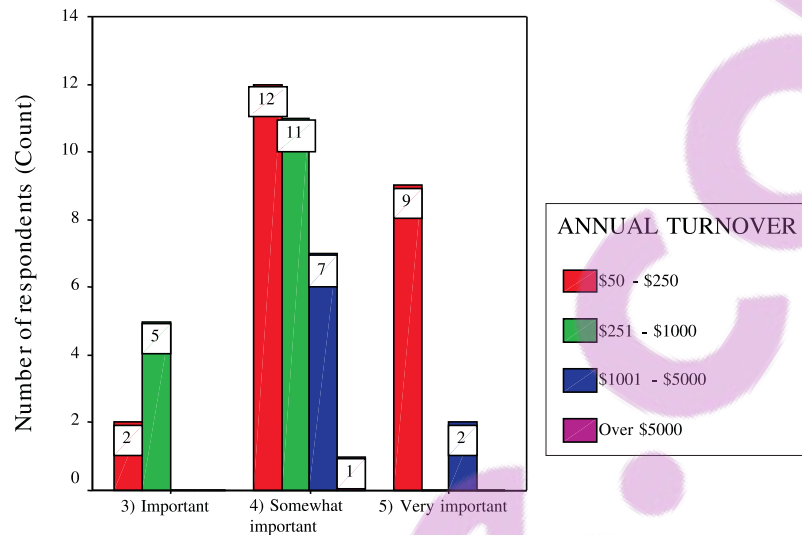


Figure 7.10: Value of knowledge about own market

## (2) Types of knowledge important to an organisation

Respondents were asked which types of knowledge they considered important to their organisation. Clearly, organisations valued most highly their knowledge about their customers [cf. Figure 7.9] own markets [cf. Figure 7.10] competitors' market [cf. Figure 7.11], and their own products and services [cf. Figure 7.12]. The largest organisations regarded knowledge of customers and their markets as more important (somewhat) than other organisations did (100%) respectively. This is represented in Figure 7.8 – 7.14.

However, the others regarded knowledge of their own methods and processes as more important than the largest organisations did (79% against 56%). This may be because they recognise the need to have the right methods and processes in place in order to grow, or potentially because they are failing to focus sufficiently on the external environment

## (3) Methods of storing important knowledge

Having established which types of knowledge organisations prize the most, the researcher asked them how they held that knowledge. If held electronically, The researcher asked whether it was available to everyone in the organisation who might need it. The most effective way to store

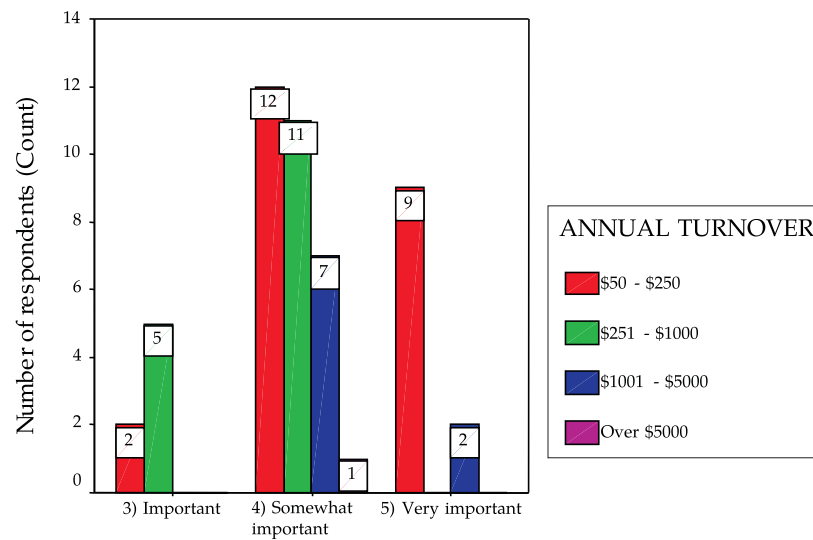


Figure 7.11: Value knowledge about competitors' market

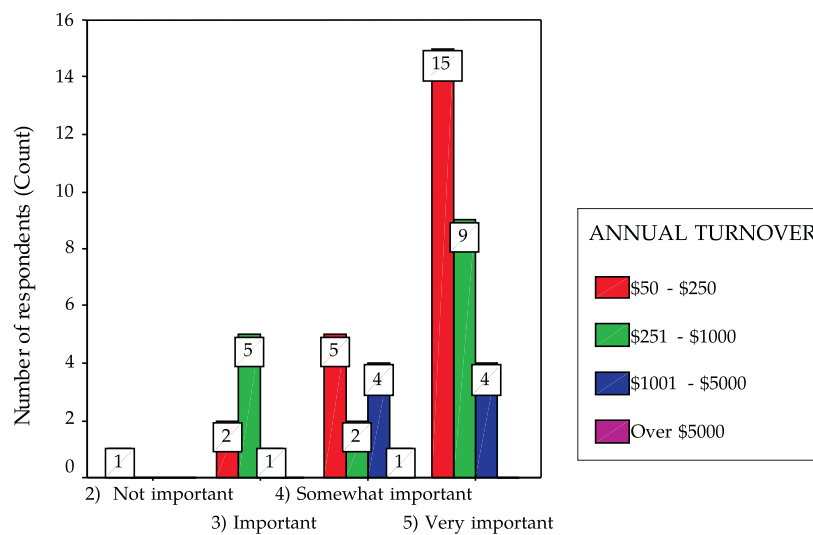


Figure 7.12: Value knowledge about own products/services



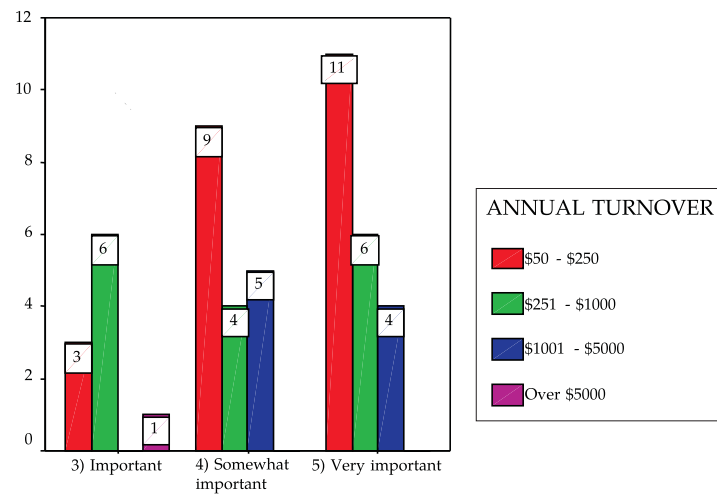


Figure 7.13: Value knowledge on employees skills

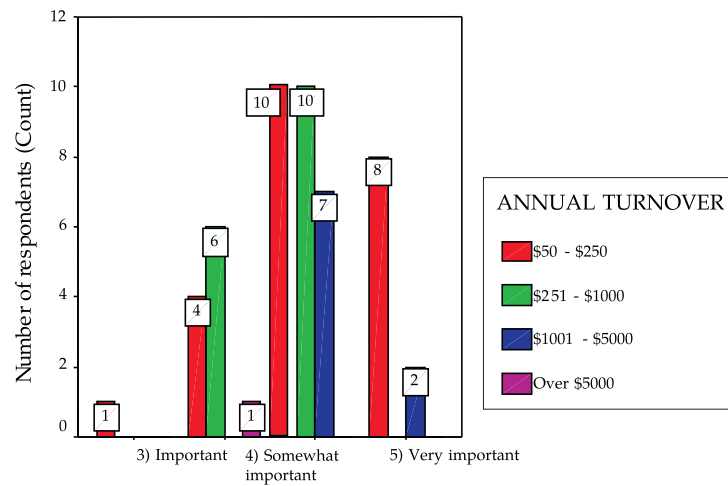


Figure 7.14: Value knowledge on regulatory environments

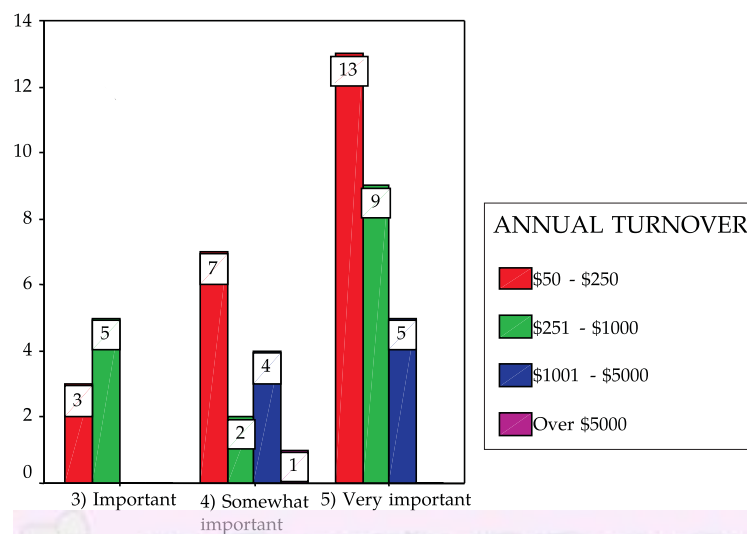


Figure 7.15: Value knowledge on methods and processes

knowledge is in people's heads – the human mind is still more powerful than any computer at storing, sorting and retrieving the sort of knowledge, which is most valuable to organisations. Transferring such knowledge between individuals is usually best done verbally to capture details and nuances. However, as the previous section's findings show, relying on individuals can be fraught with risk.

This is where technology can help. Technology is not a panacea. Electronic formats can make knowledge difficult to exploit. But storing knowledge in electronic formats means that, at the very least, it can be used for other applications. Searching for it becomes easier, and the exploitation of knowledge becomes easier as the technology for knowledge systems become more powerful. However, the present findings show that while organisations are using various technologies, they are not necessarily doing so with KM in mind [cf. Table 7.17 The storage of knowledge].

Table 7.17: The storage of knowledge

Storage of knowledge	Head	Paper	Electronic format	Knowledge-based systems	Not stated
Customers	26	30	9	13	23
Methods and processes	15	51	13	2	19
Company's own markets	19	15	13	26	28
Competitors	13	40	4	11	32
Employee skills	2	38	34	9	14
Company's own products and Services	34	32	2	21	11
Regulatory environments	15	45	9	17	15

Base: all respondents (1225)

Over a 56% stored knowledge of customers in non-technology based formats (such as people's heads or on paper). Only 22% stored it in an electronic format and knowledge based systems, which are accessible to all who needed it. In the case of storage of knowledge on one's markets, over a third kept relevant knowledge on non-technology based format (people's head and paper). Only 15% of respondents made knowledge of competitors available electronically to all who needed it. However, an interesting 43% did the same for knowledge of employees' skills.

However, the tendency is to store information about the organisation – products and services, and methods and processes – rather than the external environment knowledge their organisations considered more important. For example only 15% of respondents said that knowledge of their methods and processes was available electronically to all who needed it but this was the area of knowledge one may considered to be of least importance.

(4) Time taken to locate knowledge

The researcher tested whether individuals in organisations were able to access relevant knowledge by a series of questions designed to elicit their anecdotal experience. Respondents' replies confirmed that organisations are still finding it difficult to prioritise between knowledge of different levels of importance.

Table 7.18: The storage of knowledge-based systems

Storage of knowledge	Rating
Company's own products and services	32
Methods and processes	15
Customers	22
Company's own markets	39
Regulatory environments	26
Competitors	15
Employee skills	13

base: all respondents (1225)

### 7.3.4 Technological Infrastructure

This construct, Technological Infrastructure is sub-divided into two sub-construct, with seven items each. The first sub-construct, deals with the IT infrastructure in general – at a generic level, while the second sub-construct, deals with the implementation of the IT infrastructure to support KM initiatives. Here one tested the degree to which some organisations make use of existing technology to store and disseminate information which is most critical for the organisation's success.

The reliability coefficient of the Cronbach's alpha was computed for this construct, at 0.93 in Table 7.2. The alpha suggests that the 14 items used in this construct were reliable measures of the level of technological infrastructure, (the technologies component [cf. Figure 5.4 Research Model] in organisations. Here, the internal consistency based on the five inter-item correlations, are also shown, which shows the strong association between the items/measures, and that the resultant responses are due to the differences in the opinions of the respondents and not to any misinterpretation of the items/measures of the construct.

The indicative responses were scaled to measure the extent of technological infrastructure implementation of their organisation from: (1) not at all, to (5) very large extent. The variables

are set out below.

Generic IT infrastructure:

- Internet access implemented in organisations,
- Intranet infrastructure implemented in organisations,
- Document management systems in place,
- Groupware technologies used,
- Data warehousing and data mining used,
- Decision support used, and
- Extranet support infrastructure implemented.

IT implementation:

- Internet access for KM support,
- Intranet infrastructure implemented for KM support,
- Document management systems implemented for KM support,
- Groupware technologies used to support KM initiative,
- Data warehousing and data-mining used to support KM initiatives,
- Decision support systems used to support KM initiative, and
- Extranet support infrastructure implemented for KM.

These findings are presented next in Table 7.20.

(1) Failure to exploit technological infrastructure

There are wide varieties of technologies and applications that can be used. Indeed, most have a KM angle to them. The researcher asked about some of the key types of technology in use and why they were implemented. The IT infrastructure needed for KM has often been put in place for other reasons. While 90% of respondents had implemented Internet Access only half of that

Table 7.19: Technological infrastructure

Technological Infrastructure implementation	ORG <sup>1</sup>	KM <sup>2</sup>
Internet	90	42
Intranet	66	41
Document management systems	68	48
Groupware	49	28
Data warehousing/mining	36	26
Decision support	38	25
Extranet	16	5

base: all respondents (1225)

KEY: 1.ORG: Implemented in organisation 2. KM: Implemented for KM

number had done so with KM as the primary focus. Two-thirds of respondents used Document Management Systems, 48% with KM as the primary focus and two-thirds had implemented Intranets, 41% with KM as the primary focus. Taken with the previous section's findings, these figures show that organisations are not exploiting the full potential of the technology they have.

Much of the technology is new and has been implemented as organizations have begun to experiment with new ways of using it. Having implemented the necessary technology, organisations need to populate it with data to make it worth using and to add real benefit. This in turn means that organisations must focus on keeping the information up-to-date on an on-going basis, removing out-of-date information and committing resources to this task.

However, in order to obtain the full benefits, organisations need to take a fresh look at technology from a KM perspective to see the potential.

### 7.3.5 Business Intelligence

This construct, BI, has 25 items. Here one tested the degree to which some organisations make use of KM initiatives to drive their strategy, its current status, and level of implementation. The indicative responses were scaled to measure three states of BI strategy and implementation. These being:

1. Strategic infrastructure of the KM initiatives: Nine items were used to measure the various strategies organisations were using to implement KM and intellectual capital initiatives.
2. Benefits from implementation of KM initiatives: Nine items were used to measure the perceived benefits organisations were harvesting from the implementation of the KM ini-

tiatives, and

3. Difficulties in implementing KM initiatives: The seven reversed coded items were used to measure the difficulties organisations were experiencing in implementing their KM strategies.

The variables are: Strategic infrastructure:

- Strategy is important for KM initiative,
- Current state of KM initiative,
- KM strategy is being created,
- Planning benchmarking and audit exercise,
- Developing and measuring intellectual capital,
- Planning job and process redesign of core processes,
- Establishing of informal networks,
- Establishing of formal networks, and
- Provided incentives and rewards.

Implementation of KM initiatives (Benefits):

- KM strategy enhanced value-added services,
- KM strategy resulted in reduction in problem solving time,
- Dedicated KM role,
- Importance of dedicated budget,
- Willingness to share knowledge,
- Employees learn from each other,
- Knowledge is difficult to locate,
- Individuals do not share best practice, and

- Much impetus from outside.

Implementation of KM strategy (Difficulties):

- Culture does not encourage knowledge sharing,
- Lack of funding for KM initiative,
- Lack of understanding of KM initiatives,
- Lack of appropriate technology,
- Individuals don't have time to share information, and
- No rewards for knowledge sharing.

The reliability coefficient of the Cronbach's alpha was computed for this construct – BI at 0.91

These findings are presented next.

#### (1) Need for vision and strategy

In view of the previous sections' findings, – that organisations are failing to make the best use of the technology to store and share knowledge important to them, – the researcher tested the extent to which they have a clear vision or strategy of KM and are implementing it (See Figure 7.15).

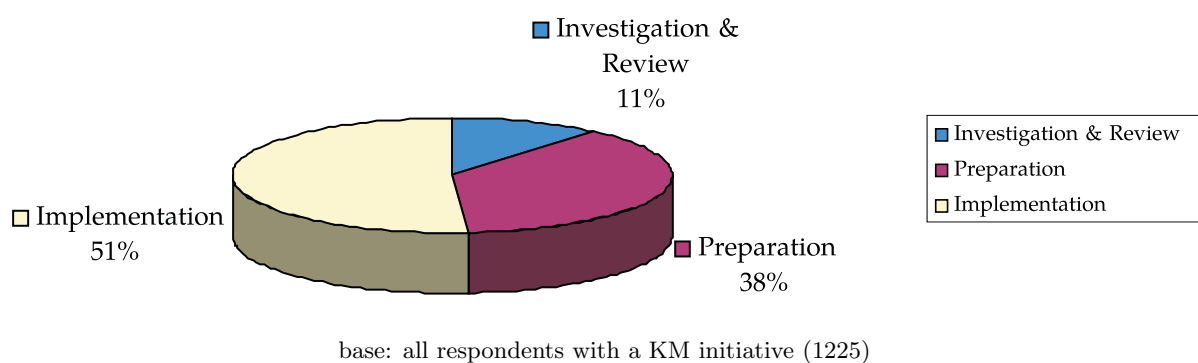


Figure 7.16: Current state of knowledge initiative

#### (2) Importance of a strategy

The researcher asked those with an initiative in place to specify how advanced it was (See Table 7.20). Just over one-tenth were investigating the problem of KM and undertaking a review of

current organisational structures for KM. Over half was actually at the implementation stage. People may lack skill in sharing knowledge, which may explain why organisations are unsure of how best to introduce the change of culture necessary. Over a third of those with a KM initiative were rising to the challenge and planning a KM strategy. Just under a third were planning job or process redesign and a fifth were planning a benchmarking exercise.

The most common activity undertaken by those with a KM initiative was the establishment of informal KM networks – typical of bottom-up rather than top-down development. Bottom-up activity is encouraging – it shows that people have a genuine interest and enthusiasm. However, top-down planning and careful re-sourcing is essential if that early enthusiasm is to be nurtured and rewarded with organisation-wide results. Less than a third were either developing or planning to develop any intellectual capital measurement initiatives. Just over a third of the respondents were looking into, or were planning to look at incentives and rewards for knowledge sharing. This is indicative of a market not yet ready to move into a different phase of KM. Those who adopt these initiatives early will put themselves in a strong position to sustain the initial effort, retain staff and the inherent IC, and therefore meet future challenges.

These activities represent a fair amount of work and need to be carefully programme-managed, pointing to the need for the appointment of a chief knowledge officer (cf. Section 6.6.3).

### (3) Need to allocate responsibility

Allocating responsibility for an activity is a signal that the organisation is taking it seriously. However, when asked, 40% of respondents whose organisations had a KM initiative said there was no one at board level responsible for the initiative

Table 7.20: Existing and planned initiatives

<b>Initiatives</b>	<b>In use</b>	<b>6 mths</b>	<b>+ 6 mths</b>
KM training/awareness	30	9	45
Create a KM strategy	34	6	53
Benchmark/audit current situation	53	29	9
Developing/measuring intellectual capital	38	0	57
Job/process redesign	33	48	15
Establishment of informal knowledge networks	43	30	15
Establishment of formal KM networks	38	6	45
Incentives and rewards for knowledge working	28	17	53

base: all respondents with a knowledge initiative(47)

Key: 1. In use:- Currently use 6 mths. – planned in 6 mths. 3. +6 mths. – planned longer.



In the case of organisations that had allocated responsibility to a named person, over a third said it was someone in an existing position. Heaping an additional responsibility on an existing function is unlikely to produce the best results. It may also lead to a slanted view of KM. This may be because organisations are unsure of the extent to which KM will benefit them. However, those which are taking it seriously – 5% of respondents with a KM initiative said their organisation had a chief knowledge officer – are likely to be the first to benefit. They are able to develop a coherent strategy which is consistent across the whole organisation. Those 5% all came from the largest organisations.

Table 7.21: Responsibilities for organisations' KM initiatives

Responsibilities for KM initiative	Rating
Chief knowledge officer	5
Named positions from IT/systems	14
Chief information officer	12
Director of business improvement	12
Named position from human resources	7
Named position from finance	5
Each department head	2
Each board director	2

base: all respondents (1225)

Given the emphasis that KM places on the importance of the individual, it is surprising that only 7% of those organisations with a KM initiative appointed the human resources function (in the absence of a dedicated KM role).

#### (4) Importance of a dedicated budget

Allocating a budget is a further sign that an organisation is taking a project seriously. However, when asked, a third of all respondents said that no budget had been allocated. This figure fell to a quarter when respondents were asked to project forward to the year 2005. However, as most organisations are only in the planning stage the true forward budgets are unlikely to be established in the short term. Organisations' fragmented approach to KM was confirmed by the current source of funds for the KM budget, with 30% of all respondents saying it was spread across all departments. By the year 2005, this figure is expected to fall to just 28%. The results indicate that almost a third of those who expects the source of funds to change, said that the finance department would be responsible for the budget in the year 2005. The IT function will remain constant as a source of funding for KM, with 17% of respondents saying it is both the current source for the KM budget and the expected one in the year 2002.

Table 7.22: Source of KM initiative budget

Source of KM initiative budget (2002)	2002	2005
Finance	5	8
Human Resources	4	3
Marketing	5	5
Research and development	6	6
Customer sales and service	1	1
Information Technology (IT)	17	17
Spread over all departments	30	28
Other	4	3

base: all respondents (1225)

### 7.3.6 Performance Analysis

This construct, Performance Analysis has 12 items, two of which are reversed-coded. The construct reports on the actual benefits achieved from the implementation of various knowledge-based strategies and practices. The indicative responses were scaled to measure the extent of KM strategic implementation in their organisation from: (1) not at all, to (5) very large extent; and (1) strongly disagree, to (5) strong agree, respectively. The researcher now presents these variables below.

The reliability coefficient of the Cronbach's alpha was computed for the Performance analysis construct at 0.80. The Alpha suggests that the items in this construct are a reliable measure of the benefits knowledge-based organisations may expect to gain from the use and implementation of KM strategies. As previously discussed, the literature supports one's view that the items are indeed reliable measures of the construct. The literature indicates that the proportion of variability in the responses to these items is due in a large part by results of differences in the responses. That is, answers to a reliable survey will differ because respondents have different opinions and not because the survey items for this construct is confusing or has multiple interpretations. The variables are:

Strategic benefits:

- Benefits from setting up KM initiatives,
- Better decision making,
- Faster response time to key issues,

- Improving productivity,
- Creating new/Additional business opportunities,
- Sharing best practices,
- Better staff attraction and retention,
- Revenue growth,
- New products and service development,
- Component interaction between technologies,
- Formalising the knowledge development cycle, and
- Overall performance.

Table 7.23: The barriers to effective implementation of KM

Barriers to KM implementation	Rating
Willingness to share knowledge but too little time for individuals to do so	33
Lack of skill in KM techniques	18
Lack of understanding of KM and benefits	26
Lack of appropriate technology	24
Lack of funding for KM initiatives	30
Current culture does not encourage knowledge sharing	26

base: all respondents (1225)

Having found that the variables do reliably measure the construct, the researcher then examine in Part 3 of this chapter, how these 12 variables contribute to the underlying (or latent) relationships between each other, in order to ascertain the structure between the variables. The study will now report the findings of the frequencies on these variables in Tables 7.23 – 7.24.

#### (1) Investing in knowledge

The conventional wisdom, confirmed as recently as five years ago by the survey conducted by the Information Systems Research Centre of Cranfield School of Management, is that the barriers to knowledge sharing are personal and cultural, revolving around individuals' unwillingness to share knowledge or put themselves out for others. The present findings suggest that individuals are willing to share knowledge but do not have the time to participate actively. This and other barriers to the implementation of KM are illustrated in Table 7.23.

## (2) Obstacles to knowledge sharing

As shown earlier, organisations are mainly at the planning stage. The researcher asked what barriers they are facing. The results show the main ones are lack of time to share knowledge (33%), lack of skill in KM (18%) and lack of understanding (26%).

Table 7.24: Importance of reasons and benefits from KM initiative

Importance of setting up KM initiative	Reasons	Benefits
Better decision-making	86	66
Faster response time to key issues	86	66
Increasing profit	81	60
Improving productivity	79	60
Creating new/additional business opportunities	78	57
Reducing costs	72	51
Sharing best practice	71	77
Better staff attraction/retention	40	57

base: all respondents with a KM initiative(1225)

However, in organisations' current situation, over two-thirds of respondents said that people wanted to share knowledge but did not have the time. Only 13% of respondents said individuals were unwilling to share knowledge and only 15% said individuals did not share best practice. Part of the problem might be thought to be "information overload" where a third of the respondents complained that there was too much knowledge. The indication is that in less than a year during which there has been much activity and focus around knowledge management, people have a better understanding of the need to share knowledge and the benefits to be derived from doing so.

But many organisations are now so lean that people do not have time to make knowledge available, share it with others, teach and mentor others, use their expertise to innovate and find ways of working smarter. Instead, they are task-focused, shifting existing workloads to tight deadlines. It takes time to learn new methods and techniques and apply them until they become embedded. It is an investment in KM that organisations need to make. Knowledge work requires organisations to give people/employees time and space to progress with other work. The issue that arises comes in quantifying the benefit, which can be hard to do directly as one explains in Paragraph 7.3.6.5. The data in Table 7.24 is relevant.

## (3) Impetus from outside

Respondents indicated that sharing knowledge with outside organisations was more likely to be

treated as a useful investment by their organisations – over a third of respondents said that knowledge was effectively shared with relevant outside organisations such as suppliers and customers. This is presumably because organisations identify external organisations as either a source of income (customers) or cost reduction (suppliers) whose financial impact on the company will be improved through the sharing of knowledge. Collaborative working with suppliers and customers will increase. It creates win-win relationships and enables organisations to complement each other's strengths and is the direction in which a number of disciplines – from supply chain management through to marketing – are developing. However, the ability to share knowledge effectively requires organisations to have their internal KM systems in place.

#### (4) Changes needed to reward structures

Respondents identified that if organisations are serious about KM, they will have to consider reflecting this in their reward and incentive structures. At most 45% of respondents said their organisation did not reward knowledge sharing, and this was considered to be the third biggest drawback to storing and sharing knowledge after lack of time and wasting effort through re-inventing the wheel (i.e. re-doing work already done elsewhere). Recasting reward structures would relieve the emphasis of conventional reward on dealing with existing deadlines and would also provide immediate reward for efforts which, in KM terms, may take longer to show through. This means focusing on allowing employees to gain personal development in return for sharing their own knowledge; which allows work to become more fulfilling, and makes the organisation more attractive to work in, with better retention of staff [cf. Table 7.25: Important issues driving KM].

### Full benefits for early adopters of KM

#### (1) The benefits are there to be realised

The researcher asked respondents whose organisations had a KM initiative to assess the reasons for embarking upon the initiative and whether their expectations had been fulfilled. Better decision-making was the single, overwhelming reason. 86% cited it as a reason and the 66% said their organisation had achieved it as a result. 86% also cited faster response time to key issues and two-thirds said they had achieved it. These and the findings for improved productivity and reduced costs are high levels of attainment, which confirm that those organisations pursuing a

KM initiative believe they are gaining benefits from it.

(2) The impact on the bottom-line will come through

Financial goals such as increasing profit and increasing the organization's share price were mentioned by respondents but were less widely achieved. In the researcher's view, there were two motives at work. The first was conventional – respondents cited these as possible benefits for budget-justification purposes (relevant, given the number of organisations still at the planning stage). The second was genuinely aspirational – respondents believe that these bottom-line benefits can be delivered by their KM initiative – and was borne out by the survey that shows clearly that some organisations are achieving these benefits.

Three-quarters of respondents with a KM initiative said they had gained a reduction in costs, up to two-thirds said they had achieved improved productivity and over half had increased profit, showing that financial benefits can be realised. Those organisations in the vanguard of KM are gaining hard-edged financial benefits, which are measurable. But many of the benefits are not financial; it needs a balanced conventional approach.

(3) The full range of benefits has still to be realized

Benefits were also realised in other areas such as creating new business opportunities (57%), sharing best practice (77%) and better staff retention (57%). Of those with a KM initiative 60% had achieved an increased revenue growth. These results indicate the potential is there for the full range of benefits promised by early proponents of KM. The researcher also asked what the key business issues driving organisations towards KM and BI, and found them primarily financial and business performance. Financial measures are, ultimately, the conventional measure by which the success of any management initiative is judged. But respondents were also concerned with their market position and, in particular, defending share against competitors. Organisations need to find a way of creating a competitive edge that will allow them to maintain their market position for sustainable growth, and KM with its broad range of benefits appears to offer that opportunity. At the technological level, organisations were also concerned about the issues of component interaction between technologies (83%) and also about how to formalise the knowledge development cycle (77%). The data in Table 7.25 is relevant.

Table 7.25: Important issues driving KM

Important issues driving KM	Issues
Improving profits	51
Defending share against competitors	41
Cost reduction	39
Growing revenue	32
Developing new products/services	20
Regulatory/legislative changes	18
Defending share against entrants	13
Assess value of merger/acquisition	12
Making globalisation decisions	12

base: all respondents (1225)

Key: Issues – Important issues (total mentioned)

### 7.3.7 Asynchronous Groupware

This construct, AG, has 18 items, subdivided into three sub-domains. These are the organisation domain with six items, the group domain with nine items, and the individual domain with three items. The construct reports on these three domains in terms of:

1. **Organisation Domain:** The overall initiative of organisations, in recent times, is to integrate asynchronous groupware technology and group-based KM efforts. It also involves the expectations of organisations to assess the effects of their ability as a whole to self-improve their quality, productivity and overall competitiveness.
2. **Group Domain:** The assessment of the productivity and performance-oriented initiatives attributed to the efforts of WITS, communities of practices, and focus groups have been the main strategy of some organisation in differentiating the outcomes of these groups into two categories, task-related and group-related outcomes.
3. **Individual Domain:** The assessment of the productivity and performance-oriented initiatives attributed to the efforts of the individual have been the main strategy of some organisation in differentiating the outcomes of these individuals into two categories, task-related and team-related outcomes.

For the organisation domain, the indicative responses were scaled to measure the extent of the integration of AG in organisation from: (1) not at all, to (5) very large extent. The indicative responses for the group domain were scaled to measure the extent of the effects of the outcomes

of the two categories in organisations in terms of task-related and group-related outcomes. The indicative responses for the individual domain measure the extent of the effects of the outcomes of the two categories in organisations in terms of task-related and team-related outcomes in their use of AG technology. The measures are the same as those of the organisation domain.

The variables are presented below.

Organisation Domain:

- KM decentralisation,
- Knowledge and information sharing,
- Openness,
- Inter-level and inter-departmental communication,
- Management support to KM decentralisation, and
- Alignment of KM with organisational goals.

Group Domain:

- Reuse of previous KM information,
- Process adoption,
- Hierarchy barriers suppression,
- Departmental heterogeneity,
- Individual influence,
- Information access,
- Duration,
- Cost, and
- Effectiveness.

Individual Domain:



- Satisfaction,
- Commitment to group proposal, and
- Learning.

The reliability coefficient of the Cronbach's alpha was computed for the AG construct at 0.95. The alpha suggests that the items in this construct is a reliable measure of the integration of AG technology in the processes of organisations to self improve their productivity; their group-based efforts and their task-based activities in their quest to harness the full potential of their organisation BI and KM strategies. As previously discussed, the literature supports one's view that the items are indeed reliable measures of the construct. The literature [Nunnally, 1978] indicates that the proportion of variability in the responses to these items is due in a large part by results of differences in the responses. That is, answers to a reliable survey will differ because respondents have different opinions and not because the survey items for this construct is confusing or has multiple interpretations.

Having found that the variables do reliably measure the construct, One then examines in Part 3 of this chapter, how these 18 variables contribute to the underlying (or latent) relationships between each other, in order to ascertain the structure between the variables.

The study no reports the results of the findings of the frequencies on these variables in Tables 7.26, 7.27 and 7.28, respectively.

#### (1) Organisation domain

The role that AG play in facilitating the use of KM practices and strategies in organisations is found to be approximately 97% in reducing inter-level and interdepartmental barriers to communication in KM groups involving members of different departments and levels.

Additionally the results showed that the use of asynchronous groupware technology AGT in group-based efforts lead to an increase in the openness in the discussion of weaknesses and opportunities of improvement related to individuals, teams, processes, organisational strategies, and other related factors at nearly 96%.

Approximately 97% of respondents reported that the use of AGT in group-based KM efforts increases the awareness about mission-based organisation's goals and how those goals might be achieved. Furthermore, 93% of respondents reported that the use of AGT in group-based

Table 7.26: Asynchronous Groupware – Organisation Domain

<b>Asynchronous Groupware I – Organisation Domain</b>	<b>VL %</b>	<b>ME %</b>	<b>NE %</b>
<b>Decentralisation</b> The use of asynchronous groupware technology in group-based KM efforts lead to a decentralisation in improvement initiatives	93.1	3.0	3.9
<b>Knowledge and Information Sharing</b> The use of asynchronous groupware technology in group-based KM efforts lead to an increase in knowledge and information sharing in the organisation	93.1	4.8	2.1
<b>Openness in Discussion</b> The use of asynchronous groupware technology in group-based KM efforts lead to an increase in the openness in the discussion of weaknesses and opportunities of improvement related to individuals, teams, processes, organisational strategies, and other related factors	95.8	2.1	2.1
<b>Inter-Level and Interdepartmental Barriers</b> The use of asynchronous groupware technology reduce inter-level and interdepartmental barriers to communication in KM groups involving members of different departments and levels	96.9	3.0	–
<b>Management support</b> The use of asynchronous groupware technology, as a publicly available information repository about the work of KM groups, lead to an increase in the support from management to decentralised improvement and as an acceptance of it as an appropriate behaviour in the organisation	94.8	3.0	2.1
<b>Awareness of organizational goals</b> The use of asynchronous groupware technology in group-based KM efforts increase the awareness about mission-based organisation's goals and how those goals might be achieved	96.9	3.0	–

VL – Very Large/Large Extent ME – Moderate Extent NE – No Clear Evidence/No Evidence

KM efforts lead to a decentralisation in their organisation's improvement initiatives. The same number of respondents (93%) also reported that the use of AGT in group-based KM efforts lead to an increase in knowledge and information sharing in their organisations. In congruence with these results is the support from senior management. Just about 95% of respondents reported that the use of AGT, as a publicly available information repository about the work of KM groups, lead to an increase in the support from management to decentralised improvement and as an acceptance of it as an appropriate behaviour in their organisations.

These results in Table 7.26.

## (2) Group domain

In regard to the use of AGT for the group domain it was reported that facilitating the inclusion and participation of members from different departments in the KM groups was just about 95%.

Additionally, the use of AGT makes it faster and easier to access information relevant to the three main phases of a KM group-business process definition, analysis, and redesign was found to be at 100%. This, consequently, leads to a reduction in the costs involved in running KM groups, along with assisting KM groups to complete their tasks faster were found to be a large extent for most firms at 91% and 93%, respectively, in both cases.

This coincides with the reported effectiveness of process design in the use of AGT leading to an increase in the effectiveness of process redesigns proposals by KM groups at 98%. The researcher also found that there is a strong association between the degrees of openness in discussion, in the organisation domain at 96% with that of the suppression of hierarchy barriers in the group domain at 93%.

The relationship is significant at the  $p < .0001$  for the Mantel-Haenszel Chi-Square. This is present in Appendix D.8. The summary statistics in the table informs that respondents are firmly of the opinion that AGT may be used to suppress hierarchy barriers to the contribution of ideas among members from different hierarchical levels in KM groups, openly within their organisation.

Additionally, the study found that 99.1% of the firms reported that the application of SGT with the predicative response of, "a very large extent", leads to an increase in the effectiveness of process redesigns proposals generated by KM groups.

Table 7.27: Asynchronous Groupware II – Group Domain

<b>Asynchronous Groupware II – Group Domain</b>	<b>VL %</b>	<b>ME %</b>	<b>NE %</b>
<b>Facilitation of Information</b> The use of AGT facilitate the use of information generated by former KM groups in a way that improves the efficiency and effectiveness of future groups	94.8	5.2	–
<b>Adoption of groupware processes</b> The use of AGT aid KM groups in adopting a pre-defined group process	94.9	5.1	2.0
<b>Suppress Barriers</b> The use of AGT suppress hierarchy barriers to even contribution of ideas among members from different hierarchical levels in KM groups	92.8	7.2	–
<b>Participation of Departments</b> The use of AGT facilitate the inclusion and participation of members from different departments in the KM groups	94.8	5.2	–
<b>Reduce Imposition of Ideas</b> The use of AGT reduce the likelihood of authoritarian leaders, facilitators or group members, being able to impose their ideas on the KM group	99.1	0.9	–
<b>Ease of Access to Information</b> The use of AGT makes it faster and easier to access information relevant to the three main phases of a KM group- business process definition, analysis, and redesign	100	–	–
<b>Assist KM Groups in Tasks</b> The use of AGT assists a KM group to complete its task faster	91	5.1	3.9
<b>Reduction in Costs</b> The use of asynchronous groupware technology lead to reduction in the costs involved in running KM groups	93.0	5.2	1.8
<b>Effectiveness of Process Design</b> The use of AGT lead to an increase in the effectiveness of process redesigns proposals generated by KM groups	97.9	2.1	–

VL – Very Large/Large Extent ME – Moderate Extent NE – No Clear Evidence/No Evidence

### (3) Individual domain

In the individual domain, the three variables (satisfaction from group interaction, commitments to group proposals, and individual learning) of this sub-construct were reported at 100%. These results suggest that individuals were willing to share the benefits they derived from the use of AGT while interacting in KM groups. Table 6.27 presents the results of these findings.

Having presented the general findings of the univariate statistics, the investigation shall now focus its attention to part three of this chapter. In this part, one discusses the testing of the four research hypotheses. The study shall also perform non-parametric pairwise correlation using Kendall's tau-b correlation coefficients, as a measure of association between the pairs of composite variables.

Table 7.28: Asynchronous Groupware III – Individual Domain

<b>Asynchronous Groupware III – Individual Domain</b>	<b>VL %</b>	<b>ME %</b>	<b>NE %</b>
<b>Satisfaction from Group Interaction</b> The use of asynchronous groupware technology increase satisfaction of KM group members as a result of group interaction	100	–	–
<b>Commitments to Group Proposals</b> The use of asynchronous groupware technology increase the commitment of KM group members to group proposals	100	–	–
<b>Individual Learning</b> The use of asynchronous groupware technology increase individual learning about the organisation and its business processes from the participation in KM groups	100	–	-

VL – Very Large/Large Extent ME – Moderate Extent NE – No Clear Evidence/No Evidence

## 7.4 Hypothesis testing

The frameworks hypothesised in Figure 5.5, Figure 5.6, and Figure 5.7 shall be used for the testing of the four hypotheses. The investigation starts first with the hypothesised measurement model. Here the researcher shall cross-validate the findings from the Kendall's tau-b coefficients with those of Spearman rank-order correlation of association to examine the relationship between the AG factors, and the measures of BI, as it relates to CA.

Given the need for relevance of the evidence, the formula for Kendall's tau b here:



$$\tau = \frac{\sum_{i < j} \text{sgn}(x_i - x_j) \text{sgn}(y_i - y_j)}{\sqrt{(T_0 - T_1)(T_0 - T_2)}} \quad (7.3)$$

where

$$T_0 = n(n - 1)/2$$

$$T_1 = \sum t_i(t_i - 1)/2$$

$$T_2 = \sum u_i(u_i - 1)/2$$

and where  $t_i$  is the number of tied  $x$  values in the  $i^{th}$  group of tied values,  $u_i$  is the number of tied  $y$  values in the  $i^{th}$  group of tied values,  $z$  is the number of observations, and  $\text{sgn}(z)$  is defined as

$$\text{sgn}(z) = \begin{cases} 1 & \text{if } z > 0 \\ 0 & \text{if } z = 0 \\ -1 & \text{if } z < 0 \end{cases}$$

In the case of hypotheses 3 and 4, the study will use bivariate correlation to examine the relationship between the AG factors and the measures of performance, as it relates to CA. This is with a view to see how they relate to KM strategies and BI. The measurement models in Figures 5.6 and 5.7, respectively, are relevant.

At this juncture, the evidence suggests that the testing of the hypothesis should be conducted along the following six steps:

- i) Assumptions : The assumptions underlying the test are stated
- ii) State hypotheses: The appropriate null and alternative hypotheses are stated
- iii) Statistical significance level: State the test hypothesis.
- iv) Calculate the test statistic ( $\tau$ ): Compute the test statistic, as well as the rationale underlying the test.
- v) Compare the  $\tau$ -value to the critical values:
- vi) Decision rule: Decide whether or not to reject the null hypotheses

This approach will be used so that the statistical models and test used to answer the research questions can become clearer, and better demonstrate how the various investigations of the research problem for this portion of the survey was handled. The researcher only reproduced the null hypotheses here, because there has been a detail treatment of all the hypotheses in Chapter 1.

#### 7.4.1 Hypothesis 1

For the purpose of relevance, the null hypothesis 1, is reproduced next.

Null Hypothesis 1 [ $H_{01}$ ]: There is no statistically significant correlation or relationship between the policies and strategies used in organisations for KM practices and those of AG systems, to self-improve their quality, productivity and competitiveness.

Hypothesis 1 relates to the rank order correlation between asynchronous groupware and KM practices (HK and SC). One shall test this hypothesis as follows:

- use a two-tailed test,
- $H_0$ : KM practices and AG systems are independent,
- $H_1$ : KM practices and AG systems are related ( $\tau \neq 0$ ),
- the test statistic for hypothesis 1, will be Kendall's tau b,
- at a significance of  $\alpha = 0.01$ .

From the results of the factor analysis, factors three and four measure KM practices in the test framework. This is human capital and structural capital, respectively. Factor 2, on the other hand, measures the AG component. One created a composite index, HK to measure the level of the personal HC knowledge in the firm of the sampled organizations. In developing the index one sums the individual items/measures to obtain one global measure for the human capital component, as reflected in the KMN [cf Figure 5.2], and Factor 3. These variables loaded highly on the rotated factors. In this study the COMPUTE procedure of SPSS was used for this purpose.

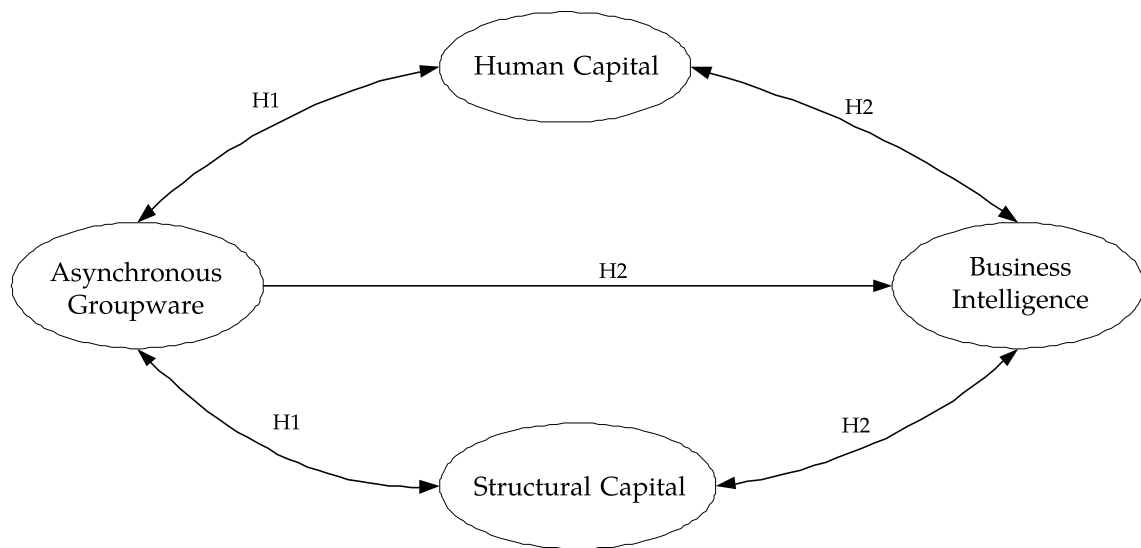


Figure 7.17: Research framework for H1 and H2 (reproduced from Figure 5.5)

The composite index of HK is illustrated in Equation 7.5. One shall use this index to explore the non-parametric pairwise correlation in Table 7.30, and to test hypothesis 1.

One flagged the non-parametric pairwise correlation matrix, using Kendall's tau b, with two-tailed, for significant correlation. This is illustrated in Table 7.30. The correlation coefficient for the HK measure of the construct, evidences the importance and value of HK to respondents are shown in the correlation matrix at a significant level of 0.01 (two-tailed).

All three composite measures are of much interest to validation of this present investigation. These are because of the strong and significant association between each other (SC, HK, and AG). This suggest that most respondents take the view that intellectual capital is a significant factor which affects the operational, tactical and strategic efficiency and effectiveness of the knowledge-based organisation. It also points to how IC ultimately affects an organisation's value chain and competitive advantage [Sveiby, 1997].

The correlation matrix, and scatter plots are illustrated next in Table 7.29 and Figure 7.18.

The syntax code for the procedure is illustrated in Table D.7.5.

The study uses three indexed variables for the nonparametric correlation for the purposes of testing hypothesis 1. These variables are SC, HK (HC) and AG. In this study a bivariate correlation between SC, HK and AG was first performed. The objective here is to determine whether there is any statistically significant correlation or relationship between the policies and



strategies used in organisations for KM practices and those of AG systems, to self-improve their quality, productivity and competitiveness.

Table 7.29: Non-parametric pairwise correlation matrix of SC, HK and AG

Kendall's tau b		SC	AG	HK
SC	Correlation Coefficient Sig. (2-tailed)	1.000 .	.310(**) .000	.545(**) .000
AG	Correlation Coefficient Sig. (2-tailed)	.310(**) .000	1.000 .	.500(**) .000
HK	Correlation Coefficient Sig. (2-tailed)	.545(**) .000	.500(**) .000	1.000 .

\*\* Correlation is significant at the 0.01 level (2-tailed). N = 1225

The study does this by computing  $\tau$  [tau] for these variables (SC, HK, and AG); to see whether there is sufficient evidence for one to conclude that KM practices, and AG systems are related.

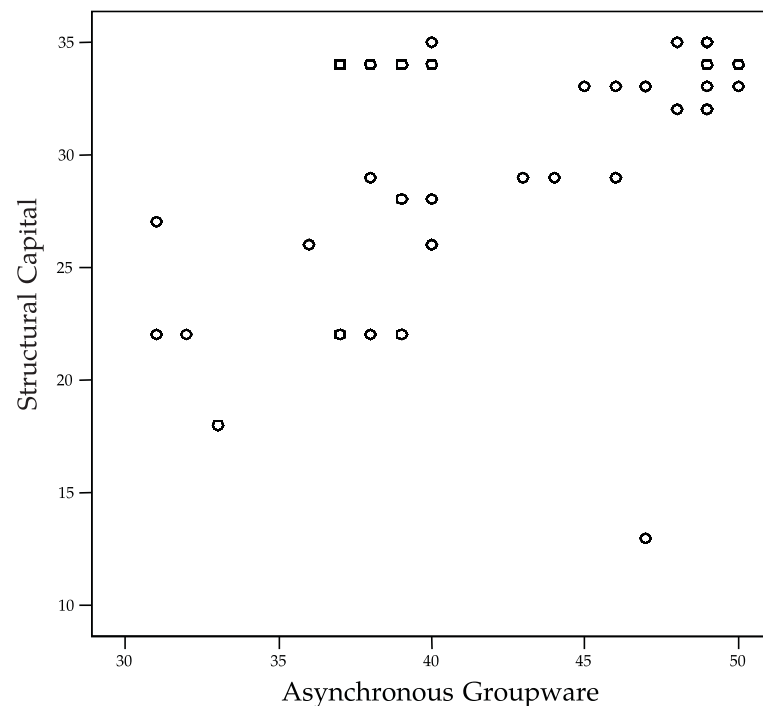


Figure 7.18: Scatter plot of SC with AG

### Decision rule

From Table 7.30 one found that there is a fairly strong and positive relationship between SC and AG, as evidenced by the Kendall's correlation coefficient of 0.310, and a p-value of 0.000 with a significance level,  $\alpha$ , of 0.01 (two-tailed). The HK variable also has a strong and positive relationship AG at 0.500, with a significance level of 0.01 (two-tailed). It is also of much interest

that there is a strong and positive correlation of 0.545 between SC and HK with a significance level of 0.01 (two-tailed). One is able to reject the null hypothesis, which states that KM practices (SC and HK) AG systems are independent. One therefore accepts the alternate hypothesis, and confidently conclude that there is a direct relationship between KM practices (SC and HK) and AG systems, in the sampled population.

#### 7.4.2 Hypothesis 2

Null Hypothesis 2 [ $H_{02}$ ]: There is no statistically significant correlation or relationship between the integration of AGT into organisations' KM practices and their strategies to self-improve their quality, productivity, and overall competitiveness.

Hypothesis 2 relates to the rank order correlation between AGT and BI. One shall test this hypothesis as follows:

While in Hypothesis 2, one shall test this it as follows:

- use a two-tailed test,
- $H_0$ : Strategies of AGT and those of BI used by organisations to self improve are independent,
- $H_1$ : Strategies of AGT and those of BI used by organisations to self improve are related ( $\tau \neq 0$ ),
- the test statistic for hypothesis 2, will be Kendall's tau b,
- at a significance of  $\alpha = 0.01$ .

The AGT factor (organisation, group, individual, technological infrastructure, and structural knowledge) are designated as the set of multiple independent variables or the predictor variables for this hypothesis. From the foregoing, the researcher specifies the measures of BI [innovativeness (current state and HK), CA, and performance analysis] as the set of multiple dependent variables or the criterion variables. The statistical problem involves identifying any latent relationships between a respondent's perceptions about the AG construct and the measures of BI.

Table 7.30: Non-parametric pairwise correlation matrix of AG and BI

Kendall's tau b		AG	BI
AG	Correlation Coefficient	1.000	.303(**)
	Sig. (2-tailed)	.	.000
	N	1225	1225
BI	Correlation Coefficient	.303(**)	1.000
	Sig. (2-tailed)	.000	.
	N	1225	1225

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

The researcher uses the model representation of hypotheses 1 and 2 from Figure 6.16 for this hypothesis. The correlation matrix in Table 6.30 points to the fact that there is a strong relationship between the two variables. Both coefficients are positive at .303.

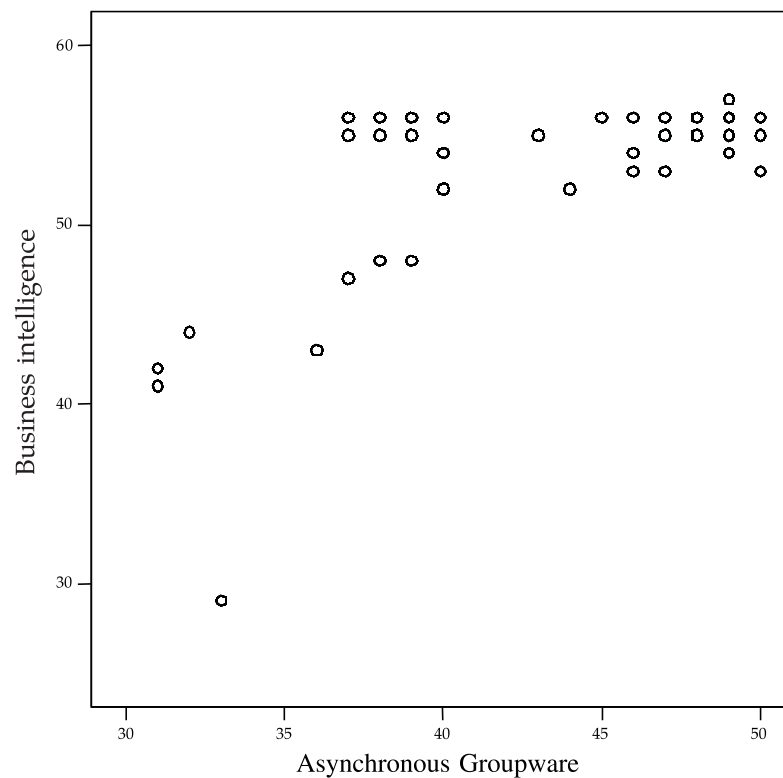


Figure 7.19: Scatter plot of AG and BI

The study also presents the scatter plot of the two variables in Figure 7.18, which supports the view that the two variables are indeed related.

From Figure 7.16, one also hypothesizes that there is some bivariate relationship between the strategies and practices of SC and BI, and between those strategies and practices of SC and BI. The researcher uses the computed variables in Equation 7.8 to test these relationships. The

Table 7.31: Non-parametric pairwise correlation of BI, HK and SC

Kendall's tau b		BI	HK	SC
BI	Correlation Coefficient	1.000	.546(**)	.639(**)
	Sig. (2-tailed)	.	.000	.000
	N	1225	1225	1225
HK	Correlation Coefficient	.546(**)	1.000	.545(**)
	Sig. (2-tailed)	.000	.	.000
	N	1225	1225	1225
SC	Correlation Coefficient	.639(**)	.545(**)	1.000
	Sig. (2-tailed)	.000	.000	.
	N	1225	1225	1225

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

resulting correlation matrix is presented in Table 7.32. The study found that the coefficients are all very positive at 0.546 for BI and HK, and 0.639 for BI and SC. These correlation are statistically significant at the  $\alpha = 0.01$  level (two-tailed). The coefficients all have p-values less than 0.001 ( $p < 0.001$ ), two-tailed.

Although there is clear evidence that these variables are related, The researcher has some concerns whether the level of relationship between AG and BI were influenced by the other two variables, namely SC and HK. The model in Figure 7.16 is relevant. The researcher decides to run the partial correlation for AG and BI controlling for HK and SC. The study uses the partial correlation procedure to compute the partial correlation coefficients in so as to describe the linear relationship between two variables (AG and BI) while controlling for the effects of the HK and SC variables. The variables were all scale variables, because of the transformation of the compute procedure used to compute these composite variables.

In this hypothesis, the partial correlations table shows both the zero-order correlations (correlations without any control variables) of all four variables and the partial correlation controlling of the first two variables controlling for the effects of the third and fourth variables.

The zero-order correlation between AG and BI is, indeed, both fairly high (0.572) and statistically significant ( $p < 0.001$ ).

The partial correlation controlling for HK and SC, however, is fairly positive (0.364) and statistically significant ( $p < 0.001$ ). One interpretation of this finding is that the observed positive "relationship" between AGT and KM practices is due to a certain degree to the underlying relationships between each of those variables and those of HK and SC, in their strategies to

Table 7.32: Correlation matrix of partial correlation for AG and BI

Control			AG	BI	HK	SC
-none- (a)	AG	Correlation	1.000	.572	.597	.425
		Significance (2-tailed)	.	.000	.000	.000
		df	0	1223	1223	1223
	BI	Correlation	.572	1.000	.562	.673
		Significance (2-tailed)	.000	.	.000	.000
		df	1223	0	1223	1223
	HK	Correlation	.597	.562	1.000	.622
		Significance (2-tailed)	.000	.000	.	.000
		df	1223	1223	0	1223
	SC	Correlation	.425	.673	.622	1.000
		Significance (2-tailed)	.000	.000	.000	.
		df	1223	1223	1223	0
HK and SC	AG	Correlation	1.000	.364		
		Significance (2-tailed)	.	.000		
		df	0	1221		
	BI	Correlation	.364	1.000		
		Significance (2-tailed)	.000	.		
		df	1221	0		

(a) controlling for HK and SC (b) Cells contain zero-order (Pearson) correlations.

self-improve their quality, productivity, and overall competitiveness.

In fact, the use of AGT in organisations increase as the application of KM practices increases because of the current awareness and value organisations place on KM practices and strategies to self-improve their quality, productivity and overall competitiveness. This fact is bore out in value organisations place on their IC, and the harvesting of BI

The researcher revisited the zero-order correlations in Table 7.33, and found that AGT and BI practices are highly positively correlated with the control variable, HK and SC, at 0.572, and 0.425 [AG with HK and SC]; and 0.562 and .673 [BI with HK and SC], respectively.

Removing the effects of these variables has not significantly affected the correlation between the other two variables in any appreciable degree.

**Decision rule** The analysis of the data in this hypothesis shows a definite relationship between these two sets of constructs. This provides some evidence that AG is related to BI, and for that matter, KM strategies and practices; and CA.

One is able to reject the null hypothesis, which states that the strategies of AGT and those of BI used by organisations to self improve are independent. One therefore accepts the alternate hypothesis, and confidently conclude that there is a direct relationship between Strategies of AGT and those of BI used by organisations to self improve are related.

### 7.4.3 Hypothesis 3

Null Hypothesis 3 [ $H_{03}$ ]: There is no statistically significant difference between the way organisations assess the productivity and performance-oriented initiatives attributed to the efforts of task-related outcomes, and those of group, in the use of AGT.

Hypothesis 3 relates to the rank order correlation between those productivity and performance – oriented initiatives, which are attributed to the efforts of task-related outcomes, and those of group-related outcomes, in the use of AGT. The study shall test this hypothesis using the composite variables of “task” and “group”, controlling for “OL”:

- use a two-tailed test,

- $H_0$ : productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AGT are independent,
- $H_1$ : productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AGT are related,
- the test statistic for hypothesis 3, will be Kendall's tau b,
- at a significance of  $\alpha = 0.01$ .

The study follows the same protocol of hypotheses 1 and 2, and model hypothesis 3 as illustrated in Figure 7.20.

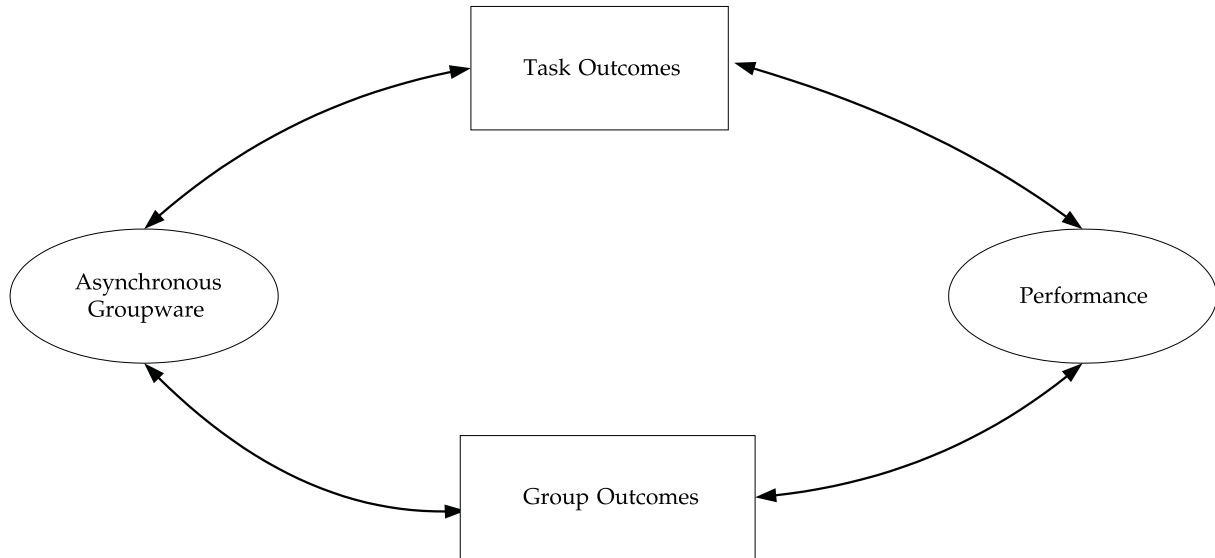


Figure 7.20: Research framework for hypothesis 3 (reproduced from Figure 5.6)

The study creates a composite index for each of these variables. The researcher uses the COMPUTE procedure of SPSS, similarly to that of Table D.7.5 [cf. D.7.5 Syntax code for indexed variables used in hypotheses]. The index includes the following variables:

$$\begin{aligned}
 task &= gd01c, gd01e, gd01g, id01a, id01b, id01c \\
 group &= od01a, od01b, od01c, od01d, od01e, od01f \\
 team &= gd01a, gd01b, gd01c, gd01d, gd01e, gd01f, gd01g, gd01h, gd01i
 \end{aligned} \tag{7.4}$$

One flagged the non-parametric pairwise correlation matrix, using Kendall's tau b, with two-

tailed, for significant correlation. This is illustrated in Table 7.33. The study measures two variables in this table. They are the composite variable of “task” and “group”, as illustrated in Equation 7.4. The study also uses the Spearman’s rho correlation coefficients to cross validate the results obtained from Kendall’s tau-b.

The correlation matrix, and scatter plots are illustrated next.

Table 7.33: Non-parametric correlation matrix for task and group outcomes

			task outcomes	group outcomes
Kendall’s tau b	task outcomes	Correlation Coef- ficient	1.000	.612(**)
		Sig. (2-tailed)	.	.000
		N	1225	1225
	group outcomes	Correlation Coef- ficient	.612(**)	1.000
		Sig. (2-tailed)	.000	.
		N	1225	1225
Spearman’s rho	task outcomes	Correlation Coef- ficient	1.000	.723(**)
		Sig. (2-tailed)	.	.000
		N	1225	1225
	group outcomes	Correlation Coef- ficient	.723(**)	1.000
		Sig. (2-tailed)	.000	.
		N	1225	1225

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

The study also presents the scatter plot of the two variables in Figure 7.20, which supports the view that the two variables are indeed related. The study found one major outlier which was of some concern, but upon further analysis found that it did not affect the relationship of the two variables in any significant manner.

From Figure 7.19, one hypothesizes that there is some bivariate relationship between the initiatives and strategies of task outcomes those of group outcomes, as they relate to the use of asynchronous groupware technology, in organisations’ efforts to improve their productivity and performance. The composite variables used to test this relationship, or to ascertain if there are any significant difference are computed in Equation 7.4. The study presents the resulting correlation matrix in Table 7.34. One found that the coefficients are all very positive at 0.612 for task and group, using Kendall’s tau b. These coefficients have p-values less than 0.001 ( $p < 0.001$ ), and level of significance at 0.01, two tailed.



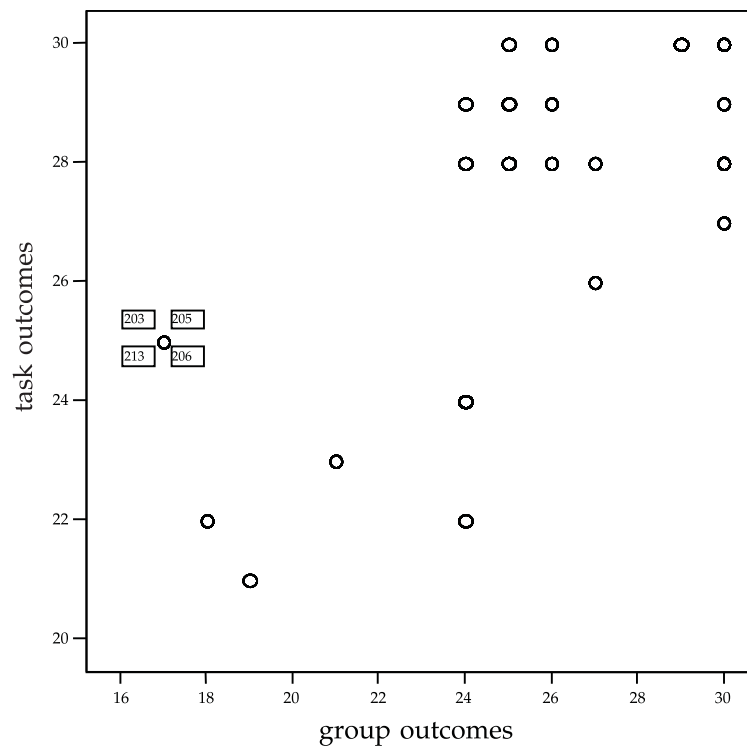


Figure 7.21: Scatter plot for task and group outcomes

At this juncture one could safely reject the null hypothesis. This is because it points to the proposition that the two variables (task and group outcomes) were independent, and accept the alternate hypothesis, which holds that the two variables were related, and that no difference exist between the efforts of the initiatives that firms use in order to improve their performance and productivity, in the use of AGT.

Notwithstanding this, one was compelled to explore the underlying relationship of these two variables much further, by controlling for the effects of the variable “organisational learning”. This variable is an index of the following ten manifest variables

$$\text{COMPUTE OL} = \text{SUM}(\text{BI02D}, \text{GD01H}, \text{TI01B}, \text{GD01H}, \text{GD01A}, \text{TI01A}, \text{SK01D}, \text{TI02A}, \text{BI04}) \quad (7.5)$$

These ten manifest variables are a composite of Factor 4: OL, as set out in Table 7.12. These variables measure:

1. The level of implementation of IC in organisations (BI02D);

2. The existence of a KM strategy has resulted in a reduction in the time it takes to solve mission critical problems in organisations (BI04);
3. Whether the use of AG technology facilitate the use of information generated by former KM groups in a way that improves the efficiency and effectiveness of future groups (GD01A);
4. Whether the use of AGT makes it faster and easier to access information relevant to the three main phases of a KM group – business process definition, analysis and redesign (GD01F);
5. The reduction in cost of using AGT in the running of KM groups.(GD01H);
6. The degree to which organisation value the knowledge they have and harvest about their competitors’ market (SK01D);
7. The benefits accruing from the implementation of an organisation-wide internet access infrastructure (TI01A);
8. The benefits accruing from the implementation of an organisation-wide infrastructure (TI01B);
9. The benefits accruing from the implementation of, and use of data warehousing and data mining technologies (TI01E);
10. The benefits accruing from the implementation of an organisation-wide internet access infrastructure for the use of KM support (TI02A).

The factor loadings for these ten variables range from a low of 0.510 to a high of 0.910, illustrating the representativeness of the structure of this factor.

The researcher therefore takes the view that one can confidently posit that this indexed variable , OL, describes those initiatives and strategies that some firms use to deploy and measure the efforts of AGT among various artefacts in their organisations, with a view to improve productivity and performance.

Although there is clear evidence that the three variables task, group and OL are related, as shown in the upper portion of Table 7.35, where the results of the zero-order correlation between “task” and “OL” is, a strong and positive at 0.862 and statistically significant ( $p < 0.001$ ). Also the correlation of coefficient between “group” and “OL”, is fairly strong and positive at 0.538 with a p-value less than 0.001 ( $p < 0.001$ ), which is statistically significant.

Table 7.34: Correlation matrix of partial correlation for task and group

Control Variables			task outcomes	group outcomes	OL
-none-(a)	task outcomes	Correlation	1.000	.745	.862
		Significance (2-tailed)	.	.000	.000
		df	0	1223	1223
	group outcomes	Correlation	.745	1.000	.538
		Significance (2-tailed)	.000	.	.000
		df	1223	0	1223
	OL	Correlation	.862	.538	1.000
		Significance (2-tailed)	.000	.000	.
		df	1223	1223	0
OL	task outcomes	Correlation	1.000	.656	
		Significance (2-tailed)	.	.000	
		df	0	1222	
	group outcomes	Correlation	.656	1.000	
		Significance (2-tailed)	.000	.	
		df	1222	0	

(a) controlling for OL (b) Cells contain zero-order (Pearson) correlations.

Notwithstanding this, the researcher decides to run the partial correlation for “task” and “group” controlling for “OL”. One uses the partial correlation procedure to compute the partial correlation coefficients to describe the linear relationship between the two variables (task and group) while controlling for the effects of the “OL” variable. The variables were all scale variables, because of the transformation of the compute procedure used to compute these composite variables.

In this hypothesis, the partial correlations table shows both the zero-order correlations (correlations without any control variables) of all three variables and the partial correlation controlling of the first two variables controlling for the effects of the third variable.

The partial correlation controlling for “OL”, however, is fairly strong and positive (0.656), and statistically significant ( $p < 0.001$ ).

One interpretation of this finding is that the observed positive “relationship” between the variables of “task outcomes” and “group outcomes” is due to a certain degree to the underlying relationship between each of these variables. Also of relevance is the relationship of “OL” with those variables, in the way organisations assess their productivity and performance-oriented ini-

tiatives, which are attributed to the efforts of task-related outcomes, and those of group-related outcomes, in the use of AGT.

Consequently, removing the effects of the variable, “OL” has not significantly affected the correlation between the variables “task” and “group” in any appreciable degree. This was demonstrated earlier when the zero-order correlation was studied.

**Decision rule** From Table 7.34 one found that there is a fairly strong and positive relationship between the variables “task” and “group” as evidenced by the Kendall’s tau b correlation coefficient of 0.612, and a p-value less than 0.001 ( $p < 0.001$ ) with a significance level,  $\alpha$ , of 0.01 (two-tailed). The statistical significance of this relationship was cross validated with the Spearman’s rho correlation. The Spearman’s rho correlation coefficient is 0.723, as is evidenced in Table 7.34. Its p-value is also less than 0.001 ( $p < 0.001$ ) at a significance level of 0.01 (two-tailed).

The “OL” variable also has a strong and positive relationship with “task” and “group”, respectively. The results in Table 7.35 is relevant. One is able to reject the null hypothesis, which states that the productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AG technology are independent;

Thus accepting the alternate hypothesis, and confidently conclude that there is a direct relationship between those productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AGT, in the sampled organizations.

#### 7.4.4 Hypothesis 4

Null Hypothesis 4 [ $H_{04}$ ]: There are no statistically significant differences between the ways organisations assess the productivity and performance-oriented initiatives attributed to the efforts of the individual in task-related outcomes in their use of AGT, and those of individuals in team-related outcomes.

Hypothesis 4 relates to the rank order correlation between those productivity and performance – oriented initiatives, which are attributed to the efforts of the individual in task-related outcomes, and those of individuals in team-related outcomes, in the use of AGT. The study shall test this

hypothesis using the composite variables of “task” and “team”, controlling for “OL”:

- use a two-tailed test,
- $H_0$ : productivity and performance initiatives attributed to the efforts of the individual in task-related outcomes and those of individuals in team-related outcomes in the use of AGT are independent,
- $H_1$ : productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AGT are related,
- the test statistic for hypothesis 3, will be Kendall’s tau b,
- at a significance of  $\alpha = 0.01$ .

The researcher followed the same protocol of hypothesis 3, and model hypothesis 4 as illustrated in Figure 7.21.

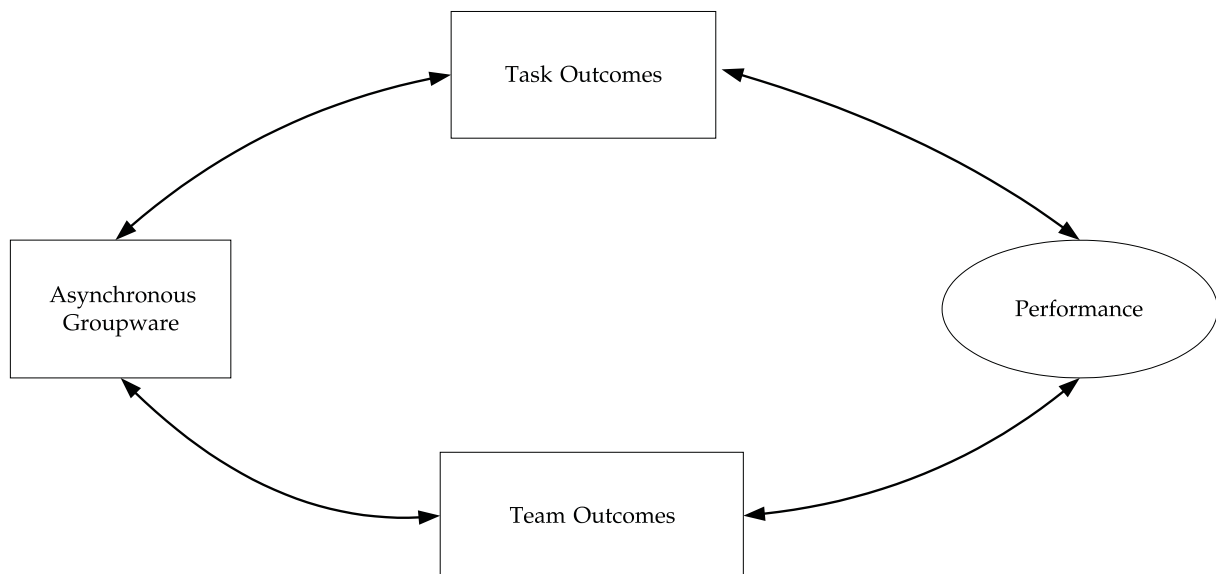


Figure 7.22: Research framework for hypothesis 4 (reproduced from Figure 5.7)

The study uses the variables of the composite index created in Equation 6-9 [cf. Equation 7.4 Composite index for task, group, and team]

The study flagged the non-parametric pairwise correlation matrix, using Kendall’s tau b, with two-tailed, for significant correlation. The present study measure two variables in Table 7.37. They are the composite variable of “task” and “group”, as illustrated in Equation 7.9. The

present study also uses the Spearman's rho correlation coefficients to cross validate the results obtained from Kendall's tau-b.

The study illustrates the correlation matrix, and scatter plots in Table 7.37 and Figure 7.22.

The study also presents the scatter plot of the two variables in Figure 7.22, which supports the view that the two variables exhibit a nearly perfect and positive linear relationship.

From Figure 7.21, one hypothesizes that there is some bivariate relationship between the initiatives and strategies of task outcomes those of team outcomes, as they relate to the use of asynchronous groupware technology by individuals in organisations' efforts to improve their productivity and performance. The composite variables used to test this relationship, or to ascertain if there are any significant difference are computed in Equation 7.4. The researcher presents the resulting correlation matrix in Table 7.36, below.

Table 7.35: Non-parametric correlation matrix for task and team outcomes

			task outcomes	team outcomes
Kendall's tau b	task outcomes	Correlation Coefficient	1.000	.892(**)
		Sig. (2-tailed)	.	.000
		N	1225	1225
	team outcomes	Correlation Coefficient	.892(**)	1.000
		Sig. (2-tailed)	.000	.
		N	1225	1225
Spearman's rho	task outcomes	Correlation Coefficient	1.000	.960(**)
		Sig. (2-tailed)	.	.000
		N	1225	1225
	team outcomes	Correlation Coefficient	.960(**)	1.000
		Sig. (2-tailed)	.000	.
		N	1225	1225

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

The study found that the coefficients are all very strong, and positive at 0.892 for task and team using Kendall's tau b. These coefficients have p-values less than 0.001 ( $p < 0.001$ ), and level of significance at 0.01, two tailed. The statistical significance of this relationship was cross validated with the Spearman's rho correlation. The Spearman's rho correlation coefficient is just as strong and positive at 0.960, as is evidenced in Table 7.37. It p-value is also less than 0.001 ( $p < 0.001$ ) at a significance level of 0.01 (two-tailed).

Now, one could safely reject the null hypothesis. This is because, it points to the proposition that the two variables (task and team outcomes) were independent. One could then also safely

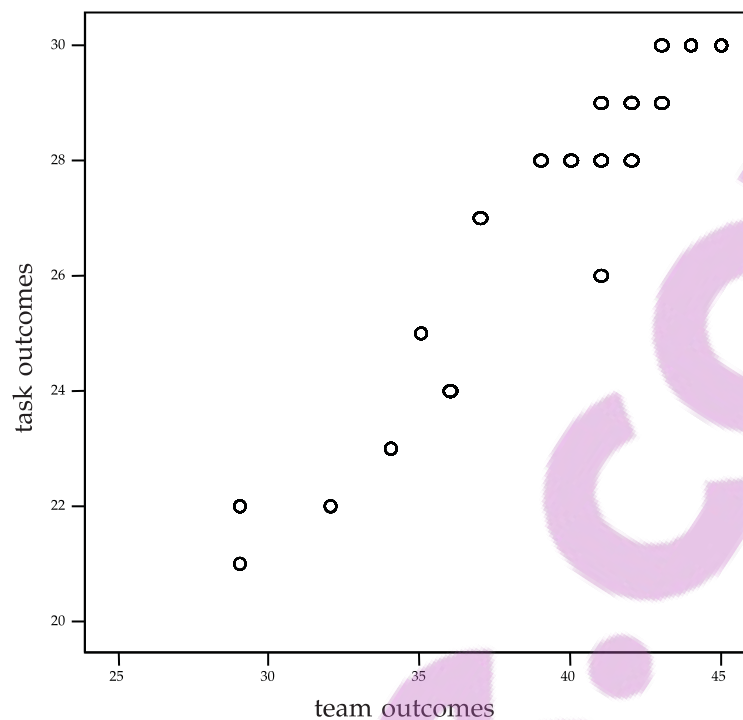


Figure 7.23: Scatter plot of task and team outcomes

accepts the alternate hypothesis, which holds that the two variables were related; and that no differences exist between the efforts of the initiatives that firms use in order to improve their performance and productivity, in the use of AGT by individuals.

Notwithstanding this, the researcher was compelled to explore the underlying relationship of these two variables much further, by controlling for the effects of the variable “OL”. This variable is an index of the ten manifest variables set out in Equation 7.10 [cf. Equation 7.5 Composite index for OL].

Although there is clear evidence that the three variables task, team and OL are related, as shown in the upper portion of Table 7.37, where the results of the zero-order correlation between “task” and “OL” is, a strong and positive at 0.862 and statistically significant ( $p < 0.001$ ). Also the correlation of coefficient between “team” and “OL”, is very strong and positive at 0.899 with a p-value less than 0.001 ( $p < 0.001$ ), which is statistically significant.

Notwithstanding this, the researcher decides to run the partial correlation for “task” and “team” controlling for “OL”. The study uses the partial correlation procedure to compute the partial correlation coefficients to describe the linear relationship between the two variables (task and team while controlling for the effects of the “OL” variable. The variables were all “scale”

variables, because of the transformation of the COMPUTE procedure used to compute these composite variables. This fact allows the investigation to perform a regression analysis on these variables, to ascertain whether a linear relationship do exist between them. This analysis will be undertaken later on in this section, for hypothesis 4.

Table 7.36: Correlation matrix of partial correlation for task and team, controlling for ol

Control Variables			task outcomes	team outcomes	OL .
-none-(a)	task outcomes	Correlation	1.000	.964	.862
		Significance (2-tailed)	.	.000	.000
		df	0	1223	1223
	team outcomes	Correlation	.964	1.000	.899
		Significance (2-tailed)	.000	.	.000
		df	1223	0	1223
	OL .	Correlation	.862	.899	1.000
		Significance (2-tailed)	.000	.000	.
		df	1223	1223	0
OL .	task outcomes	Correlation	1.000	.850	
		Significance (2-tailed)	.	.000	
		df	0	1222	
	team outcomes	Correlation	.850	1.000	
		Significance (2-tailed)	.000	.	
		df	1222	0	

(a) Cells contain zero-order (Pearson) correlations.

In this hypothesis, the partial correlations table shows both the zero-order correlations (correlations without any control variables) of all three variables and the partial correlation controlling of the first two variables controlling for the effects of the third variable, as previously explained.

The partial correlation controlling for “OL”, however, is very strong and positive (0.850), and statistically significant ( $p < 0.001$ ).

One interpretation of this finding is that the observed positive “relationship” between the variables of “task outcomes” and “team outcomes” is due to a certain degree to the underlying relationship between each of these variables. Also of relevance is the relationship of “OL” with those variables, in the way organisations assess their productivity and performance-oriented initiatives, which are attributed to the efforts of individuals in task-related outcomes, and those of



individuals in team-related, in the use of AGT. Consequently, removing the effects of the variable, “OL” has not significantly affected the correlation between the variables “task” and “team” in any appreciable degree. This was demonstrated earlier when the zero-order correlation was studied.

### The Linear Regression Model

The fact that there is evidence that a strong and positive relation exist between the two variables, that is “task” and “team”, one decide to test a regression model between these two variables for hypothesis 4. In this scenario, the linear regression model assumes that there is a linear, or “straight line”, relationship between the dependent variable (task) and each predictor (team). This relationship is set out in the following formula, [cf. Equation 7.6]:

$$y_i = b_0 + b_1x_i + \dots + b_px_{ip} + e_i \quad (7.6)$$

where

$y_i$  is the value of the  $i^{th}$  case of the dependent scale variable

$p$  is the number of predictors

$b_j$  is the value of the  $j^{th}$  coefficient,  $j=0, \dots, p$   $x_{ij}$  is the value of the  $i^{th}$  case of the  $j^{th}$  predictor

$e_i$  is the error in the observed value for the  $i^{th}$  case.

The model is linear because increasing the value of the  $j^{th}$  predictor by one unit increases the value of the dependent by  $b_j$  units. Note that  $b_0$  is the intercept, the model-predicted value of the dependent variable when the value of every predictor is equal to 0.

For testing hypotheses, in general, about the values of model parameters, the linear regression model also assumes the following:

- The error term has a normal distribution with a mean of zero.
- The variance of the error term is constant across cases and independent of the variables in the model. If an error term has a non-constant variance, it is then heteroscedastic.
- The value of the error term for a given case is independent of the values of the variables

in the model and of the values of the error term for other cases. One uses the linear regression to determine whether the task-related outcomes can be predicted by the team-related outcomes. Before running the regression analysis, one examines the scatter plot of task-related outcomes by team-related outcomes to determine whether a linear model is a reasonable analysis for these variables.

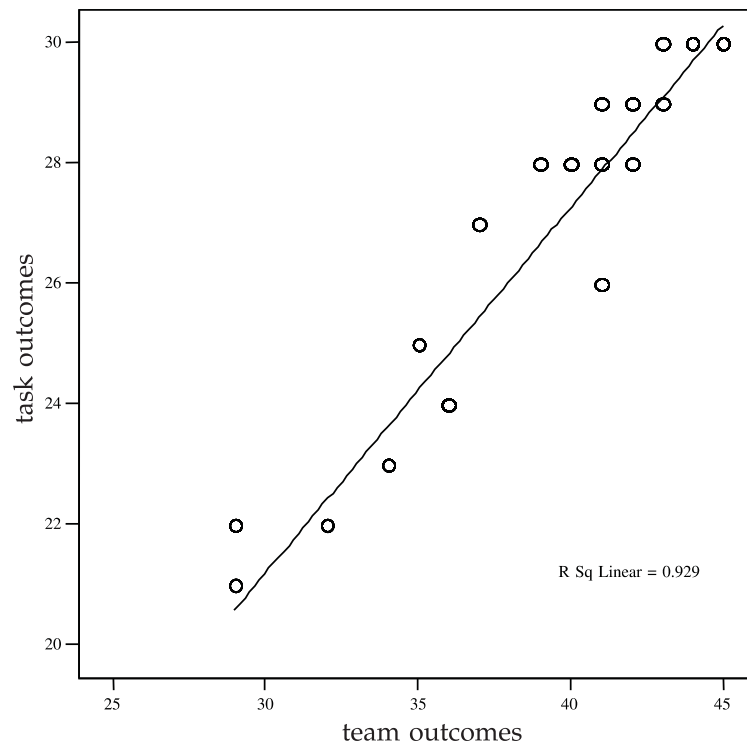


Figure 7.24: Scatter plot of task and team with regression line

The resulting scatter plot appears to be suitable for a linear regression model. The researcher now sets out the procedure used for running the regression analysis. One investigates the linearity of this model and model fit by performing a number of diagnostic tests of the regression model. One uses the SPSS linear regression analysis procedure, by invoking the following menu options:

- Analyze
  - Regression
    - \* Linear.

One then selects “task” as the dependent variable, and “team” as the independent variable. One then selected “OL” as the case labelling variable.

In the menu options, one clicks Plots, and proceed to select \*SDRESID – Studentized residuals, as the y variable and \*ZPRED – Standardized predicted values, as the x variable. The researcher then selected Histogram and Normal probability plot. The researcher did this, so as to obtain the model fit statistics.

From the foregoing, one produces a linear regression model for individual’s task-related outcomes, based on individuals’ team-related outcomes. Diagnostic plots of the Studentized residuals by the model-predicted values were requested, and various values were saved for further diagnostic testing, in the data table.

#### (1) Checking the Model Fit

One then extracted the output of the regression analysis, the results of which are presented in Appendix E. This table [cf. Table 7.37] shows the coefficients of the regression line.

Table 7.37: Regression model coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.011	.196		15.367	.000
	team outcomes	.606	.005	.964	126.222	.000

(a) Dependent Variable: task outcomes

This table implies that the expected individual’s task-related outcomes are equal to  $3.011 + 0.606 * team$ . The interpretation of this seems to suggest that if organisations want to assess the productivity and performance-oriented initiatives attributed to the efforts of the individual in task-related outcomes in their use of AGT, and those of individuals in team-related outcomes, then the predicted individual’s task-related outcomes would be determined by use of this formula. This of course presupposes that the organization would have ascribed some value to the variable “team”, in order to compute the weights for their productivity and performance-oriented initiatives.

The results are next presented in the ANOVA table, in Table 7.39.

The ANOVA table tests the acceptability of the model from a statistical perspective.

In Table 7.39, the “Regression” row displays information about the variation accounted for by the model. Whilst, the “Residual” row displays information about the variation that is not

Table 7.38: ANOVA test of the Regression Model

## ANOVA (b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7725.334	1	7725.334	15931.889	.000(a)
	Residual	593.030	1223	.485		
	Total	8318.364	1224			

(a) Predictors: (Constant), team outcomes

(b) Dependent Variable: task outcomes

accounted for by the model. The regression and residual sums of squares are different, which indicates that the model explains the variation in the individual's task-oriented outcomes.

The significance value of the F statistic is less than 0.05, which means that the variation explained by the model is not due to chance. While the ANOVA table is a useful test of the model's ability to explain any variation in the dependent variable, it does not directly address the strength of that relationship.

Table 7.39: Regression Model summary

## Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.964 (a)	.929	.929	.696

(a) Predictors: (Constant), team outcomes

(b) Dependent Variable: task outcomes

The model summary table reports the strength of the relationship between the model and the dependent variable. R, the multiple correlation coefficient, is the linear correlation between the observed and model-predicted values of the dependent variable. Its large value (0.964) indicates a strong relationship. "R Square", the coefficient of determination, is the squared value of the multiple correlation coefficient. It shows that 0.929 of the variation in task-oriented outcomes is explained by the model.

As a further measure of the strength of the model fit, the study compares the standard error of the estimate in the model "Summary Table" [cf Table 7.39 Regression Model summary] to the standard deviation of task-oriented outcomes in the descriptive statistics table.

## (2) Checking the Normality of the Error Term

A residual is the difference between the observed and model-predicted values of the dependent

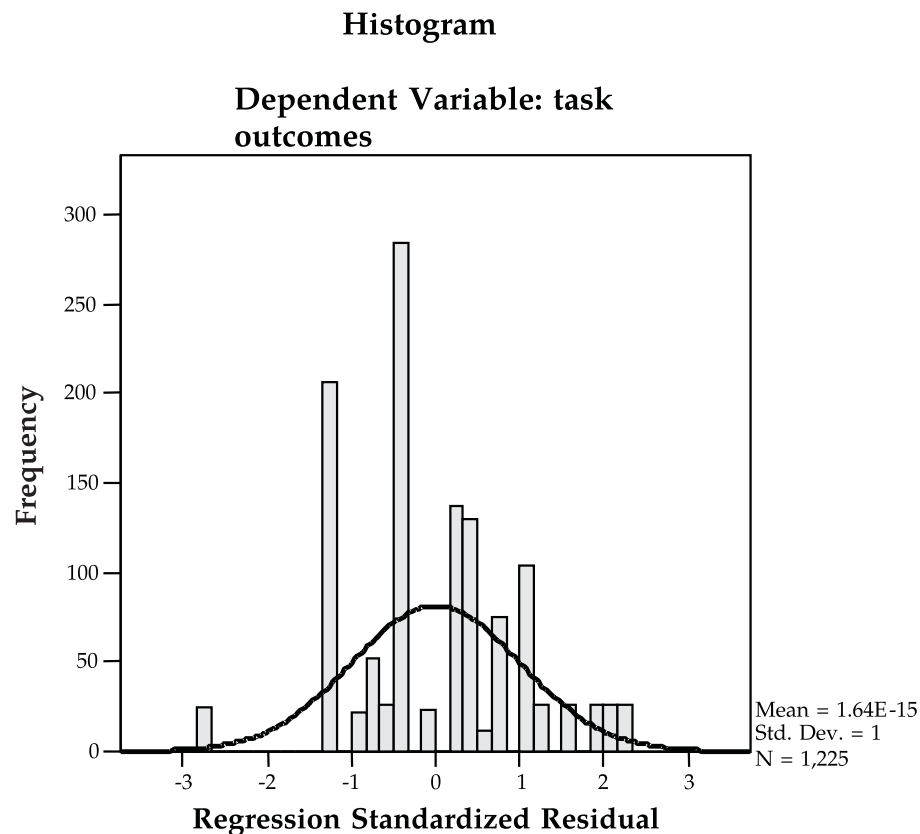


Figure 7.25: Histogram of the Residuals

variable. The residual for a given construct is the observed value of the error term for that construct. Consequently a histogram or P-P plot of the residuals should assist with the checking of the assumption of normality of the error term.

In this study the shape of the histogram approximately follows the shape of the normal curve [cf. Figure 7.26].

Whilst the P-P plotted residuals follow a 45-degree line. It would seem that neither the histogram nor the P-P plot indicates that the normality assumption is being violated in this instance.

### (3) Checking Independence of the Error Term

The plot of residuals by the predicted values shows that the variance of the errors increases with increasing predicted task-related outcomes. This is, otherwise a reasonable scatter plot. These results are then revalidated by checking the residuals by "the efforts of individuals in team-related outcomes". The standardized residual is then used, as the y (dependent) variable, instead of team-related outcomes as the y (independent) variable, as was the case for Figure

### Normal P-P Plot of Regression Standardized Residual

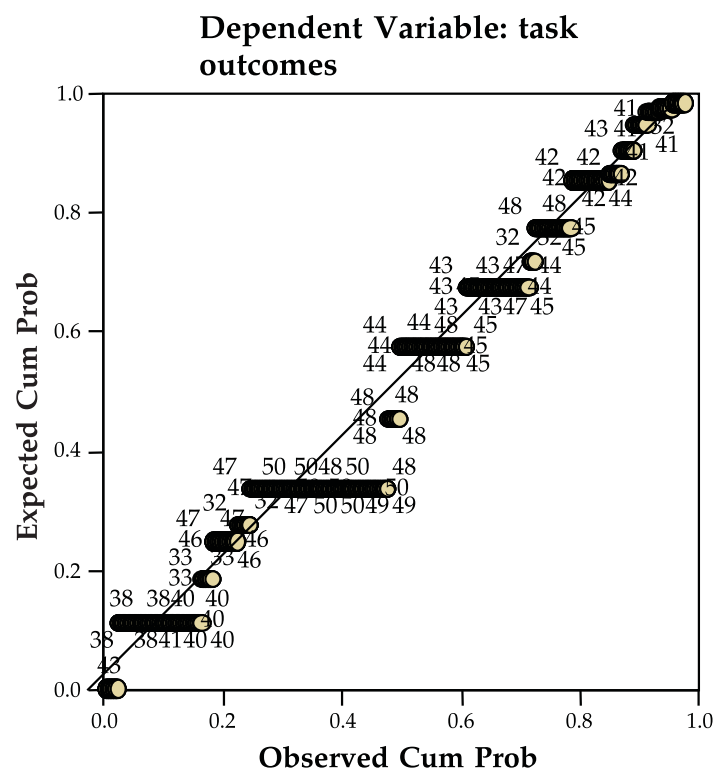


Figure 7.26: Normal P-P Plot of Regression Standardized Residual

7.23. The resulting scatter plot, Figure 6.26, shows the same results.

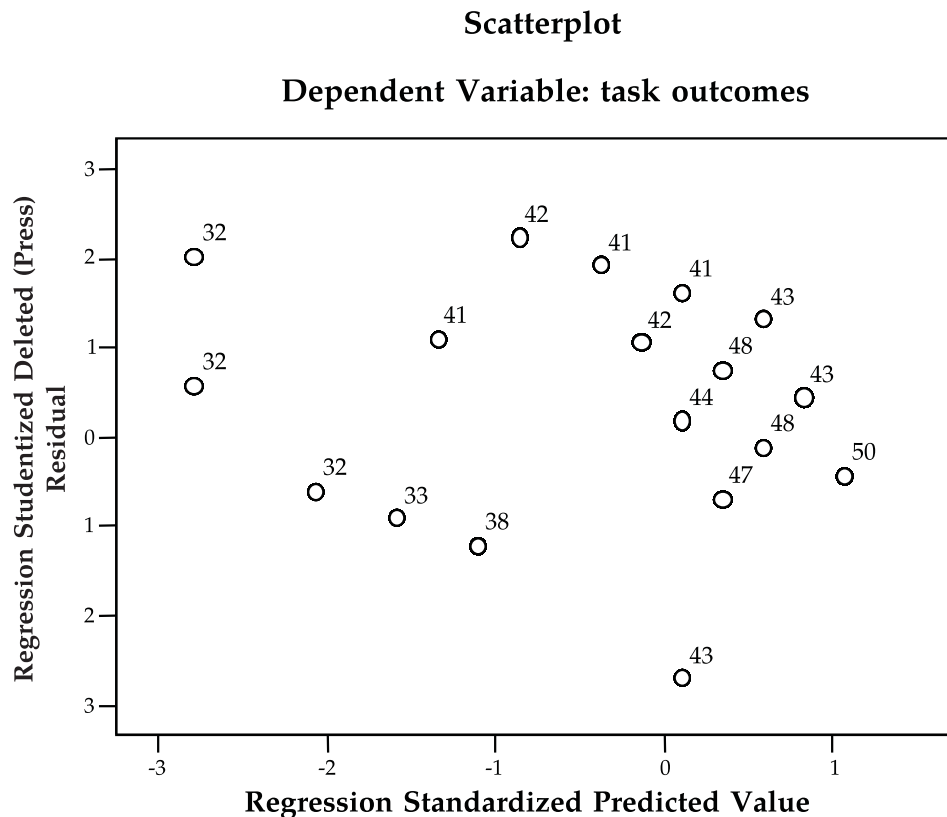


Figure 7.27: Scatterplot of dependent variable: task outcomes

There is, however, some heteroscedasticity in the residuals; this may be corrected in further analyses. Whilst this is outside the scope of this research, one approach might be to define a weighting variable based on the inverse of the individuals, team-related outcomes, and how these impact the productivity and performance of the organisation. In using this weighting variable, the researcher should be able to decrease the influence of individuals' task-related outcomes impacts and highly variable individual's task-related outcomes, resulting in more precise regression estimates.

#### (4) Identifying Influential Points

The researcher then checks the influential points of the residuals by using Cook's Distance as the y variable, and the Centred Leverage value as the x variable. One also uses "OL" as the labelling variable. The resulting scatter plot, Figure 7.28, shows a point far to the left of the others. This case has a high leverage and high influence. Its high leverage gives it extra weight in the computation of the regression line, and the high influence indicates that it did affect the slope of the regression line. One can deal with an influential point by using a weighting variable

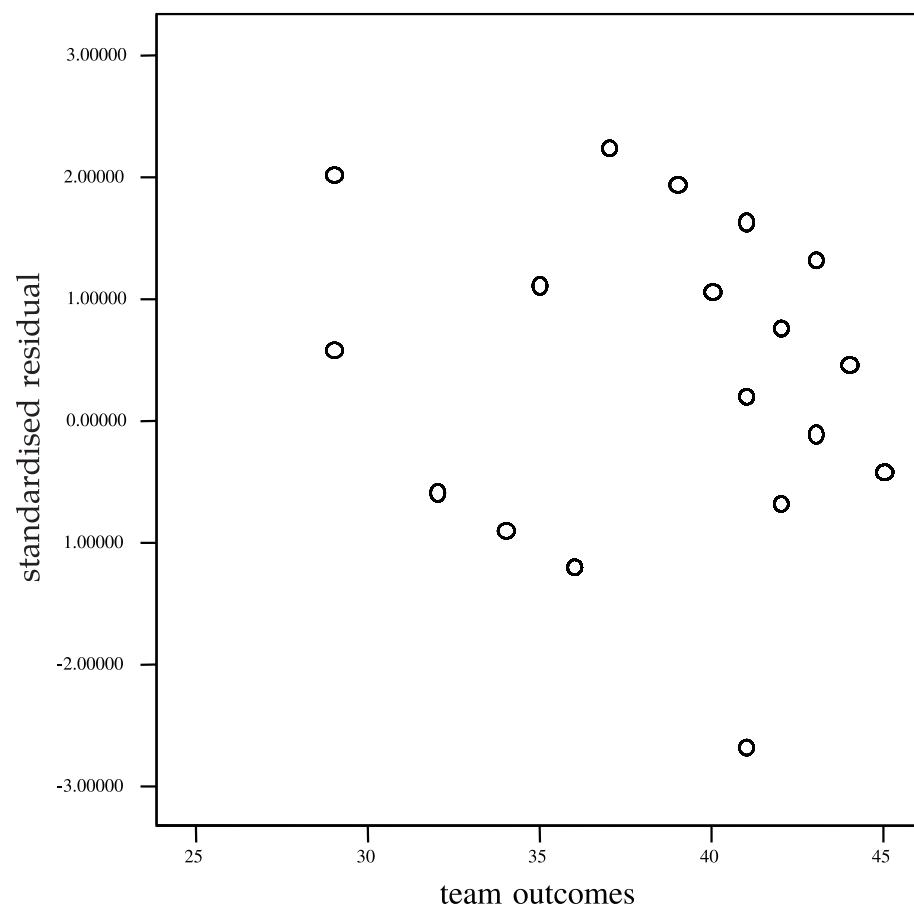


Figure 7.28: Scatter plot of standardised residual versus team outcomes



that gives the influential point less weight. This was not done at this juncture.

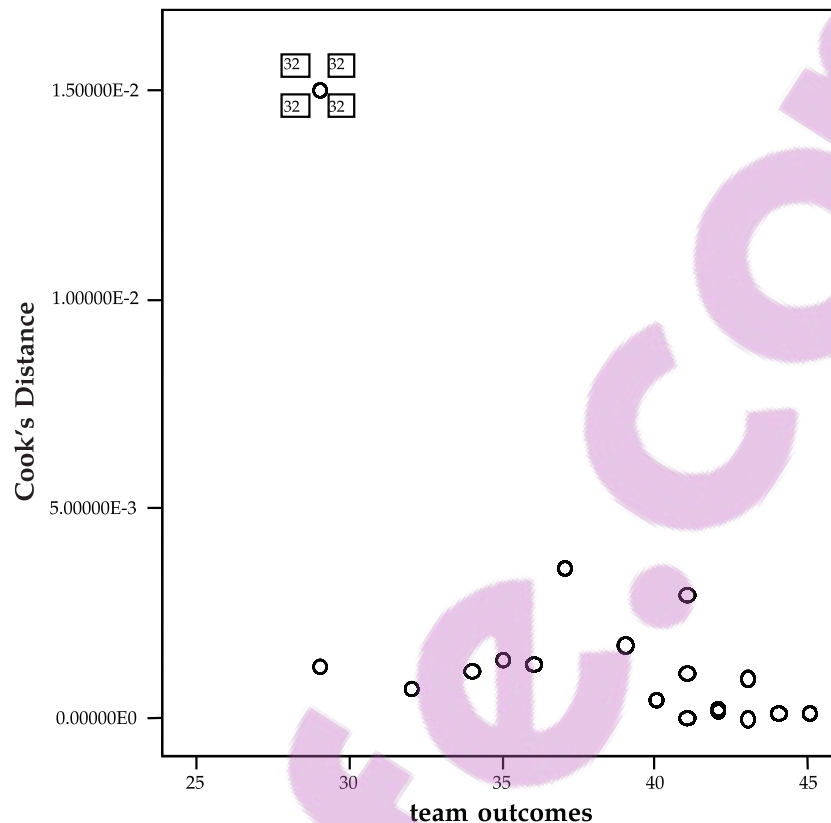


Figure 7.29: Scatterplot of Cook's Distance versus team outcomes

**Decision rule** From Table 7.36 the study found that there is a very strong and positive relationship between the variables “task” and “team” as evidenced by the Kendall’s tau b correlation coefficient of 0.892, and a p-value less than 0.001 ( $p < 0.001$ ) with a significance level  $\alpha$ , of 0.01 (two-tailed). The statistical significance of this relationship was cross validated with the Spearman’s rho correlation. The Spearman’s rho correlation coefficient is 0.960 as is evidenced in Table 6.35. Its p-value is also less than 0.001 ( $p < 0.001$ ) at a significance level of 0.01 (two-tailed).

The “OL” variable also has a strong and positive relationship with “task” and “team”, respectively. The results in Table 7.37 are relevant.

One is able to reject the null hypothesis, which states that the productivity and performance initiatives attributed to the efforts of the individual in task-related outcomes and those of individuals in team-related outcomes in the use of AG technology are independent;

Thus accepting the alternate hypothesis, and confidently conclude that there is a direct relationship between those productivity and performance initiatives attributed to the efforts of the individual in task-related outcomes and those of individuals in team-related outcomes in the use of AG technology, in the sampled organizations.

The study went one step further to use a regression analysis model to validate this hypothesis, Equation 7.11 is relevant. Knowing the individual's task-related outcomes, for productivity and performance oriented initiatives should help organisations to assess their use of AGT infrastructure, in the provision of support for individuals' team-related outcomes. Using linear regression, the organisations should be able to make use of the relationship between the "team-related outcomes" and "task-related outcomes" to assess and improve their productivity and performance.

## 7.5 Summary

The study demonstrated that the four hypotheses have been satisfied. The research objectives have also been successfully met. These were to examine how KM strategies are enabled by the support of AG systems; and to examine how organisations are successfully implementing KM projects and products in order to improve their CA. Various statistical procedures were employed to this end.

The investigation now turns to Chapter 8, where the study shall report on the findings and results of the main survey, which was conducted among four countries as a sub-sample from the exploratory survey.

## Chapter 8

### Findings and Results II

---

*Some people do not become thinkers simply because their memories are too good.*

*Anonymous*

#### 8.1 Introduction

This chapter report the findings and analyses of the results of the KM practices survey (KMP), which was conducted in one sector, the information communications and technologies (ICT) sector, in four of the countries drawn from the exploratory survey. The results and analyses of the pilot survey were reported in chapter 7. These four countries are also members of the Organisation for Economic Cooperation and Development (OECD). This fact was one of the main motivations for their selection. These countries, as reported elsewhere in this thesis, are Australia, Canada, New Zealand, and the United Kingdom. The sample profile, along with the response rate information is presented in Table 6.1. A summary of the items used in the questionnaire for the KM practices survey is presented in Table E.1.

##### 8.1.1 Research Constructs

Aside from the usual demographic statistic, the survey sought to measure the following ten constructs at the firm level:

Constructs	Items
i) <b>current state of KM practices (6 sub-constructs):</b>	
a. policies and strategies (KM 1001 – KM1004)	4
b. leadership (KM1005 – KM 1008)	4
c. incentives (KM 1009 – KM1012)	4
d. knowledge capture and acquisition (KM1013 – KM1014)	4
e. training and mentoring (KM1015 – KM1020)	6

f. communication (KM1021 – KM1023)	3
<b>ii) reasons for using KM practices (KM2001 – KM2012)</b>	<b>12</b>
<b>iii) results of using KM practices (KM2101 – KM2114)</b>	<b>14</b>
<b>iv) responsibilities of KM practices (KM2201 – KM2202)</b>	<b>2</b>
<b>v) effectiveness of KM practices (KM2301 – KM2302)</b>	<b>2</b>
<b>vi) sources of KM practices (KM2401 – KM2402)</b>	<b>2</b>
a. internal (KM2401I)	
b. external.(KM2401II)	
<b>vii) spending on KM practices (KM2501 – KM2503)</b>	<b>3</b>
<b>viii) resistance to KM practices (2 sub-constructs): (KM2601 -KM2602)</b>	<b>2</b>
a. officers and workers (KM2602A)	
b. functions, departments or business units (KM2601)	
<b>ix) implementation incentives (KM2701 – KM2702)</b>	<b>2</b>
<b>x) asynchronous groupware (3 sub-constructs):</b>	<b>18</b>
a. organisation domain (od01a – od01f)	6
b. group domain (gd01a – gd01i)	8
c. individual domain (id01a – id01c)	3

### 8.1.2 Reliability Analysis

The researcher performs a reliability analysis on the items/variables of the instrument, using Cronbach's alpha to ensure that the items/variables measured the hypothesized underlying themes of the construct. The procedure followed in this researcher is documented in chapter 7, section 7.2.1. The overall reliability coefficient (Cronbach's alpha) for all 80, (80 of 121) items of the instrument was 0.587 for Cronbach's Alpha, and 0.697 for the Cronbach's alpha based on standardised items. One presents the results of the output in Table E.2. This is reasonably high, and points to the reliability of the instrument to measure KM practices and strategies from a unidimensional perspective. As discussed previously in chapter 5, this level of reliability, 0.60, is reasonably reliability for this type of research ([Suhr, 1999], and [Nunnally, 1978:191])

Because of this, one decides on investigating the factor structure of the hypothesized constructs by performing a factor analysis on the data set.

## 8.2 Factor Structure

In running this procedure, the researcher uses the same procedures which was followed in chapter 7, for determining the number of factors to extract. The factor analytic procedure is dependent on meeting four common criteria [Suhr, 1999]. These are:

- a) the eigenvalue-one criterion,
- b) the scree test,
- c) the proportion of variance accounted for, and
- d) the interpretability criterion.

The researcher discussed these previously in chapter 7 [cf. 7.2.2]. One used these criteria to extract components/ or common factors, which one shall used in the rest of this chapter. One shall use these retained factors in the application of the non-parametric statistics for hypotheses 3 and 4, the Levene's test of equality, and the confirmatory factor analysis, which shall be considered in Chapter 9, in this research.

The researcher now reports on each of these separately, as was done in Chapter 6. After which the findings and analyses are presented, using univariate and bivariate analyses on each retained factor. The researcher then proceeds to test Hypotheses 3 and 4, using Spearman's Rank coefficient ( $\rho$ ) at the significant level of ( $\alpha$ ) 0.05. The objective of this is to validate the results of these two hypotheses in Chapter 6. The researcher used the principal component procedure as was done in Chapter 6, and retained five factors. Table E.3., shows the output [cf. E.3 Factor analysis – Output].

### 8.2.1 Principal Component

**1. The eigenvalue-one criterion** The principal components analysis results were analysed using the same procedures as was done in Chapter 7. In this analysis, one initially retained 27 components, using the eigenvalue – one criterion [Kaiser, 1960]. This was presented in Table E3.3 -Total Variance Explained.

Table 8.1: Communalities – Learning

INDIVIDUAL INFLUENCE	1.000	.784
INFORMATION ACCESS	1.000	.786
DURATION	1.000	.807
COST	1.000	.791
EFFECTIVENESS	1.000	.876
SATISFACTION	1.000	.917
COMMITMENT TO GROUP PROPOSALS	1.000	.947
LEARNING	1.000	.942

Extraction Method: Principal component Analysis. Extracted from Table E3.2

The researcher found that the communalities for this survey were reasonably high. This therefore support our reason for using the eigenvalue-one criterion, as an initial test for determining the number of factors to retain. Stevens (1986) recommends the eigenvalue-one criterion for observation over 250 where the mean communality is greater than or equal to .060. This view is supported by the output in Table 8.1 and Table E3.2 – Communalities, where the communalities for Factor 1, average communality is greater than 0.65. Thus satisfying the requirement recommended by Stevens (1986).

The eigenvalue-one criterion, in this case would cause one to retain too many components, 27 instead of 5. The researcher shows the eigenvalue Table in Table 8.2 – Total Variance explained: Initial eigenvalues, for the first 27 components. These are also illustrated in Table E3.3 - Total Variance Explained. These 27 components all have eigenvalue greater than 1.000, thus the reason for retaining them for further analysis based on the criterion decision rule. One is however, a bit concerned that although the eigenvalue-one criterion gives us 27 components with eigenvalues greater than 1, and where the 27th component has an eigenvalue of 1.00, the 28th component has an eigenvalue of 0.972. One is not able, therefore to use the eigenvalue-one criterion with the same confidence, as one did in Chapter 6. Nevertheless, one presents the other results of total variance explained from Table E 3.3 in Tables 8.2 to 8.4 for further consideration. The researcher presents the results of the total variance explained, in Table 8.2.

The concept of the total variance explained, Table 8.2, is that the initial solution is actually that of the 27 principal components. The researcher notices that these 27 components, Table 8.2 accounts for approximately 7.232% of the variability of the original 80 variables, which were analysed. These eigenvalues, which is illustrated in the total column of Table 8.2, is the eigenvalues for the multivariate space of the original variables. These are ordered by size. One also plotted them in the scree plot, in Figure 8.1.

Table 8.2: Total variance explained: initial eigenvalues

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	8.331	10.413	10.413
2	5.447	6.809	17.223
3	3.828	4.785	22.007
4	3.332	4.164	26.172
5	3.050	3.813	29.984
6	2.593	3.241	33.226
7	2.364	2.955	36.180
8	2.306	2.883	39.063
9	2.280	2.850	41.914
10	2.101	2.626	44.539
11	2.004	2.504	47.044
12	1.918	2.398	49.442
13	1.798	2.247	51.689
14	1.755	2.194	53.883
15	1.685	2.107	55.990
16	1.615	2.018	58.008
17	1.494	1.868	59.876
18	1.458	1.822	61.698
19	1.407	1.759	63.456
20	1.378	1.723	65.179
21	1.310	1.638	66.817
22	1.234	1.542	68.359
23	1.183	1.479	69.838
24	1.154	1.442	71.280
25	1.096	1.370	72.650
26	1.059	1.324	73.974
27	1.007	1.258	75.232

Extraction Method: Principal component Analysis. Extracted from Table E3.2

Table 8.3: Extraction Sums of Squared Loadings

Component	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	8.331	10.413	10.413
2	5.447	6.809	17.223
3	3.828	4.785	22.007
4	3.332	4.164	26.172
5	3.050	3.813	29.984
6	2.593	3.241	33.226
7	2.364	2.955	36.180
8	2.306	2.883	39.063
9	2.280	2.850	41.914
10	2.101	2.626	44.539
11	2.004	2.504	47.044
12	1.918	2.398	49.442
13	1.798	2.247	51.689
14	1.755	2.194	53.883
15	1.685	2.107	55.990
16	1.615	2.018	58.008
17	1.494	1.868	59.876
18	1.458	1.822	61.698
19	1.407	1.759	63.456
20	1.378	1.723	65.179
21	1.310	1.638	66.817
22	1.234	1.542	68.359
23	1.183	1.479	69.838
24	1.154	1.442	71.280
25	1.096	1.370	72.650
26	1.059	1.324	73.974
27	1.007	1.258	75.232

Extraction Method: Principal component Analysis. Extracted from Table E3.2



Table 8.4: Rotation Sums of Squared Loadings

Component	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	6.538	8.172	8.172
2	4.585	5.731	13.903
3	3.026	3.782	17.685
4	2.835	3.544	21.229
5	2.437	3.046	24.274
6	2.196	2.745	27.019
7	2.150	2.688	29.707
8	2.099	2.624	32.331
9	2.067	2.584	34.915
10	2.060	2.575	37.490
11	2.043	2.554	40.043
12	2.010	2.512	42.555
13	1.919	2.398	44.954
14	1.890	2.362	47.316
15	1.884	2.354	49.670
16	1.864	2.330	52.000
17	1.851	2.314	54.313
18	1.831	2.288	56.602
19	1.749	2.187	58.788
20	1.738	2.172	60.961
21	1.737	2.171	63.131
22	1.719	2.149	65.280
23	1.711	2.139	67.419
24	1.595	1.993	69.412
25	1.561	1.951	71.364
26	1.558	1.948	73.312
27	1.536	1.920	75.232

Extraction Method: Principal Component Analysis. Extracted from Table E3.3

Table 8.3 shows the extracted components. They explain 75.232% of the variability in the original 80 variables, so one can considerably reduce the complexity of the data set by using these 27 components, with only an 24.768% loss of information. This is rather high. The researcher shall examine these results later in this chapter. In Table 8.4, the rotation maintains the cumulative percentage of variation explained by the extracted components, but that variation is now spread more evenly over the 27 components. The large changes in the individual totals suggest that the rotated component matrix will be easier to interpret than the unrotated matrix.

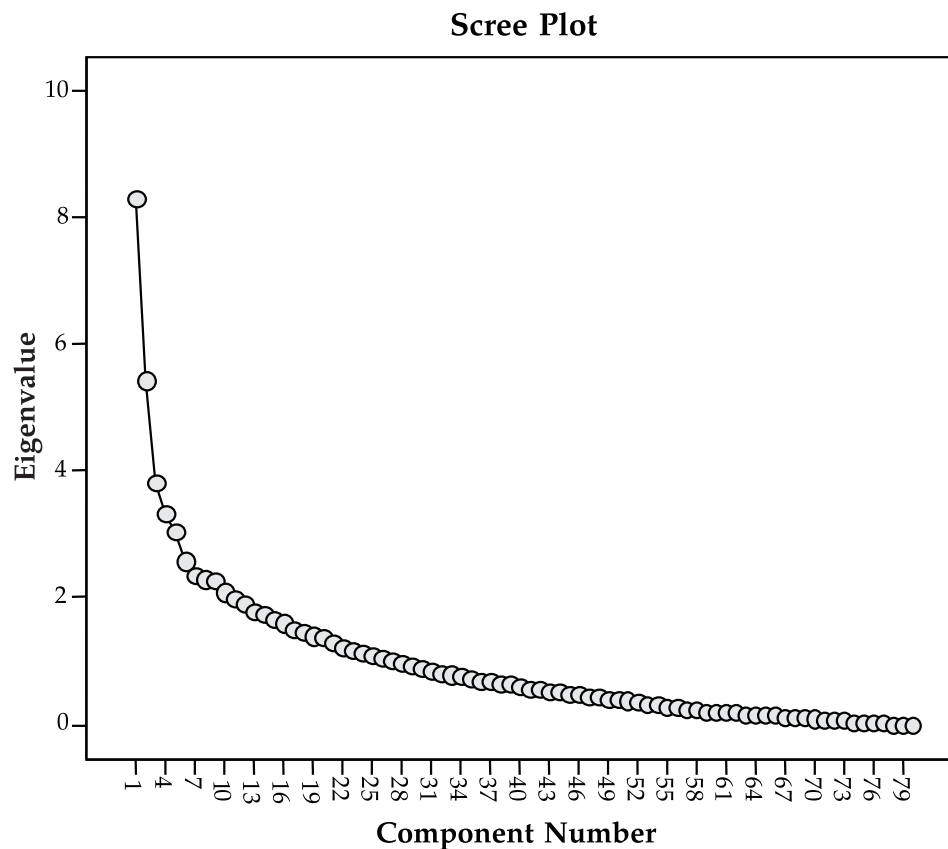


Figure 8.1: Scree plot of KM practices

**2. Scree Plot** With the scree test [Cattell, 1966], one plotted the eigenvalues listed in Table 8.2 against their order (or associated component), and look for a “break” between the components with relatively large eigenvalues and those with small eigenvalues. The components that appear before the break are assumed to be meaningful and are retained for rotation; those appearing after the break are assumed to be unimportant and are not retained, see Figure 8.1. As was done in Chapter 7, one uses the display of the curve to identify a useful number of factors to retain by looking for large values that separate well from the smaller eigenvalues. The scree plot in Figure 8.1, shows that one may safely, retain the five factors, which is significantly different

from the number of components identified in Table 8.2. The study discusses the basic criteria for retaining factors using the eigenvalue-one criterion previously.

Hatcher (1996) recommends that one should retain only those components that appear before the last “big” breaks, for further analysis. This is the case between components 5 and 6. One is not faced with the dilemma of multiple breaks, in this research as illustrated in the scree plot, in Figure 8.1. In this plot, one can see that there are relatively large breaks between component 1 and 2, component 2 and 3, and component 3 and 4. The breaks between component 4 and 5 is, however, small, but distinct. While, the breaks between component 5 and 6, is indeterminate, and may be considered negligible, along with the breaks between components 6 and 27. The researcher regards these as trivial for the purposes of determining a factor structure.

The results extracted from the rotated component matrix [cf. E.3.4 (1) Rotated Component Matrix (a)] are illustrated in Tables 8.5 to Table 8.9, support our decision.

The breaks in the scree plot in Figure 7.2 are for components 1, 2, 3, 4 and 5 are reasonably obvious. However, components 6 and 14 gave the researcher some initial concerns, thus causing one to resort to other methods to resolve whether they should be retained. These methods shall be discussed later, when one examines the other two criteria, namely “the proportion of variance accounted for criterion”, and “the interpretability criterion”.

**3. Proportion of variance accounted for** A third criterion in deciding on the number of factors to retain involves retaining a component if it accounts for a specified proportion (or percentage) of variance in the data set. In this criterion to this is to retain enough components so that the cumulative percent of variance accounted for is equal to some agreed minimal value. For this part of the research, components 1, 2, 3, 4 and 5 accounted for approximately 10.413%, 6.809%, 4.785%, 4.164% and 3.813% of the variance, respectively. The sum of these percentages is 29.984%. This means that the cumulative percent of variance accounted for by components 1, 2, 3, 4 and 5 is 29.984%, while it is 75.232% for the first 27 components, using the eigenvalues greater 1 criterion, as discussed previously (see Table 7.2). In general, when researchers use the “cumulative percent of variance accounted for”, as the criterion for solving “the number of components retained”, they usually retain enough components so that the cumulative percent of variance accounted for at least 70% (and sometimes 80%). This would seem to be validated by our decision to retain only five components. While, it may be argued that the proportion of

variance criterion is acceptable in certain situation, its use is rather arbitrary. Kim and Mueller (1986) has criticised its use as being subjective. In this study, the researcher shares this view, given the results from the exploratory survey of chapter 6.

**4. The interpretability criteria** One of the most widely used criterion for solving the “number-of-components” problem is the interpretability criterion (Hatcher, 2002:26-27): He proffers the following four rules to do this:

- (i) Are there at least three variables (items) with significant loadings on each retained component? In Table 8.5 one sees that component 1, has 8 of the 80 variables under consideration. While in Table 8.6 component 2, has 12 variables. In Table 8.7, component 3 has 5 variables. In Table 8.8, component 4 has 4 variables. Component 5, from Table 8.9, has 3 variables represented.
- (ii) Do the variables that load on a given component share the same conceptual meaning? This is the case of component 1, which seems to be measuring the organisational learning (ol) construct. One illustrates this in Table 8.5. Component 2, on the other hand, in Table 8.6, seems to be measuring the structural capital infrastructure of the firm with 13 uniquely loaded variables. Table 8.7 represents component 3, and measures the asynchronous groupware (AG) infrastructure construct, with 5 uniquely loaded variables. Human knowledge/capital (HK) is uniquely measured in Table 8.8, component 4 with 4 variables. Component 5 has 3 variables, which is uniquely measuring the business intelligence (BI) construct, in Table 7.13.
- (iii) Do the variables that load on different components seem to be measuring different components? The five retained components in this part of the research have variables that are conceptually different constructs. This is the case in Tables 8.5 – Tables 8.9, as explained above in (ii).
- (iv) Does the rotated factor pattern demonstrate “simple structure”? Simple structure means that the pattern possesses two characteristics: (a) Most of the variables have relatively high factor loadings on only one component, and near zero loadings on the other components, and (b) most components have relatively high factor loadings for some variables, and near-zero loadings for the remaining variables. The researcher found simple structure in this part of the research, as is evidenced by the five factors, which are retained.

These factors are now illustrated below in Tables 8.5 to 8.7.

Table 8.5: Learning

Components	Factor 1	Loading
ID01B	COMMITMENT TO GROUP PROPOSALS	.928
ID01C	LEARNING	.926
GD01C	EFFECTIVENESS	.906
IID01A	SATISFACTION	.882
GD01H	COST	.803
GD01E	INDIVIDUAL INFLUENCE	.789
GD01F	INFORMATION ACCESS	.783
GD01G	DURATION	.773

Extraction Method: Principal Component Analysis.

Extracted from Table E3.3

These five factors exhibit simple structure against the criteria established in chapter 7. The five factors are:

- Organisational learning
- Structural capital
- Asynchronous groupware
- Human knowledge
- Business intelligence

Table 8.6: Structural Capital

Components	Factor 2	Loading
KM1003	POLICIES FOR WORKER RETENTION	.824
KM2108	INCREASE ADAPTATION OF PRODUCTS	.689
OD01B	KNOWLEDGE and INFORMATION SHARING	.554
KM2105	INCREASED NUMBER OF MARKETS	.539
KM1015	PROVIDES FORMAL TRAINING	-.459
KM2010	PROTECT STRATEGIC KNOWLEDGE	.457
KM2107	ADD NEW PRODUCTS OR SERVICES	.424
KM2008	ACCEPTANCE OF INNOVATIONS	.349
KM1009	MONETARY INCENTIVES	.407
KM2003	CAPTURE AND USE OF KNOWLEDGE	
KM2001	COMPETITIVE ADVANTAGE	.316
KM2301	MEASUREMENT OF KM EFFECTIVENESS	-1.341
KM2110	PREVENT DUPLICATION	.314

Extraction Method: Principal Component Analysis. Extracted from Table E3.4

One shall then subject these factors to a CFA with PROC CALIS, a SAS procedure for structural equation. This one shall consider in Chapter 9.

The findings and analyses of the KMP Survey are presented next. In this study one starts by giving an overview of the six most common practices, which were found to be in use by the surveyed firms. These are presented in Tables 8.10 to 8.18.

Table 8.7: Asynchronous Groupware

Components	Factor 3	Loading
KM2011	EASE COLLABORATIVE WORK	.788
KM2113	CAPTURE KNOWLEDGE FROM BUSINESS ENTERPRISES	.579
KM2112	CAPTURE KNOWLEDGE FROM PUBLIC INSTITUTIONS	.389
KM2101	HORIZONTAL KNOWLEDGE SHARING	-.388
KM2114	INVOLVEMENT OF WORKERS	.323

Extraction Method: Principal Component Analysis. Extracted from Table E3.4

Table 8.8: Human Knowledge

Components	Factor 4	Loading
KM1020	OFF-SITE TRAINING TO KEEP SKILLS CURRENT	.725
KM1019	REIMBURSEMENT OF EDUCATION FEES	-.454
KM1013	RESOURCES FOR DETECTING KNOWLEDGE	.420
KM2003	CAPTURE and USE OF KNOWLEDGE	-.345

Extraction Method: Principal Component Analysis. Extracted from Table E3.4

Table 8.9: Business Intelligence

Components	Factor 5	Loading
GD01B	PROCESS ADOPTION	.755
KM2006	PROTECTION FROM LOSS OF KNOWLEDGE	.384
KM2002	INTEGRATION OF KNOWLEDGE	.314

Extraction Method: Principal Component Analysis. Extracted from Table E3.4

## 8.3 KM Practices and Strategies

### 8.3.1 The most popular KM practices

The users of KM practices in the selected sub-sector indicated that almost every firm (94%) looked to its knowledge officers or KM unit to be responsible for providing KM leadership. For just 29% of knowledge officers or KM units this was a recently adopted practice.

Firms also show their inclination towards capturing and using knowledge by the participation of

their employees in project teams with external experts (91%). There is also a strong inclination to use knowledge from formal knowledge repositories, such as public institutions, universities and government sources (68%).

Every firm in the sub-sector using at least one KM practice actively captured and used knowledge obtained from other industry sources such as industrial associations, competitors, clients and suppliers. Respondents reported this at 57%.

The two next most popular KM practices in use fell under training and mentoring. This form of practices indicates how firms develop, transfer and retain the knowledge of their workers. Training and mentoring practices included formal and informal training that encouraged the development of new knowledge or skills in workers as well as the transfer of work experiences between new and experienced workers ([Dixon, 2000]; [Cross and Israelit, 2000]; and [Baird, Deacon and Holland, 2000]). While some of these practices, such as apprenticeships, have been used for hundreds of years, their continued use emphasises the importance of transferring and sharing knowledge in the workplace. Not all workplace skills can be put down in writing (codified) and distributed through documentation [Denning, 2001]. Some skills and knowledge are shared and transferred through practical application or “doing”. At most 61% of firms encouraged experienced workers to transfer their knowledge to new or less experienced workers. This it would seem is a policy that is increasing since nearly 21% of firms adopted it since 1999. The provision of informal training on KM practices was also widespread – over 85% of firms reported using it. The high proportion of recent adopters of this practice (24%) perhaps indicates a recent rising awareness of KM practices by firms in the sub-sector.

The researcher then examined those KM practices which were least used by the sampled firms.

### 8.3.2 The least used KM practices

One found that there are three broad categories where KM practices were not predominately used. These are the policies and strategies oriented categories, incentives for using and promoting the use of KM practices, and the presence of infrastructure for documenting, transferring and communicating KM practices throughout the organisation, and between different levels and types of artefacts.

Collaborative work on project teams that were physically separated (virtual teams), and the

Table 8.10: The most popular KM practices

<b>Current state of knowledge management I</b>	<b>In Use %</b>	<b>In Use Since 1999 %</b>
<b>Leadership</b>		
Knowledge management practices were a responsibility of the knowledge officer or knowledge management unit	94	29
Knowledge management practices were a responsibility of non-management Workers	77	39
Knowledge management practices were explicit criteria for assessing worker Performance	70	35
Knowledge management practices were a responsibility of managers and Executives	50	31
<b>Knowledge Capture and Acquisition</b>		
Firm encouraged workers to participate in project teams with external experts	91	28
Firm dedicated resources to detecting and obtaining external knowledge and communicating it within the firm	84	47
Firm captured and used knowledge obtained from public research institutions including universities and government laboratories	68	43
Firm captured and used knowledge obtained from other industry sources such as industrial associations, competitors, clients and suppliers	57	32
<b>Training and Mentoring</b>		
Firm encouraged workers to continue their education by reimbursing tuition fees for successfully completed work-related courses	86	26
Firm provided informal training related to knowledge management	85	24
Firm used formal mentoring practices, including apprenticeships	76	66
Firm encouraged experienced workers to transfer their knowledge to new or less experienced workers	61	21
Firm provided formal training related to knowledge management practices	46	27
Firm offered off-site training to workers in order to keep skills current	29	10



preparation of written documentation such as lessons learned, training manuals, good work practices, articles for publication, etc (organisational memory) were the least popular KM practices being used by firms in this survey, both being at 27%. These practices, however, seemed to be changing as over 8% and 7% respectively of early adopters have started to use these practices since 1999.

The second least popular practice for knowledge sharing and transfer was off-site training to workers in order to keep skills current (29%). The adoption rate of 10% is also very low. This may be due to the practice where firms encouraged their employees to continue their training and skills development by reimbursing them (86%), and with an adoption rate of 26%.

Table 8.11: The least used KM practices

Current state of knowledge management	In Use %	In Use Since 1999 %
<b>Policies and Strategies</b>		
Policies or programs intended to improve worker retention	73	21
Values system or culture intended to promote knowledge sharing	63	32
Written knowledge management policy or strategy	63	21
Used partnerships or strategic alliances to acquire knowledge	61	45
<b>Incentives</b>		
Knowledge sharing was rewarded with monetary incentives	64	35
Knowledge sharing was rewarded with non-monetary incentives	43	27
<b>Communications</b>		
Workers shared knowledge by regularly updating databases of good work practices, lessons learned or listings of experts	52	18
Workers shared knowledge in collaborative work by project teams that are physically separated (virtual teams)	27	8
Workers shared knowledge by preparing written documentation such as lessons learned, training manuals, good work practices, articles for publication, etc. (organisational memory)	27	7

### 8.3.3 Firms are turning to communications practices

Having and requiring good documentation and making these materials available is recognised as being vital to maintaining high quality work standards [Field, 2001]. Accessing the lessons learned by others as well as good work practices helps to prevent firms from repeating errors while allowing new project teams to build on the work of their predecessors [Dixon, 2000; Baird, Deacon and Holland, 2000]. As the results indicate, in 27% of firms workers prepared written documentation such as lessons learned, training manuals, and good work practices.

These activities taken together assist firms in developing their organisational memory. For almost 7% of firms that are developing their organisational memories through documentation (or codification of knowledge) this was a new practice. In addition, nearly 40% of users not already codifying their knowledge indicated that they intended to put the practice in place in the next 24 months.

Updating databases of good work practices, lessons learned or listings of experts is another method of creating organisational memory, usually electronically. Over 52% of users indicated their use of updating databases. Suggesting a growing interest in this type of practice, for over 18% of the firms that updated databases of good work practices recently introduced this practice. These results coincide with the proposed by Probst and Romhardt (1999). Their model describes a practice -oriented approach, which is illustrated in Figure 8.2.

On the operational level, the model consists of the six core processes. These are knowledge identification, knowledge acquisition, knowledge transfer, knowledge use, and knowledge retention. These core processes of KM practices are sequentially related, and informed the development of a global organisational-wide KM programme. At this level, the operational core processes are embedded in a co-ordinating framework, which includes two of the major processes of KM practices. These are the definition of the knowledge practices and the evaluation of these practices. In general, the model, Figure 7.1, represents the traditional management processes with the underlying objective of KM practices conversion and measurement. Given this approach, one is able then, to differentiate between three broad areas of KM practices. These are:

- normative knowledge practices,
- strategic knowledge practices, and
- operative knowledge practices.

The normative knowledge practices deals with the enterprise structure. Strategic knowledge practices determine the state and context of knowledge within the individual areas of an organisation for its future success and competitive advantage. The operational knowledge practices also deals with the strategies specifications of these practices within the context of KM.

In the first core processes, knowledge identification, an inventory is made both internally and externally of knowledge resources of all kinds of knowledge bases, from database to knowledge

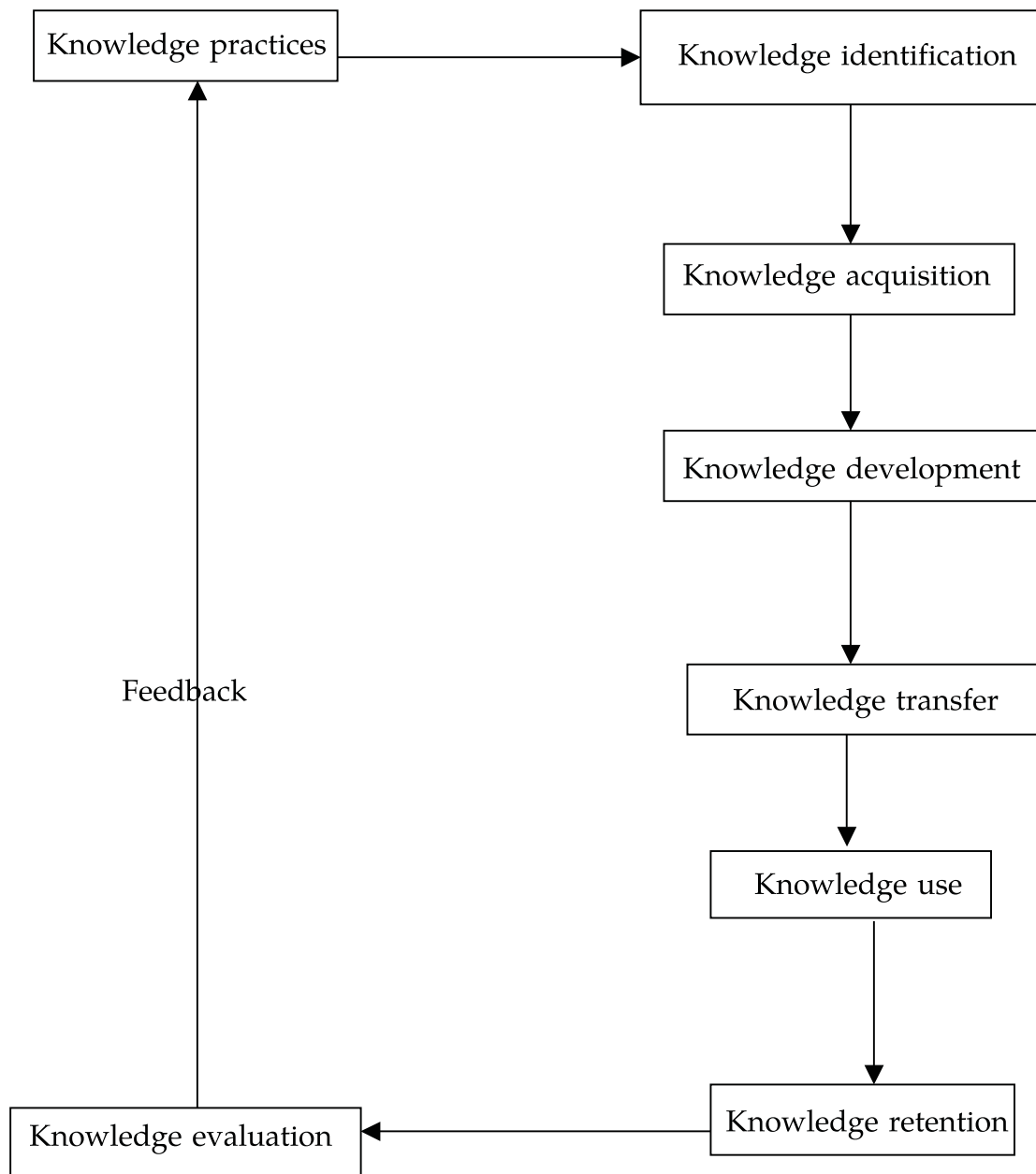


Figure 8.2: Building blocks of knowledge managements [Adapted from Probst et al., 1999]

experts and brokers. In this context knowledge maps are usually of much assistance.

The next process is knowledge acquisition. There are four different types of knowledge acquisition in organisations. The acquisition of other companies can exist through co-operation or in complete transfer of merger of the organisation concerned. The acquisition of both formal and informal knowledge can be through the integration of customers' information and needs in the development process. The recruitment of specialists, knowledge brokers and intellectual capital resources, sometimes only for a temporary or contractual period, falls under the acquisition of external knowledge bases products are similar to the acquisition of knowledge expertise and abilities.

Knowledge development plays two important roles in the organisation. On the one hand it deals with creativity and problem-solving, whilst on the other hand it is the catalyst for harvesting and growing knowledge throughout the organisation. It facilitates collaboration and building of community of practice. As such it provides the mechanism for greater group communication, thus fostering knowledge sharing and knowledge transfer.

Meaningful knowledge transfer is not just making knowledge and organisational information accessible. This at times can prove to be even counter productive. What is required is a structured framework for transferring knowledge. The prerequisite is that one needs to know the requirements of the individual users and to spread relevant knowledge directly to them. In this regard, AG, and other flexible IT infrastructure and communication technologies can make invaluable contribution, to the organisation collaborative strategies and practices.

The culture for the productive use of knowledge is encouraged. If knowledge use is not rooted in the psychic of the organisation, then the investment in the knowledge base cannot be justified. In fact over time the data will prove ineffective and unreliable, as users lose faith in the data, the information and subsequently the knowledge. Hence, a system approach is required for the structured availability and use of the knowledge repositories. Knowledge retention is the next process in the model. It deals with the conscious organization of knowledge bases, its timeline includes the future growth and development, its storage and also a mechanism for the regular updating, and security of the organisation knowledge. The selection of knowledge is important, but a balance between the relevance of that knowledge and the cost of implementation and management of the bases must be reached.

The final process that of knowledge evaluation, takes one back to the normative, strategic and operational knowledge practices, which were previously discussed. This process provides a feedback mechanism for the model. It informs the model of any shortcomings, and corrects and suggests process improvements, which can be made, to the knowledge practices and strategies of the firm.

### 8.3.4 Knowledge acquisition always vital

Sharing knowledge and information generated from work within the firm is one method that firms use to manage their knowledge. Another important aspect of managing knowledge is acquiring it from outside of the firm.

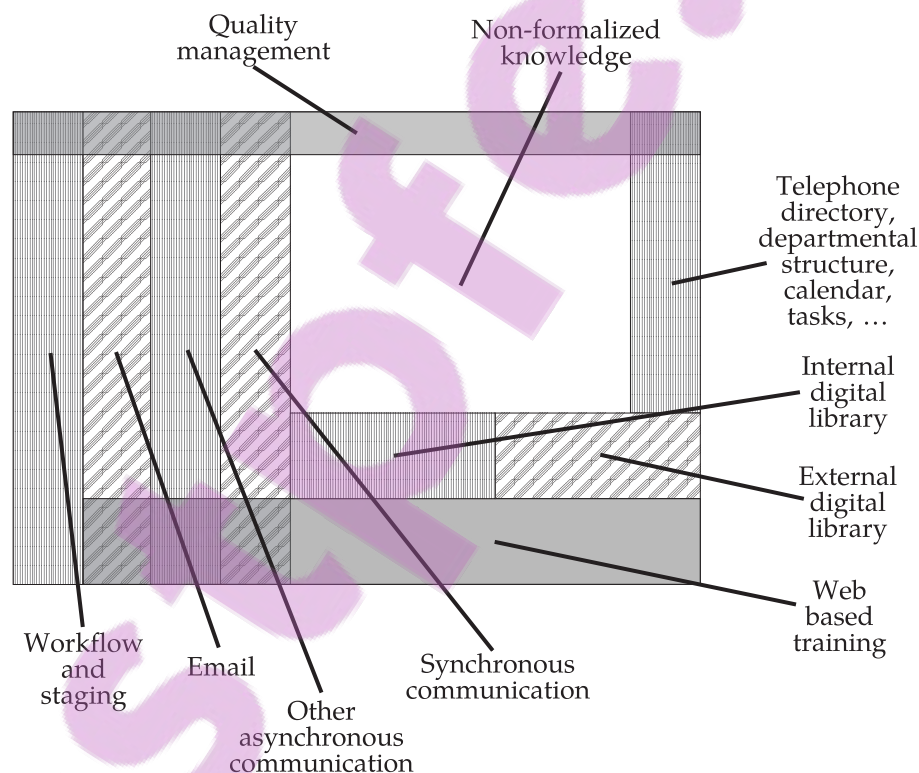


Figure 8.3: Tools of KM [adapted from Mauer (1999)]

This can be done through hiring of new employees, an aspect of KM that was not covered by this Survey, but was addressed in the Exploratory Survey, as well as by capturing knowledge generated elsewhere.

This point was discussed in the previous section, under knowledge acquisition. Obtaining knowl-

edge from public research institutions, dedicating resources to obtaining external knowledge and encouraging workers to participate in project teams with external experts were the most frequently used methods of knowledge acquisition. This represents a usage of 91% and 84% respectively, with early adoption of 28% and 47% respectively.

These results are consistent with the model proposed by Mauer (1999) as they relate to knowledge transfer. The model follows next in Figure 8.3. The Figure illustrates the different processes, from Maurer (1999). The total knowledge of an organization is managed through these tools and knowledge stocks. They include such knowledge and organizational aids as telephone directories and appointment calendars, internal and external digital libraries, web based training, synchronous and asynchronous groupware communication, such as email and workflows and quality management processes.

### 8.3.5 Culture Backed by Policies Important to KM

Firms in the sub-sector generally believed that their corporate cultures or value systems encouraged knowledge sharing and 63% (both practices) had policies or programmes in place that were intended to improve worker retention. – 73% for this practice. Attrition rates for firms' employee turnover are topics of many investigations [Sunter, 2001; Bowlby, 2001; Picot and Dupuy, 1996; and Picot, Heisz and Nakamura, 2001]. Retirement and a seasonal business cycle are some of the natural causes of employee turnover. And for the most part, firms know and plan for their business cycles and employee retirement [Hamdani, 1996]. In a growth, market in which workers with specialised skills are in high demand, attrition rates can be very high. As such, it becomes prohibitive for firms, in a market driven economy [Catt and Scudamore, 1997; and Kaye and Jordon-Evans, 1999]. The results of this Survey indicate that firms in the sub-sector are anticipating the need to formally plan the retention of employees. Worker retention policies could in part reflect the costs to firms associated with new hires ranging from providing basic orientation programs to the time and productivity lost while employees learn how to do their new tasks efficiently.

Using partnerships or strategic alliances specifically to acquire knowledge was a common KM practice for firms with almost 61% participating. Of interest, this high rate may reflect the importance that this strategy played in small to medium size firms.

### 8.3.6 Leadership from Management and Executives

#### Formal KM unit and reward through incentives

As already stated, in most firms, KM practices were the responsibility of everyone, from the KM unit (94%), to the non-management workers (77%) and to managers and executives (50%). The findings also showed that over 70%) of the firms explicitly assessed worker participation in KM as part of their performance reviews. Interestingly, most firms gave both monetary and non-monetary incentives as rewards for knowledge sharing – 64% and 43% respectively.

## 8.4 Reasons Knowledge Management Practices were adopted

The following section looks at the importance users of at least one KM practice attribute to reasons for using KM practices [cf. Table 0 12 Reasons for using KM practices I].

#### Worker retention

Table 8.12: Reasons for using KM practices I

Reasons Knowledge Management Practices Were used – I	1	2	3	4
<b>Worker Retention</b>				
Improve worker retention	31	31	62	56
<b>Protect Strategic Knowledge</b>				
Identify and/or protect strategic knowledge present in firm	21	35	56	44
<b>Competitive Advantage</b>				
Improve competitive advantage of firm	37	13	50	20
<b>Knowledge Sharing</b>				
Promote sharing or transferring knowledge with clients or customers	24	22	46	54
<b>Improve Business Processes</b>				
Increase efficiency by using knowledge to improve production processes	18	22	40	60
<b>Training</b>				
Train workers to meet strategic objectives of the firm	21	15	36	64

1. Critical, 2. Important, 3. Critical or Important, 4. Somewhat or Not at all important

### 8.4.1 Improving Worker Retention

#### **Protect Strategic Knowledge and Competitive Advantage Critical to Firms**

Approximately 62% of all firms reported that improving worker retention was critically important to them. While more than 56% reported that identifying and protecting the strategic knowledge that was present in the firm was critically important to their business. At most 50% of them also asserted that improving the competitive advantage of the firm to be a critical reason to use KM practices; only about 20% of the firms found this reason of little importance. Promoting sharing or transferring of knowledge with clients or customers was reported at 46%, and increasing efficiency by using knowledge to improve production processes was found to be a critical reason to use knowledge management practices at 40%. It was followed closely by training workers to meet strategic objectives of the firm 36%. and ease collaborative work of projects or teams that are physically separated was reported at 35%; integrating knowledge within the firm 14% These findings suggest that firms are employing KM practices strategically to improve their competitive performance and productivity.

### 8.4.2 Improving Workers Skills and Knowledge

#### **KM practice most effective**

KM practices were considered most effective for two human resources-oriented results. These results suggest that knowledge sharing, creation, generation, and maintenance are perceived as important to a firm productivity; its excellent capital and development BI.

The most effective result of using KM practices was improving corporate or organisational memory at 65%. The second most effective result was preventing duplicate research and development at 46% and increasing the adaptation of products or services to client requirements at 46%.

These results suggest that corporate memory, knowledge sharing, creation, generation and maintenance are perceived as important to firm productivity. Knowledge management practices were also very effective or effective at creating a client-oriented firm. Approximately 46% of firms indicated that the KM practices they used were very effective or effective at increasing the adaptation of products or services to client requirements as well as improving client relations.



Table 8.13: Reasons for using KM practices II

<b>Reasons Knowledge Management Practices Were used – II</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>Collaboration</b> Ease collaborative work of projects or teams that are physically separated (i.e. different work sites)	23	12	35	30
<b>Knowledge Capture</b> Improve the capture and use of knowledge from sources outside the firm	14	19	33	67
<b>Knowledge Loss</b> Protect the firm from loss of knowledge due to workers departures	13	18	31	69
<b>Innovation</b> Acceptance Increase worker acceptance of innovations	13	14	27	73
<b>Sharing of Knowledge</b> Improve sharing or transferring of knowledge with partners in strategic alliances, joint ventures or consortia	14	19	20	67
<b>Knowledge Integration</b> Help integrate knowledge within the firm	6	8	14	86

Percentage is calculated for KM practitioners (used at least one KM practice)

1. Critical, 2. Important, 3. Critical or Important, 4. Somewhat or Not at all important

Table 8.14: Effectiveness of results of using KM practices – I

<b>Effectiveness in using Knowledge Management Practices – I</b>	<b>1</b>	<b>2</b>
<b>Corporate Memory</b> Improved corporate or organisational memory	65	35
<b>Duplication</b> Prevented duplicate research and development	46	54
<b>Products and Service adaptation</b> Increased the adaptation of products or services to client requirements	46	54
<b>Knowledge Sharing</b> Increased knowledge sharing vertically (up the organisational Hierarchy)	44	56
<b>Customer Service</b> Improved client or customer relations	44	57
<b>Market Penetration</b> Increased the number of markets (more geographic locations)	39	61
<b>Production and Innovation Flexibility</b> Increased flexibility in production and innovation	38	68

1. Very Effective and Effective, 2. Somewhat Effective and Not at all Effective

### 8.4.3 Increasing Capture of Knowledge from Public Research Institutions

#### **KM practice not very effective**

At most 75% of firms indicated that KM practices were not very effective at increasing the capture of knowledge from public research institutions. This result, however, indicates the low propensity of the firms to capture and use knowledge from public research institutions. When the results are viewed for firms actually capturing knowledge from public research institutions, then the picture changes with 25% of these firms finding the practice either very effective or effective. This indicates that firms could answer these questions for their own set of practices. This could also hold true for the low level of effectiveness for preventing duplicate research and development which is asserted to be 54%.

Some firms may have responded not at all effective due to the fact that they do not undertake research and development. Finally, while knowledge management practices were considered effective for client orientation, they were not considered effective for increasing markets by adding more geographic locations. This was reported as being not effective at 61%. Again this may reflect the nature of the sub-sectors sampled, that firms served local markets or that the firms had not expanded their number of markets.

## 8.5 Asynchronous Groupware

### 8.5.1 Organisation domain

The role that AG play in facilitating the use of KM practices and strategies in organisations is found to be over 51% in reducing inter-level and interdepartmental barriers to communication in KM groups involving members of different departments and levels.

Additionally the results showed that the use of AGT in group-based efforts lead to an increase in the openness in the discussion of weaknesses and opportunities of improvement related to individuals, teams, processes, organisational strategies, and other related factors at over 49%. The same level of usage was also reported for the use of AGT in group-based KM efforts increase the awareness about mission-based organisation's goals and how those goals might be achieved.

Table 8.15: Effectiveness of results of using KM practices – II

<b>Effectiveness in using Knowledge Management Practices – II</b>	<b>1</b>	<b>2</b>
<b>Knowledge Capture</b> Increased the ability to capture knowledge from other business enterprises, industrial associations, technical literature, etc.,	37	63
<b>Aid Development of new products and Services</b> Helped add new products or services	36	57
<b>Development of Skills and Knowledge</b> Improved skills and knowledge of workers	36	64
<b>Improvement of efficiency and/or productivity</b> Improved worker efficiency and/or productivity	35	65
<b>Knowledge Sharing</b> Increased knowledge sharing horizontally (across departments, function or business units)	34	66
<b>Involvement of workers</b> Improved the involvement of workers in the workplace activities	28	73
<b>Knowledge capture</b> Increased the ability to capture knowledge from public research institutions including universities and government laboratories	25	75

Percentage is calculated for KM practitioners (used at least one KM practice)  
 1. Very Effective and Effective, 2. Somewhat Effective and Not at all Effective

### 8.5.2 Group domain

It was reported that, the use of AGT for the group domain, facilitating the inclusion and participation of members from different departments in the KM groups was over 43%.

Also, it was found that the use of AGT makes it faster and easier to access information relevant to the three main phases of a KM group. These were business process definition, analysis, and redesign, and were reported at 41%. Respondents also reported that it leads to the reduction in the costs involved in running these KM groups, and along with assisting KM groups to complete their tasks faster. These were found to be at a large extent for most firms at 38% in both cases.

Additionally, it was found that 36% of the firms reported that the application of synchronous groupware technology, to a very large extent, lead to an increase in the effectiveness of process redesigns proposals generated by KM groups.

Table 8.16: Asynchronous Groupware I – Organisation Domain

<b>Asynchronous Groupware I – Organisation Domain</b>	<b>VL %</b>	<b>ME%</b>	<b>NE%</b>
<b>Decentralisation</b> The use of AGT in group-based KM efforts lead to a decentralisation in improvement initiatives	26	31	44
<b>Knowledge and Information Sharing</b> The use of AGT in group-based KM efforts lead to a n increase in knowledge and information sharing in the organisation	41	11	39
<b>Openness in Discussion</b> The use of AGT in group-based KM efforts lead to an increase in the openness in the discussion of weaknesses and opportunities of improvement related to individuals, teams, processes, organisational strategies, and other related factors	49	8	44
<b>Inter-Level and Interdepartmental Barriers</b> The use of AGT reduce inter-level and interdepartmental barriers to communication in KM groups involving members of different departments and levels	51	17	34
<b>Management support</b> The use of AGT, as a publicly available information repository about the work of KM groups, lead to an increase in the support from management to decentralised improvement and as an acceptance of it as an appropriate behaviour in the organisation	39	42	30
<b>Awareness of organizational goals</b> The use of AGT in group-based KM efforts increase the awareness about mission-based organisation's goals and how those goals might be achieved	49	16	35

VL – Very large/Large Extent ME – Moderate Extent NE – No Clear Evidence/No Evidence

Table 8.17: Asynchronous Groupware II – Group Domain

<b>Asynchronous Groupware II – Group Domain</b>	<b>VL %</b>	<b>ME%</b>	<b>NE%</b>
<b>Facilitation of Information</b> The use of AGT facilitate the use of information generated by former KM groups in a way that improves the efficiency and effectiveness of future groups	23	38	40
<b>Adoption of groupware processes</b> The use of AGT aid KM groups in adopting a pre-defined group process	24	8	68
<b>Suppress Barriers</b> The use of AGT suppress hierarchy barriers to even contribution of ideas among members from different hierarchical levels in KM groups	33	18	49
<b>Participation of Departments</b> The use of AGT facilitate the inclusion and participation of members from different departments in the KM groups	43	18	40
<b>Reduce Imposition of Ideas</b> The use of AGT reduce the likelihood of authoritarian leaders, facilitators or group members, being able to impose their ideas on the KM group	36	21	44
<b>Ease of Access to Information</b> The use of AGT makes it faster and easier to access information relevant to the three main phases of a KM group- business process definition, analysis, and redesign	41	23	36
<b>Assist KM Groups in Tasks</b> The use of AGT assists a KM group to complete its task faster	38	23	40
<b>Reduction in Costs</b> The use of AGT lead to reduction in the costs involved in running KM groups	38	22	40
<b>Effectiveness of Process</b> Design The use of AGTy lead to an increase in the effectiveness of process redesigns proposals generated by KM groups	36	19	46

VL – Very large/Large Extent ME – Moderate Extent NE – No Clear Evidence/No Evidence

### 8.5.3 Individual domain

In the individual domain it was reported that the use of asynchronous groupware technology increase the commitment of KM group members to group proposals; and increasing individual learning about the organisation and its business processes from the participation in KM groups were reported to be use at a very large extent of 38% in both cases.

Table 8.18: Asynchronous Groupware III – Individual Domain

<b>Asynchronous Groupware III – Individual Domain</b>	<b>VL %</b>	<b>ME%</b>	<b>NE%</b>
<b>Satisfaction from Group Interaction</b> The use of AGT increase satisfaction of KM group members as a result of group interaction	18	15	45
<b>Commitments to Group Proposals</b> The use of AGT increase the commitment of KM group members to group proposals	38	19	43
<b>Individual Learning</b> The use of AGT increase individual learning about the organisation and its business processes from the participation in KM groups	38	19	43

VL – Very large/Large Extent ME – Moderate Extent NE – No Clear Evidence/No Evidence

## 8.6 Other statistical tests and analyses

In this research, one computes a composite index for the 5 retained components in Figures 8.7 and 8.9, respectively. One uses the COMPUTE procedure of SPSS for Windows version 12 for this purpose. The syntax code is set out below in Table E.4.1.

The interest, here, is to compute the descriptive statistics for the constructs:

AG – Asynchronous Groupware

SC – Structural Capital

HK – Human Knowledge/Capital

OL – Organisational Learning, and

BI – Business Intelligence.

The study first computes the means, standard deviations, and standard errors of the means, for the sub-domain of AG support dimensions, and the KM projects implementation constructs for the whole sample . The researcher then uses independent T tests to assess whether there were

any significant differences between the mean scores of the AG construct, and the KM strategy constructs (SC). The results are illustrated in Table 8.19.

Table 8.19: Descriptive statistics for composite indices: KM practices

	N	Mean	Std.	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Asynchronous Groupware	121	7.6612	1.97718	.555	.220	-.425	.437
Structural Capital	121	30.7686	5.26428	-.080	.220	-1.124	.437
Organisational Learning	121	28.1901	6.50040	-.936	.220	.108	.437
Business Intelligence	121	6.9504	2.08107	.107	.220	-1.050	.437
Human Knowledge	121	14.0992	1.43994	.556	.220	.204	.437
Valid N (listwise)	121						

The results are indeterminate, and will not be used any further.

For the independent T tests, our interest was to test the AG component against the SC component. The objective was to assess whether there were any significant differences between the mean scores of AGT implementation and KM strategy (SC), for organisations based on their annual turnover. In this case, one assesses the differences between medium-sized firms, medium-sized being those firms with turnover of \$251 – \$1000 million, while large-sized firms are for firm with turnover in excess of \$1001 - \$5000 million.

Table 8.20: Group Statistics for AG and SC

	Turnover	N	Mean	Std. Deviation	Std. Error Mean
Asynchronous Groupware	\$251 – \$1000	26	7.1923	2.05950	.40390
	\$1001 – \$5000	55	7.5273	1.91345	.25801
Structural Capital	\$251 – \$1000	26	29.3077	5.46091	1.07097
	\$1001 – \$5000	55	30.4545	5.39141	.72698

The result here in Table 8.20 is self-explanatory.

Levene's test for equality of variance was used to test for significant differences, at a 0.05 significance level; between the ways, organisations assess the productivity and performance-oriented initiatives attributed to the efforts of task-related outcomes, and those of group-related outcomes in the use of AGT. The tests are indeterminate. The researcher, therefore, did not use the results of the Levene's tests for any further analysis.

The researcher also conducted bivariate analyses on the four constructs of “task-related outcomes”, “group-related outcomes”, “team-related outcomes”, and “OL”. The objective of the

Table 8.21: Independent Samples Tests

Variables		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Asynchronous Groupware	Equal variances assumed	.069	.793	-.718	79	.475	-.33497	.46668	-1.2639	.59393
	Equal variances not assumed			-.699	46.018	.488	-.33497	.47928	-1.2997	.62976
Structural Capital	Equal variances assumed	.000	.984	-.890	79	.376	-1.14685	1.28841	-3.7114	1.41766
	Equal variances not assumed			-.886	48.572	.380	-1.14685	1.29440	-3.7486	1.45493

research is to measure and access the extent of the significance and strength of the relationships as hypothesised in Hypotheses 3 and 4.

The researcher tested the strength of the association between the integration of AGT in the use of these KM practices. In order to do this Kendall's tau b, and Spearman's rho was used. For this purpose the "OL" construct was used as a control variable.

The results of the two hypotheses are presented next. These hypotheses are reproduced from Chapter 7.

### 8.6.1 Hypothesis 3

#### Null hypothesis 3 [ $H_{O3}$ ]:

There is no statistically significant difference between the way organisations assess the productivity and performance-oriented initiatives attributed to the efforts of task-related outcomes, and those of group, in the use of AGT.

In Chapter 6, the researcher showed that Hypothesis 3 relates to the rank order correlation between those productivity and performance-oriented initiatives, which are attributed to the



efforts of task-related outcomes, and those of group-related outcomes, in the use of AGT. The researcher shall test this hypothesis using the composite variables of “task” and “group”, controlling for “OL”, as it relates to KM practices and strategy for the KM practices survey.

- use a two-tailed test;
- $H_o$ : productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AGT are independent;
- $H_1$ : productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AG technology are related;
- the test statistic for Hypothesis 3, will be Kendall’s tau-b,
- at a significance level of  $\alpha = 0.01$ .

The researcher follows the same protocol as was done in Chapter 6, for Hypotheses 3 and 4. The research framework for Hypotheses 3 and 4 are set out in Figures 7.20 and 7.22.

The researcher then created a composite index for each of these variables. In this study the COMPUTE procedure of SPSS was used, similarly to that of Equation 7.4 [cf. Equation 7.4 Composite index for task, group, and team]. The index includes the following variables:

$$\begin{aligned}
 task &= gd01c, gd01e, gd01g, id01a, id01b, id01c \\
 group &= od01a, od01b, od01c, od01d, od01e, od01f \\
 team &= gd01a, gd01b, gd01c, gd01d, gd01e, gd01f, gd01g, gd01h, gd01i
 \end{aligned} \tag{8.1}$$

The researcher flagged the non-parametric pairwise correlation matrix [cf. Table 7.23], using Kendall’s tau-b, with two-tailed, for significant correlation. This is illustrate in Table 7.23. The two variables which are measured are illustrated in this table. They are the composite variables of “task” and “group”, as are illustrated in Equation 8.1. One also uses the Spearman’s rho correlation coefficients to cross validate the results obtained from Kendall’s tau-b.

The correlation matrix, and scatter plots are illustrated next.



Table 8.22: Non-parametric correlation matrix for task and group outcomes

			Task-related outcomes	Group-related outcomes
Kendall's tau-b	Task-related outcomes	Correlation Coefficient	1.000	.003
		Sig. (2-tailed)	.	.96
		N	121	121
	Group-related outcomes	Correlation Coefficient	.003	1.000
		Sig. (2-tailed)	.964	.
		N	121	121
Spearman's rho	Task-related outcomes	Correlation Coefficient	1.000	-.003
		Sig. (2-tailed)	.	.975
		N	121	121
	Group-related outcomes	Correlation Coefficient	-.003	1.000
		Sig. (2-tailed)	.975	.
		N	121	121

The study also presents the scatter plot of the two variables in Figure 8.4 [cf. Figure 8.4 Scatter plot for task and group outcomes], which supports the view that the two variables are independent, for the survey.

From the framework in Figure 7.20, one hypothesises that there is some bivariate relationship between the initiatives and strategies of task outcomes, and those of group outcomes, as they relate to the use of asynchronous groupware technology, in organisations' efforts to improve their productivity and performance. The composite variables used to test this relationship, or to ascertain if there are any significant difference are computed in Equation 8.1. One presents the resulting correlation matrix in Table 8.22. The study found that although the coefficients are all very positive at 0.003 for task and group, using Kendall's tau b. These coefficients have p-values greater than 0.05.

One also found that the Spearman rho returns a weak correlation between the two variables.

One is therefore able to accept the null hypothesis. This is because it points to the proposition that the two variables (task and group outcomes) were indeed independent. This means that the two variables were unrelated, and that there is much difference existing between the efforts of the initiatives that firms use in order to improve their performance and productivity, in the use of AGT, for firms in the KM practices survey. This is different from the results obtained in Chapter 7, of this hypothesis.

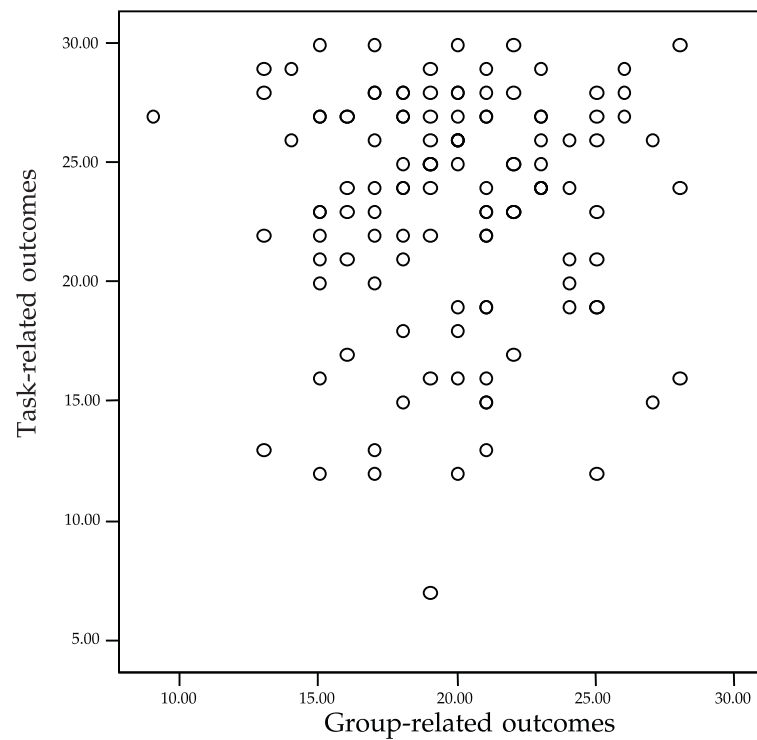


Figure 8.4: Scatter plot for task and group outcomes

### 8.6.2 Hypothesis 4

#### Null hypothesis 4 [ $H_{o4}$ ]:

There are no statistically significant differences between the ways organisations assess the productivity and performance-oriented initiatives attributed to the efforts of the individual in task-related outcomes in their use of AGT, and those of individuals in team-related outcomes.

As was done in Chapter 7, Hypothesis 4 relates to the rank order correlation between those productivity and performance – oriented initiatives. These are attributed to the efforts of the individual in task-related outcomes, and those of individuals in team-related outcomes, in the use of AGT. One shall test this hypothesis using the composite variables of “task” and “team”, controlling for “OL”

- use a two-tailed test;
- $H_o$ : productivity and performance initiatives attributed to the efforts of the individual in task-related outcomes and those of individuals in team-related outcomes in the use of AGT are independent;

- $H_1$ : productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AGT are related;
- the test statistic for Hypothesis 3, will be Kendall's tau b,
- at a significant level of  $\alpha = 0.01$ .

The researcher follows the same protocol of hypothesis 3, and model hypothesis 4 as illustrated in Figure 7.22.

The researcher uses the variables of the composite index created in Equation 8.2 [cf. Equation 8.2 Composite index for task, group, and team]. One flagged the non-parametric pairwise correlation matrix [cf. Table 8.23], using Kendall's tau b, with two-tailed, for significant correlation. The researcher measures two variables in Table 8.23. This is the non-parametric correlation matrix for each of the two variables: task and team outcomes. They are the composite variable of "task" and "group", as illustrated in Equation 7.9 . One also use the Spearman's rho correlation coefficients to cross validate the results obtained from Kendall's tau-b.

The researcher presents the scatter plot of the two variables in Figure 8.5, which supports the view that the two variables exhibit a nearly perfect and positive linear relationship.

From Figure 7.22, one hypothesizes that there is some bivariate relationship between the initiatives and strategies of task outcomes those of team outcomes, as they relate to the use of AGT by individuals in organisations' efforts to improve their productivity and performance. The composite variables used to test this relationship, or to ascertain if there are any significant difference are computed in Equation 7.9. One presents the resulting correlation matrix in Table 8.23, below.

The study found that the coefficients are all very strong, and positive at 0.601 for "task" and "team", using Kendall's tau b. These coefficients have p-values less than 0.001 ( $p < 0.001$ ), and level of significance at 0.01, two tailed.

The statistical significance of this relationship was cross validated with the Spearman's rho correlation. The Spearman's rho correlation coefficient is just as strong and positive at 0.752, as is evidenced in Table 8.23. Its p-value is also less than 0.001 ( $p < 0.001$ ) at a significance level of 0.01 (two-tailed).

Now, one could safely reject the null hypothesis, in the case for hypothesis 4. This is because,

Table 8.23: Non-parametric correlation matrix for task and team outcomes

			Task-related outcomes	Team-related outcomes
Kendall's tau_b	Task-related outcomes	Correlation Coefficient	1.000	.601**
		Sig. (2-tailed)	.	.000
		N	121	121
	Team-related outcomes	Correlation Coefficient	.601**	1.000
		Sig. (2-tailed)	.000	.
		N	121	121
Spearman's rho	Task-related outcomes	Correlation Coefficient	1.000	.752**
		Sig. (2-tailed)	.	.000
		N	121	121
	Team-related outcomes	Correlation Coefficient	.752**	1.000
		Sig. (2-tailed)	.000	.
		N	121	121

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

Table 8.24: Correlation matrix of partial correlation for task and team, controlling for ol

Control Variables			Task-related outcomes	Team-related outcomes	Organisational learning
-none- <sup>a</sup>	Task-related outcomes	Correlation Coefficient	1.000	.843	.946
		Sig. (2-tailed)	.	.000	.000
		df	0	119	119
	Team-related outcomes	Correlation Coefficient	.843	1.000	.817
		Sig. (2-tailed)	.000	.	.000
		df	119	0	119
	Organisational learning	Correlation Coefficient	.946	.817	1.000
		Sig. (2-tailed)	.000	.000	.
		df	119	119	0
Organisational Learning	Task-related outcomes	Correlation Coefficient	1.000	.377	
		Sig. (2-tailed)	.	.000	
		df	0	118	
	Team-related outcomes	Correlation Coefficient	.377	1.000	
		Sig. (2-tailed)	.000	.	
		df	118	0	

(a) Cells contain zero-order (Pearson) correlations.

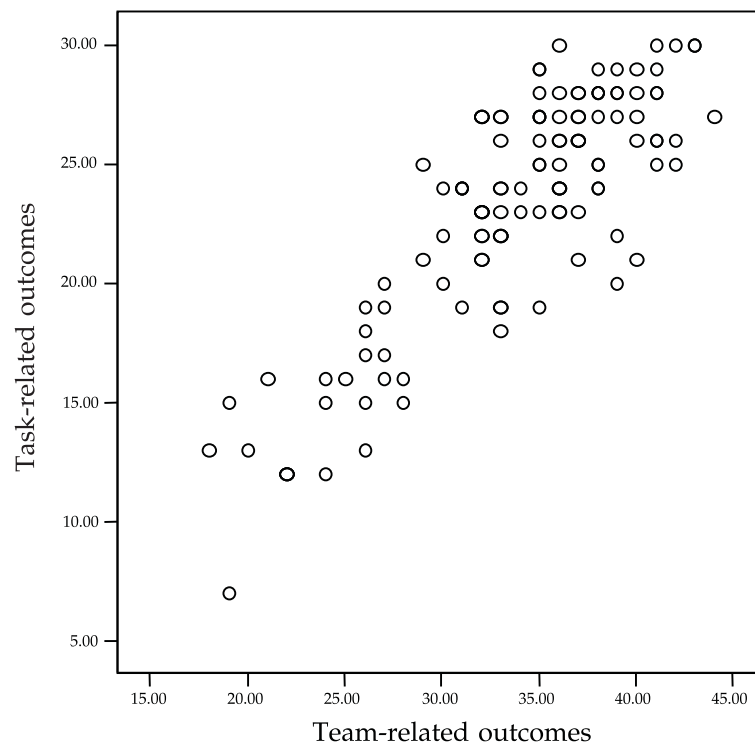


Figure 8.5: Scatter plot of task and team outcomes

it points to the proposition that the two variables (task and team outcomes) were independent. One could then safely accept the alternate hypothesis, which holds that the two variables are related; and that no differences exist between the efforts of the initiatives that firms use in order to improve their performance and productivity, in the use of AGT by individuals. This coincides with the results of the same hypothesis in chapter 7.

Notwithstanding this, the researcher was compelled to explore the underlying relationship of these two variables much further, by controlling for the effects of the variable “OL”. This variable is an index of the 8 manifest variables, which makes up the first factor of the rotated principal components, which one had set out in Table 8.5 [cf. Table 8.5 Learning]

Although there is clear evidence that the three variables “task”, “team” and OL are related, as shown in the upper portion of Table 8.24, where the results of the zero-order correlation between “task” and “OL” are, a strong and positive at 0.946, and statistically significant ( $p < 0.001$ ). In addition, the correlation of coefficients between “team” and “OL”, is very strong and positive at 0.843 with a p-value less than 0.001 ( $p < 0.001$ ), which is statistically significant.

Notwithstanding this, the researcher decides to run the partial correlation for “task” and “team” controlling for “OL”. One uses the partial correlation procedure in computing the partial correla-

tion coefficients. The objective was to describe the linear relationship between the two variables “task” and “team” while controlling for the effects of the “OL” variable.

In this hypothesis, hypothesis 4, the partial correlations table shows both the zero-order correlations (correlations without any control variables) of all three variables and the partial correlation, which is controlling of the first two variables, controlling for the effects of the third variable, as previously explained.

The partial correlation controlling for “organisational learning OL”, is moderately strong and positive, with the correlation coefficient at approximately 0.4 (0.377), and is statistically significant at a p-value less than 0.001, ( $p < 0.001$ ).

One is able to draw the same conclusion as one did in Chapter 6. The main interpretation of this finding is that the observed positive “relationship” between the variables of “task outcomes” and “team outcomes” is due to, a certain degree, the underlying relationship between each of these variables. Also, of relevance is the relationship of “OL” with those variables, in the way organisations assess their productivity and performance-oriented initiatives, which are attributed to the efforts of individuals in task-related outcomes, and those of individuals in team-related, in the use of AGT.

Consequently, removing the effects of the variable, “OL” has not significantly affected the correlation between the variables “task” and “team” in any appreciable degree. This was demonstrated earlier when the zero-order correlation was demonstrated.

### Decision rule

From Table 8.5 one found that there is a very strong and positive relationship between the variables “task” and “team” as evidenced by the Kendall’s tau b correlation coefficient of 0.601 and a p-value less than 0.001 ( $p < 0.001$ ) with a significance level of 0.01 (two-tailed). The statistical significance of this relationship was cross validated with the Spearman’s rho correlation. The Spearman’s rho correlation coefficient is 0.752 as is evidenced in Table 8.23 Its p-value is also less than 0.001 ( $p < 0.001$ ) at a significance level of 0.01 (two-tailed).

The “OL” variable also has a strong and positive relationship with “task” and “team”, respectively. The results in Table 8.24 are relevant.

The evidence seems to suggest that the null hypothesis should be rejected. The null hypothesis states that the productivity and performance initiatives attributed to the efforts of the individual in task-related outcomes and those of individuals in team-related outcomes in the use of AGT are independent.

Thus accepting the alternate hypothesis, and confidently conclude that there is a direct relationship between those productivity and performance initiatives attributed to the efforts of the individual in task-related outcomes and those of individuals in team-related outcomes in the use of AGT, in the sampled organizations.

## 8.7 Summary

This then takes one into exploring how groupware in general and AG, in particular affects KM strategies. This exploration requires an understanding of the nature of the non-positivistic research strategy. Figure 5.4: The research model is relevant.

This will be the subject of Chapter 10, where the Action Research methodology is used in Directorate, a public administration agency in Botswana, to explore the use of knowledge transfer through team-related work in implementing a new computerised personnel management system (CPMS).



## Chapter 9

### Evaluation

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*Whereas at one time the decisive factor of production was the land and later capital ... today, the decisive factor is increasingly man himself, that is, his knowledge.*

*Pope John Paul II (1991), Centesimus Annus.*

#### 9.1 Introduction

In this chapter, the researchers uses the *Calis* procedure in SAS/SAT, version 9.1 (SAS Institute Inc., 2003), to test a combined path model with the hypothesized latent (unobserved) variables, which resulted from the retained components/factors,(cf. Table 9.1) of the EFA procedure, which were discussed in Chapter 7. The study then use these factors as latent variables to test our research measurement model: the KM-BI model, which were discussed in Chapter 2, [cf. Figure 2.1: Model for KM-BI (from Campbell and Pellissier, 2000)], and is reproduced here as Figure 9.1.

#### 9.2 Hypothesized path analytic structure

##### 9.2.1 Assessing the fit between model and data

The study converts the research model into a latent-variable path model to illustrate the theoretical relationships of the extracted factors. This model is presented next in Figure 9.2. The “+” predicts positive casual relationships between the latent factors of F3, F4 and F5 with F2, and F2, F3 and F5 with F1, respectively.

The study analysed the data from Chapter 7, using a number of approaches. The models, which were tested, were covariance structure models with multiple indicators for all latent constructs. Standard deviations and Inter-correlations for the 46 manifest variables, from the retained factors are presented in Table 9.1, and are distilled in Tables 9.2, 9.3, 9.4, 9.5, and 9.6, respectively.

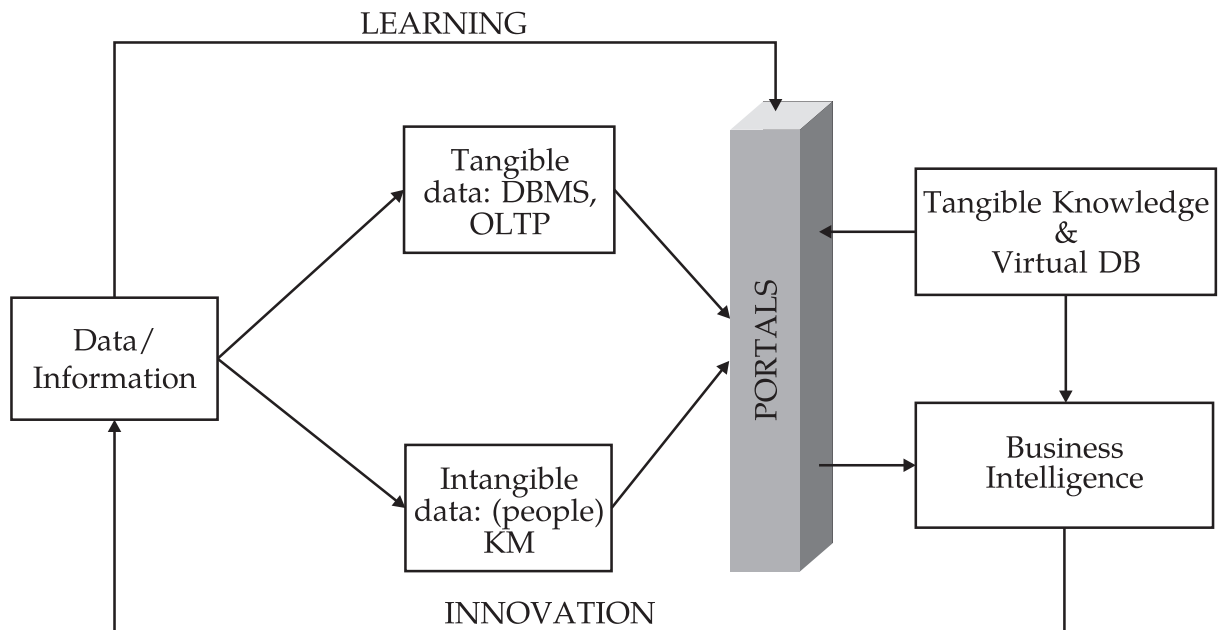


Figure 9.1: Model for KM-BI (from Campbell and Pellissier, 2000), reproduced from Figure 2.1

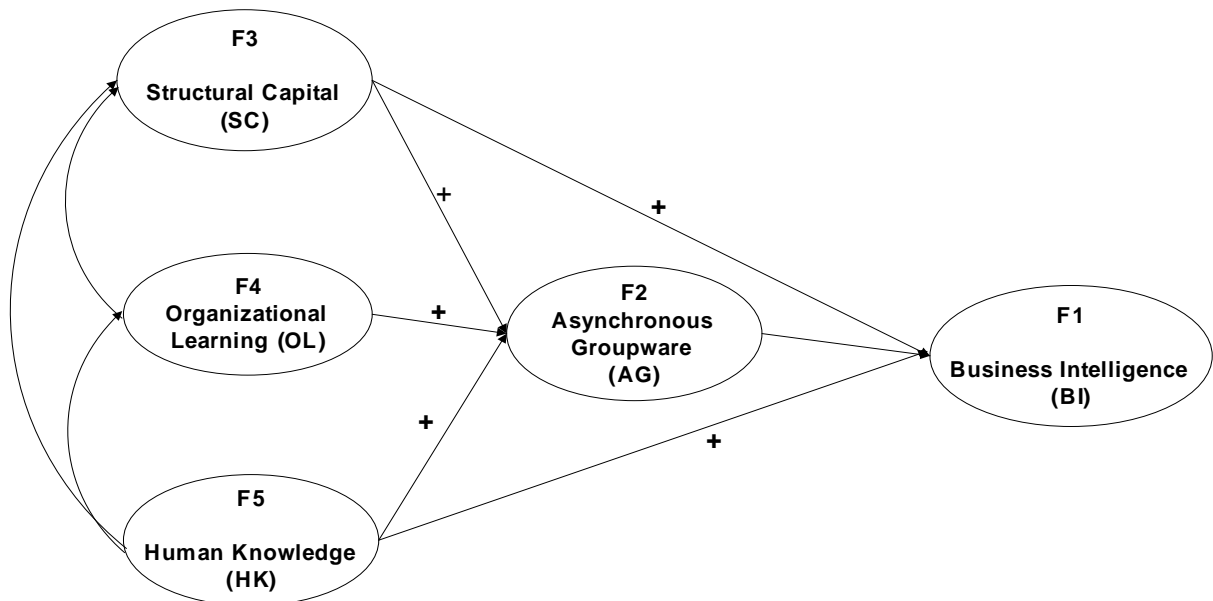


Figure 9.2: The hypothesized theoretical model for KM-BI

Table 9.1: Factors and indicator variables used in KM-BI model

Factors	Latent variables	Indicator (manifest) variables
F1	Business Intelligence (BI)	V43, V44, V53, V54, V58, V63, V64, V68, V71
F2	Asynchronous Groupware (AG)	V16, V17, V41, V55, V76, V77, V81, V82, V84
F3	Structural Capital (SC)	V21, V24, V25, V27
F4	Organisational Learning (OL)	V3, V8, V9-V15, V18, V20, V36, V42, V76, V94
F5	Human Knowledge	V29, V32, V35, V46, V52, V85, V90, V92

The analysis in this chapter followed a three-step procedure based in part on the two-step approach recommended by Anderson and Gerbing (1988). The researcher, however, opted for an additional step, where the exploratory component of the data was used, so as to definitively identify the underlying factors. This was done in the first step, where, the CFA was used, by applying the *Proc Calis* procedure in SAS/SAT version 9.1, as mentioned previously, to test each of the five factors as illustrated next, in Table 9.1.

In step two, CFA was used to develop a measurement model that demonstrated an acceptable fit to the data. In step three, the measurement model was modified so that it came to represent the theoretical (causal) model of interest. This theoretical model was then tested and revised – the structural model, until a theoretically meaningful and statistically acceptable model was found.

The Cronbach Coefficient Alpha, both the raw and the standardized indices for the five factors, was computed [cf. Appendix C]. Hatcher (2002:137) states that it is important to assess a multiple-scale reliability to see how to improve the data analysis and the conclusions from the research. This view leads us to accept Sekaran's assertion [Sekaran, 1992:173] that ... *the reliability of a measure indicates the stability and consistency with which the instrument is measuring the concept and helps to assess the goodness of the data* (Sekaran, 1992:173]. A reliability coefficient indicates the variance in an observed variable accounted for by true scores given by participants in a study – it therefore excludes the measurement error associated with the score [Hatcher, 2002]. An instrument is said to be reliable when it provides consistent scores with repeated administration and with administration by alternate forms [Hatcher, 2002].

The following two tests can be used to determine scale reliability:

- the test-retest reliability, and
- internal consistency reliability [Hatcher, 2002].

The first test is usually impractical due to time constraints. Cronbach's alpha reliability coefficient is used for multipoint scaled items (as used in this research) and measures the consistency with which the respondents answer all the items in a measure – it is also known as the internal consistency reliability of a scale (Hatcher, 2002). *Internal consistency is the extent to which the individual items that constitute a test correlate with one another or with the test total* (Hatcher 1994:132). The formula, Equation 9.1 for Cronbach's coefficient alpha is used for this purpose.

$$r_{xx} = \left( \frac{N}{N-1} \right) \left( \frac{S^2 - \sum S_i^2}{S^2} \right) \quad (9.1)$$

where:

$r_{xx}$  = Cronbach's coefficient alpha,

$N$  = number of items constituting the instrument,

$S$  = sum of the scale score,

$S^2$  = variance of the summated scale scores, and

$\sum S_i^2$  = the sum of the variances of the individual items that constitute this scale.

Cronbach (1951:331) states that *an estimates, is a lower bound to, the proportion of test variance attributable to common factors among the items.*

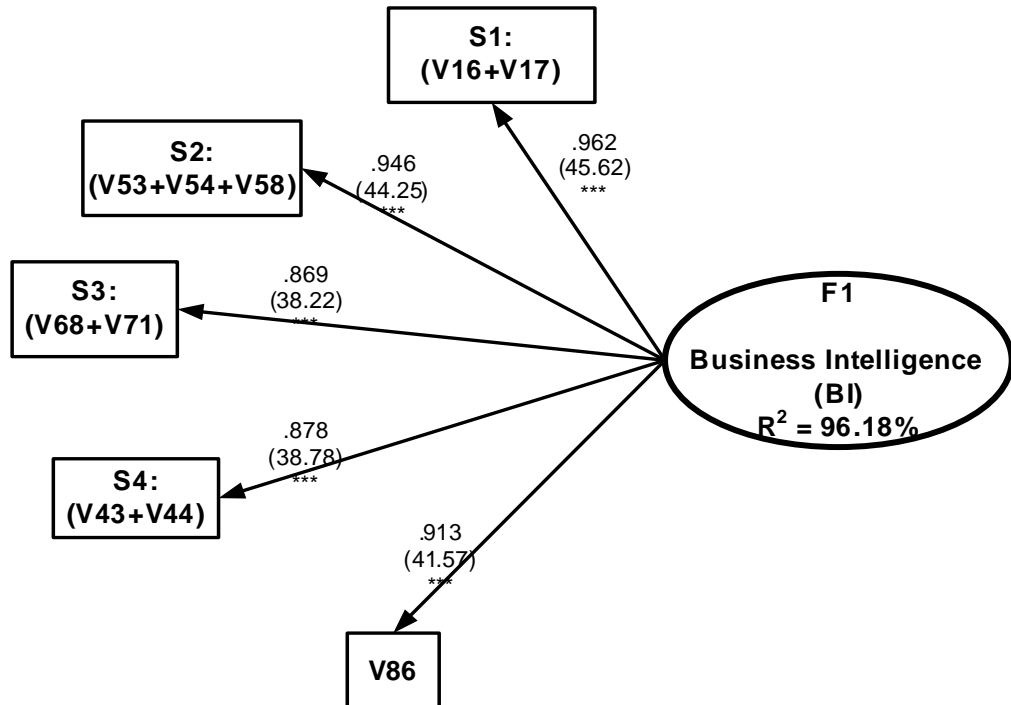
These indices were found to be very reliable, and consistent with the measures of the hypothesized factors. They are set out next.

$$Raw = 0.959283 \quad Standardized = 0.959966$$

### 9.2.2 The Initial CFA Factor Structure: F1 (BI)

The researcher then tested this factor for good fit and found the results, presented in Table 9.2.

There is no near zero standard error for this construct.



Note: top number is factor loading (path), t-values are in brackets, \*\*\* significant at  $p$ -value  $< 0.0001$ .

Figure 9.3: Factor 1 – Business Intelligence (BI)

Table 9.2: Significance of standardized estimates for BI construct

Items	Mean	Std. Dev.	Loadings	Std. Err.	t-value*	$R^2$
V86	4.65	0.645	0.9129	0.0142	41.57	0.8335
S1	4.77	0.584	0.9616	0.0123	45.64	0.9246
S2	4.64	0.635	0.9456	0.0136	44.25	0.8941
S3	4.19	0.581	0.8685	0.132	38.22	0.7543
S4	4.72	0.602	0.8775	0.0136	38.87	0.7700

Note: \*All t tests were significant at  $p < .001$  level.

### Measures of model fit for BI construct

The Log file shows that the *Convergence criterion was satisfied* for assessing the fit between the model and the data.

Goodness of Fit = 0.9249, $\chi^2 = 269.24$ $df = 5$ , $p < 0.0001$
Bentler's Comparative Fit Index (CFI) = 0.9652
Bentler and Bonett's (1980) Non-normed Index (NNFI) = 0.9304
Bentler and Bonett's (1980) NFI = 0.9646
Root Mean Square Residual (RMR) = 0.01
RMSEA <sup>a</sup> Estimate = 0.2078
Composite Factor Reliability = 0.9618
Variance Extracted Estimate = 0.8353
<sup>a</sup> Root Mean Square Error of Approximation

The composite reliability and the variance extracted estimate are derived as set out in Equation 9.2, and Equation 9.3, respectively.

$$\text{Composite reliability} = \frac{(\sum L_i)^2}{(\sum L_i)^2 + \sum \text{Var}(E_i)} \quad (9.2)$$

$$\text{Variance Extracted Estimate} = \frac{\sum L_i^2}{\sum L_i^2 + \sum \text{Var}(E_i)} \quad (9.3)$$

where,

$(\sum L_i)^2$  = the squared sum of the standardised factor loading for that factor,

$\sum L_i^2$  = the sum of the squared standardised factor loading for that factor, and

$\sum \text{Var}(E_i)$  = the sum of the error variance associated with the individual indicator variables.

The present study found the resulting values of the composite reliability, Equation 9.2, and the variance extracted estimate, Equation 9.3 as:

Composite reliability = 0.9618, and Variance Extracted Estimate = 0.8353, respectively.

Here, approximately 84% of the variance is captured by the BI construct, and only 16% ( $1 - 0.84 = 0.16$ ) is due to measurement error. Fornell and Larcker (1981), suggest that it is desirable that

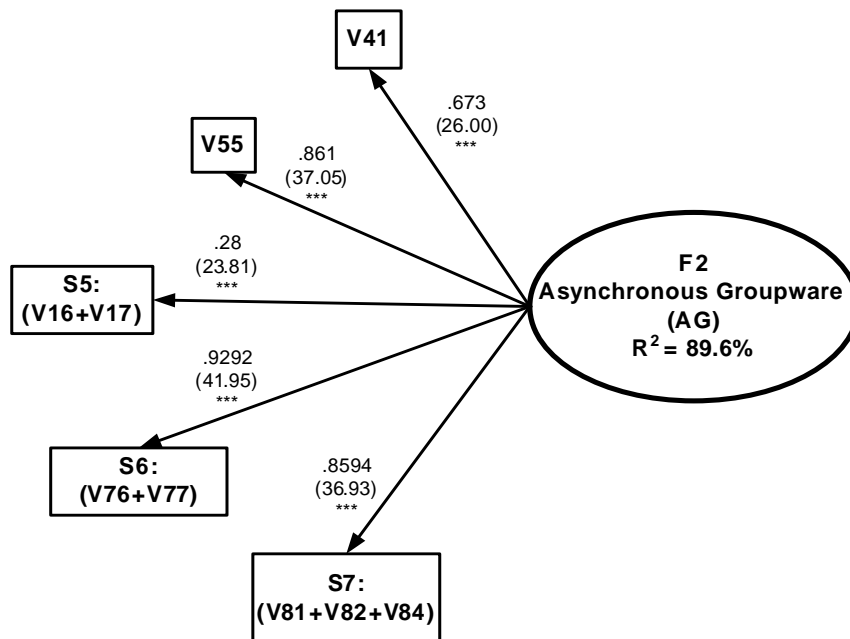
Table 9.3: Significance of standardized estimates for AG construct

Items	Mean	Std. Dev.	Loadings	Std. Err.	t-value*	$R^2$
V41	3.795	0.929	0.6248	0.0240	26.0026	0.4527
V55	4.383	0.598	0.5148	0.0139	37.0473	0.7415
S6	4.234	0.625	0.3928	0.0165	23.8068	0.3946
S7	4.393	0.575	0.5346	0.0127	41.9527	0.8633
S8	4.457	0.513	0.4412	0.0119	36.9318	0.7386

Note: \*All t tests were significant at  $p < .001$  level.

constructs exhibit measurement error of 0.5 or larger, because estimates less than .50 indicate that variance due to measurement error is larger than the variance captured by the factor.

### 9.2.3 The Initial CFA Factor Structure: F2 (AG)



Note: top number is factor loading (path), t-values are in brackets, \*\*\* significant at  $p$ -value  $< 0.0001$ .

Figure 9.4: Factor 2 – Asynchronous Groupware (AG)

The researcher then tested this factor for good fit and found the results, presented in Table 9.3.

There is no near zero standard error for this construct.

Table 9.4: Significance of standardized estimates for SC construct

Items	Mean	Std. Dev.	Loadings	Std. Err.	t-value*	$R^2$
V21	4.353	0.983	0.9592	0.0211	44.700	0.9200
V24	4.183	0.896	0.7528	0.0220	30.605	0.5668
V25	4.274	0.980	0.9356	0.0214	42.797	0.8754
V27	3.929	0.603	0.7375	0.0150	29.736	0.5439

Note: \*All t tests were significant at  $p < .001$  level.

### Measures of model fit for AG construct

The Log file shows that the *Convergence criterion was satisfied* for assessing the fit between the model and the data.

Goodness of Fit = 0.9573, $\chi^2 = 123.63$ $df = 5$ , $p < 0.0001$
Bentler's Comparative Fit Index (CFI) = 0.9698
Bentler and Bonett's (1980) Non-normed Index (NNFI) = 0.9396
Bentler and Bonett's (1980) NFI = 0.9686
Root Mean Square Residual (RMR) = 0.0153
RMSEA Estimate = 0.1392
Composite Factor Reliability = 0.896
Variance Extracted Estimate = 0.63814.

Composite reliability = 0.896

Variance Extracted Estimate = 0.63814

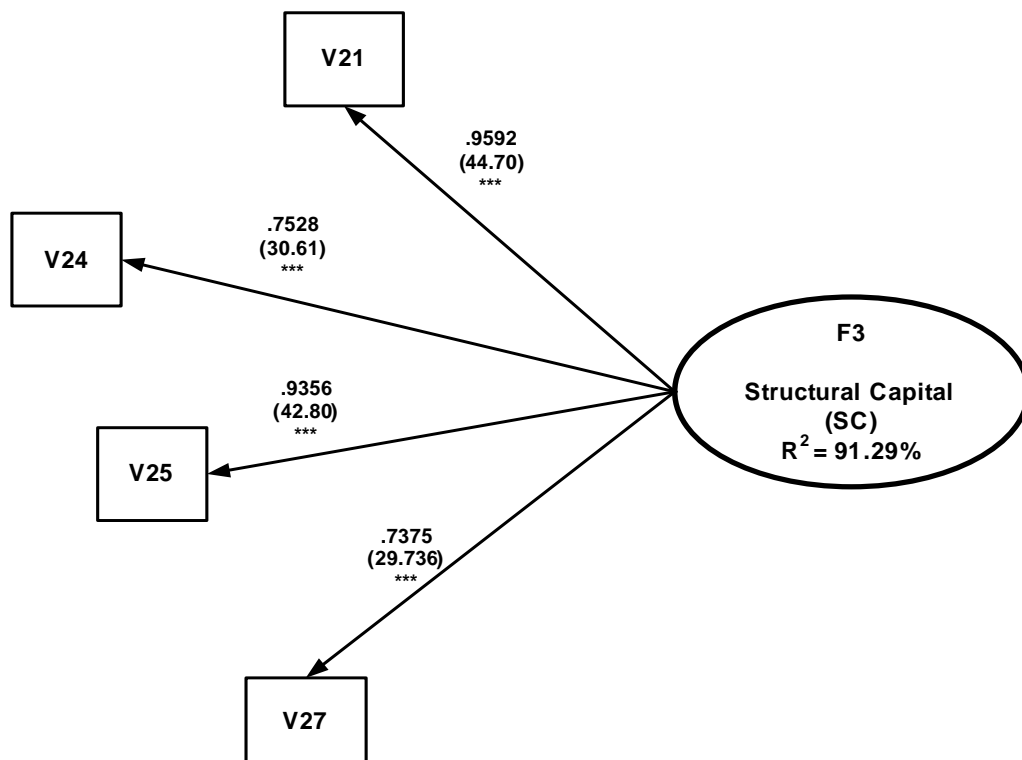
Here, 64% of the variance is captured by the AG construct, and nearly 36% is due to measurement error.

#### 9.2.4 The Initial CFA Factor Structure: F3 (SC)

The researcher then tested this factor for good fit and found the results, presented in Table 9.4.

There is no near zero Standard error for this construct.





Note: top number is factor loading (path), t-values are in brackets, \*\*\* significant at  $p$ -value < 0.0001.

Figure 9.5: Factor 3 – Structural Capital (SC)

Table 9.5: Significance of standardized estimates for OL construct

Items	Mean	Std. Dev.	Loadings	Std. Err.	t-value*	$R^2$
V42	4.589	0.823	0.7569	0.0196	31.723	0.5729
V94	4.720	0.449	0.7516	0.0107	31.427	0.5650
S8	4.491	0.577	0.8177	0.0134	35.223	0.6686
S9	4.362	0.685	1.0374	0.0134	52.881	1.0763
S10	4.313	0.609	0.7099	0.0142	29.221	0.5040

Note: \*All t tests were significant at  $p < .001$  level.

### Measures of model fit for SC construct

The Log file shows that the *Convergence criterion was satisfied* for assessing the fit between the model and the data. Dropped because Factor Loadings  $< 0.30$  [variables dropped from factor BI in chapter 7]:

Goodness of Fit = 0.9026,  $\chi^2 = 352.1421$   $df = 2$ ,  $p < 0.0001$   
 Bentler's Comparative Fit Index (CFI) = 0.9164  
 Bentler and Bonett's (1980) Non-normed Index (NNFI) = 0.7491  
 Bentler and Bonett's (1980) NFI = 0.9160  
 Root Mean Square Residual (RMR) = 0.0252  
 RMSEA Estimate = 0.3782  
 Composite Factor Reliability = 0.9129  
 Variance Extracted Estimate = 0.7265.

Composite reliability = 0.9129

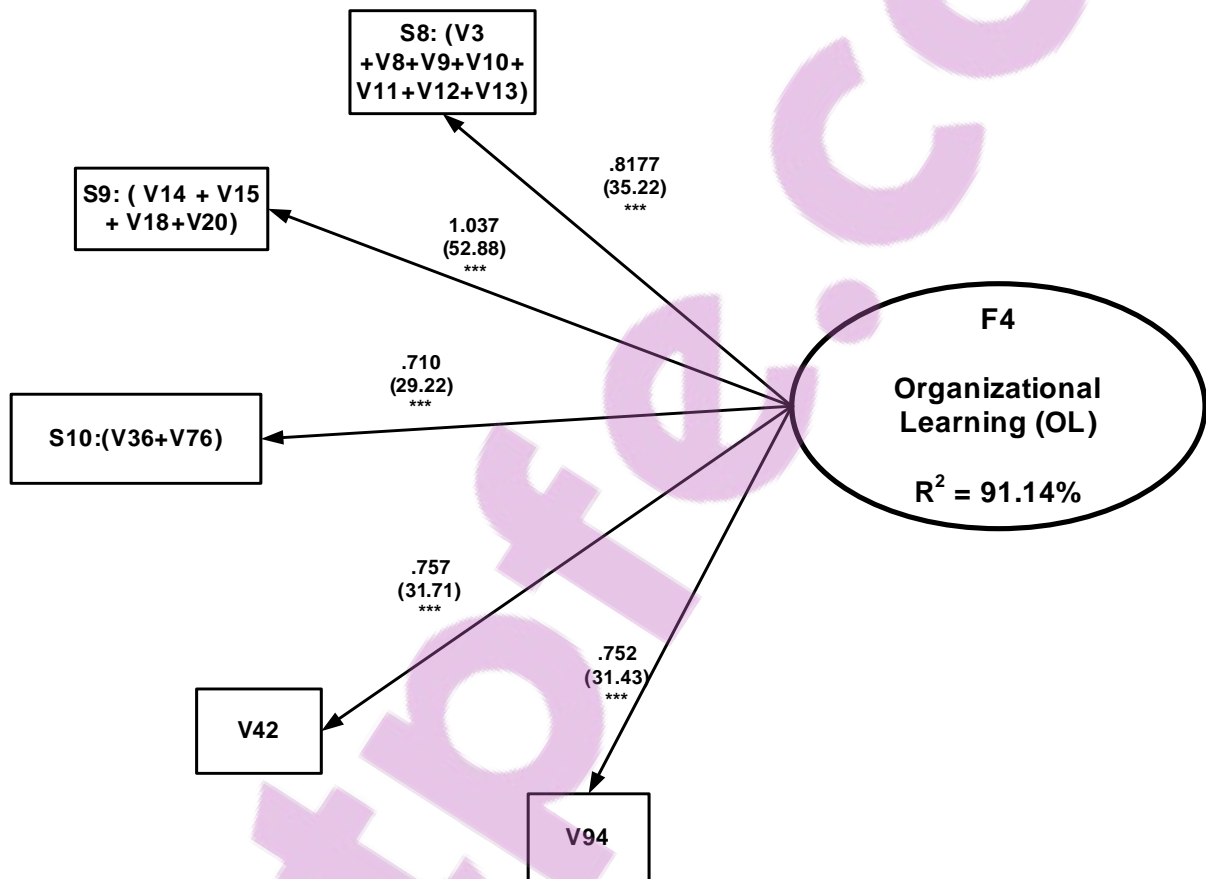
Variance Extracted Estimate = 0.7265

Here, approximately 73% of the variance is captured by the SC construct, and nearly 27% is due to measurement error.

### 9.2.5 The Initial CFA Factor Structure: F4 (OL)

The researcher then tested this factor for good fit and found the results, presented in Table 9.5.

There is no near zero standard error for this construct.



Note: top number is factor loading (path), t-values are in brackets, \*\*\* significant at  $p$ -value  $< 0.0001$ .

Figure 9.6: Factor 4 – Organisational Learning (OL)

Table 9.6: Significance of standardized estimates for HK construct

Items	Mean	Std. Dev.	Loadings	Std. Err.	t-value*	$R^2$
S11	4.364	0.590	0.7479	0.0145	30.3816	0.5593
S12	4.546	0.488	0.8731	0.0112	38.0957	0.7623
S13	4.216	0.586	0.9871	0.0123	46.8909	0.9744
V29	4.269	0.548	0.7495	0.0135	30.4696	0.5617

Note: \*All t tests were significant at  $p < .001$  level.

### Measures of model fit for OL construct

The Log file shows that the *Convergence criterion was satisfied* for assessing the fit between the model and the data.

Goodness of Fit = 0.9833,  $\chi^2 = 52.6164$   $df = 5$ ,  $p < 0.0001$   
 Bentler's Comparative Fit Index (CFI) = 0.9905  
 Bentler and Bonett's (1980) Non-normed Index (NNFI) = 0.9810  
 Bentler and Bonett's (1980) NFI = 0.9895  
 Root Mean Square Residual (RMR) = 0.0074  
 RMSEA Estimate = 0.0882  
 Composite Factor Reliability = 0.91139  
 Variance Extracted Estimate = 0.6774.

Composite reliability = 0.91139

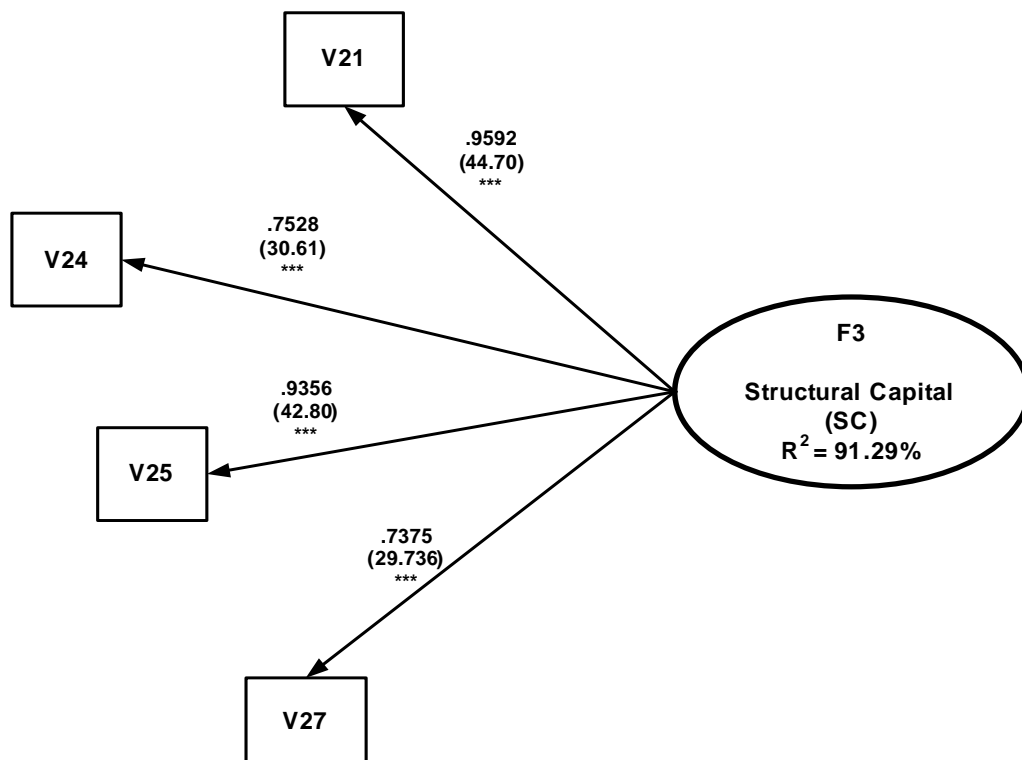
Variance Extracted Estimate = .67736

Here, 68% of the variance is captured by the OL construct, and nearly 38% is due to measurement error.

### 9.2.6 The Initial CFA Factor Structure: F5 (HK)

The researcher then tested this factor for good fit and found the following results.

There is no near zero Standard error for this construct.



Note: top number is factor loading (path), t-values are in brackets, \*\*\* significant at  $p$ -value  $< 0.0001$ .

Figure 9.7: Factor 5 – Human Knowledge (HK)

### Measures of model fit for HK construct

The Log file shows that the *Convergence criterion was satisfied* for assessing the fit between the model and the data.

Goodness of Fit = 0.9804,  $\chi^2 = 46.6499$   $df = 2$ ,  $p < 0.0001$   
 Bentler's Comparative Fit Index (CFI) = 0.9877  
 Bentler and Bonett's (1980) Non-normed Index (NNFI) = 0.9632  
 Bentler and Bonett's (1980) NFI = 0.9872  
 Root Mean Square Residual (RMR) = 0.0068  
 RMSEA Estimate = 0.1351  
 Composite Factor Reliability = 0.9080  
 Variance Extracted Estimate = 0.71443.

Composite reliability = 0.9080

Variance Extracted Estimate = 0.71443

Here, 71% of the variance is captured by the HK construct, and nearly 29% is due to measurement error.

### 9.3 Instrument Assessment (Validity and Reliability)

Each of the set of items in Table 9.2 to Table 9.6 for the Business Intelligence (Factor 1), Asynchronous Groupware (Factor 2), Structural Capital (Factor 3), Organisational Learning (Factor 4), and Human Capital/Knowledge (Factor 5), respectively, represents a dimension of an *a priori* measurement model of the theoretical KM-BI framework. The verification of this model is achieved with the use of confirmatory factor analysis (Jöreskog, 1993:294-316). In utilizing this technique in confirming factors for their study for strategic IT planning, Segars and Grover (1998:148), posit,

... the analytical framework of confirmatory factor analysis provides an appropriate means of assessing the efficacy of a pre-specified structural equation model with its associated network of theoretical concepts.

In this thesis, one uses the items resulting from the rotated factor loadings, as illustrated in Table 9.1, as the hypothesized items to, uniquely, measure these factors, for determining the

overarching construct – model of KM-BI. The approach the researcher adopts to perform this confirmation of the five components (factors) of the model – KM-BI, are examined in five separate analyses because of their distinct, although somewhat related nature. The study converted a number of the variables into factor-based scores, so as to further improve the reliability of the factors used in this part of the research.

Finally, a combined model is tested for the casual relationship of the latent variables, after the approach recommended by Larry Hatcher (Hatcher, 2002). In evaluating the confirmatory factor models, a step-by-step process suggested by Hair, Anderson, Tatham and Black (1995), and Anderson (1987) is followed.

Based on the guidelines from the foregoing, the Calis procedure in SAS Version 9.1 (SAS Institute, 2003) for structural equation modelling is used as the analytical programme for testing the statistical assumptions and for estimating the confirmatory and structural equation models developed in this research. In validating the choice of the Calis procedure over other structural equation modelling programmes, such as AMOS, EQS and LISREL, the researcher performed initial tests of skewness and kurtosis with the raw data set to examine the multivariate normality of the data. The study found that there were no significant deviations from normality or excessive kurtosis in the resulting analysis.

## 9.4 The Measurement Model

In path analysis with latent variables, a measurement model describes the nature of the relationship between

- a number latent variables, or factors, and
- the manifest indicator variables that measure those latent variables

The model<sup>1</sup> investigated in this study consisted of five latent variables corresponding to the five constructs of the KM-BI model: BI, AG, SC, OL and HK [cf. Figure 9 1 Model for KM-BI]. Each of the five latent variables was measured by at least three manifest indicator variables.

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<sup>1</sup>The initial measurement model, after identifying all parameters to be estimated – The completed program figure for confirmatory factor analysis (CFA)

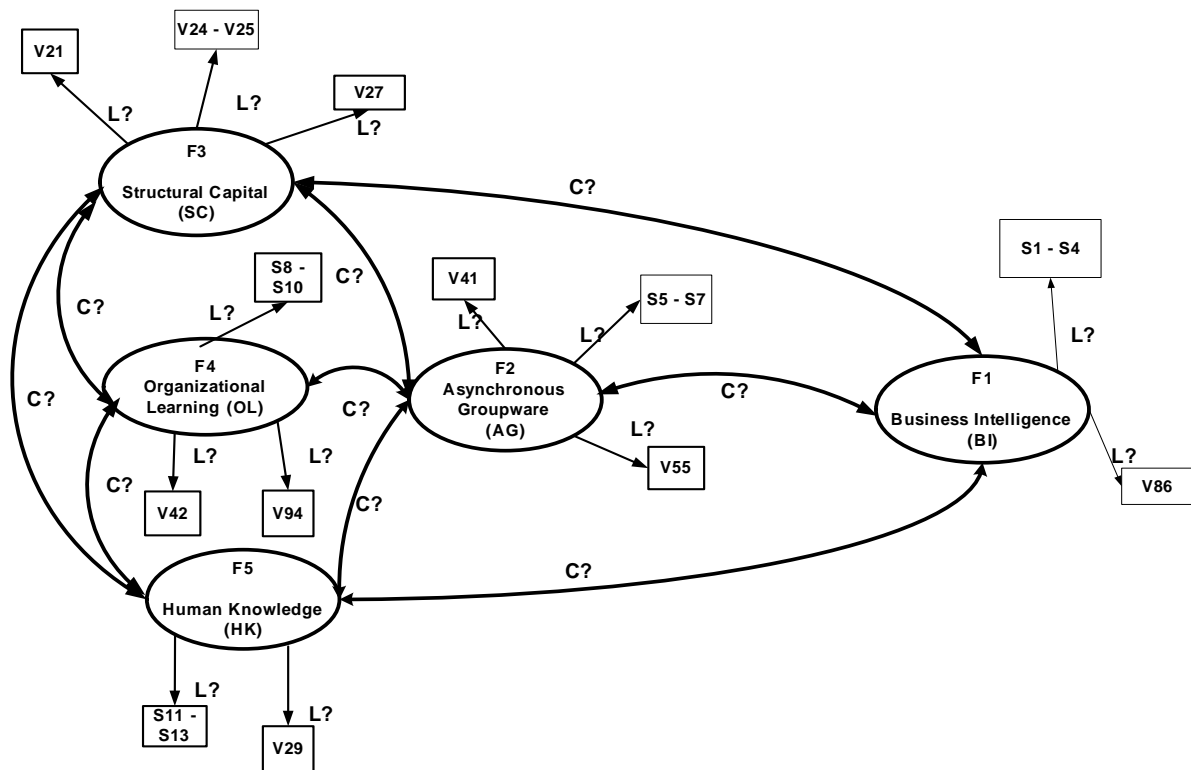


Figure 9.8: The initial measurement model

The initial measurement model, after identifying all parameters to be estimated –  
The completed program figure for confirmatory factory analysis (CFA).

#### 9.4.1 The initial measurement model

This chapter follows Bentler's (1989) convention of identifying latent variables with the letter "F" (for Factor), and labelling manifest variables with the letter "V" (for variable); one also uses S (for Scale), Figure 9.2 uses these conventions in identifying the five latent constructs investigated in this thesis, as well as the indicators that measure these constructs. The figure shows that the BI construct (F1) is measured by manifest variables V86, and S1 through S4. The AG construct (F2) is measured by manifest variables V41, V65 and V55 through S7. The SC construct (F3) is measured by manifest variables V21, V24 through V25 and V27 respectively. While, The OL construct (F3) is measured by manifest variables V42, V94 and S8 through S10. While the HK construct is measured by manifest variables V29 and S11 through S13.

The measurement model assessed in the first stages of this analysis is not identical to the model in Figure 9.2, because the model in that figure posits certain unidirectional causal relationships between the latent constructs. The measurement model, Figure 9.8, [cf. Figure 9 8 The initial measurement model] on the other hand, posits no unidirectional paths between latent variables.



Instead, in a measurement model, a covariance is estimated to connect each latent variable with every other latent variable. In Figure 9.8, a curved, two-headed arrow connecting each F variable to every other F variable indicates this. In other words, the measurement model is equivalent to a confirmatory factor analysis model in which each latent construct is allowed to covary with every other latent construct.

This measurement model was estimated using the maximum likelihood method, and the chi-square value for the model was statistically significant,  $\chi^2$  (df = 220, N = 1225) = 20245.57,  $p < .001$  [cf. G5.2 Fit Statistics]. Technically, when the proper assumptions are met, this chi-square statistic may be used to test the null hypothesis that the model fits the data. In practice, however, the statistic is very sensitive to sample size and departures from multivariate normality, and will very often result in the rejection of a well-fitting model. For this reason, it has been recommended that the model chi-square statistic be used as a goodness of fit index, with smaller  $\chi^2$  values (relative to the df) indicative of a better model fit [James, Mulaik, and Brett, 1982; Jöreskog and Sörbom, 1989].

The study presents the output for the measurement model in *Appendices G2 to G9*. *Appendices G2.1 to G2.5* provide an analysis of the initial measurement model, and identify the endogenous and exogenous variables. The study then reviewed the results of Appendix G2.5 to verify that Proc Calis did in fact analyzed the intended model. The results on *Appendices G2.5 to G2.6* also indicate which variances and covariances that should be estimated and fixed. *Appendices G3.1 and G3.2* provide information concerning the number of observations, variables, “informations” (data points), and parameters included in the analyses which one also reviews for “good fit” of the data. *Appendix G3.3* provides the covariances for the model. Finally, *Appendices G4* provides the iteration history, and indicate that the convergence criterion has been satisfied. One was then able to proceed with further analysis, since the information presented seems to be in order.

#### 9.4.2 Assessing the fit between model and data

In CFA one start with a model, Figure 9.2, that predicts the existence of a specific number of latent factors, and predicts which indicator variable load on each factor. The researcher then assesses whether the model was adequately providing a good fit. The process of reviewing the overall goodness of fit indices includes the assessment of the chi-square test, the CFI, and the

NNFI. If these preliminary assessments of fit are satisfactory, one may then proceed to review those indices that provide a more detailed assessment of fit, such as significance tests for factor loadings,  $R^2$  values, normalised residuals, and modification indices.

The reports the results for the initial measurement model using a four-step procedure, which is set out next.

**1. Step 1: Reviewing the chi-square test** The  $\chi^2$  test for goodness of fit has a number of weaknesses. As a criterion for the goodness of fit, it should be used with caution. First, the requirement that the  $\chi^2/df$  ratio should be less than 2 is rather arbitrary. Secondly, the chi-square/df ratio is affected by sample size. This means that the same model may give significantly different ratios with small samples than with large samples (Marsh et al, 1988, as cited in Hatcher, 2002:290)

The  $\chi^2$  test for the initial measurement model [*cf. Figure 9.8: The initial measurement model*] is shown on lines 6, 7 and 8 of Appendix G5.3 :Table of Goodness of Fit Indices [*cf. G5.2 Fit Statistics*]. The result is reproduced here:

$$\chi^2 = 20245.5713 \quad df = 220$$

The fact that the *p value* for this test is at .0001 is highly significant. This, technically indicate that the model does not provide a good fit of the data. The significance test however, in itself, is not sufficient evidence to reject the hypothesized model.

The  $\chi^2/df$  ratio for this initial measurement model is 92.03 ( $20245.5713/220 = 92.03$ ). The model will not therefore be acceptable, because of the general rule that stipulates that this ratio should be less than 2.00. The study shall continue, however, to check additional indices before one makes any concluding decision on the acceptability of the fit of the measurement model. This is continued this in steps two to four.

**2. Step 2: Reviewing the non-normed fit index (NNFI) and the comparative fit index (CFI)** The researcher used the Non-normed fit index (NNFI) [Bentler and Bonnet, 1980] and the Comparative fit index (CFI) (Bentler, 1989) as the overall goodness of fit indices.

In general, these indices are preferable to the normed fit index (NFI) [Bentler and Bonett, 1980], since they are less likely to produce biased estimates in small samples (Bentler, 1989; Marsh et al; 1988). Values over 0.9 on the NNFI and CFI, respectively, indicate an acceptable fit.

The results from *Appendix G5.2* [cf. *G5.2 Fit Statistics*], is reproduced here:

$$\text{Bentler's comparative fit Index (CFI)} = 0.5738$$

$$\text{Bentler and Bonett's (1980) Non-normal index (NNFI)} = 0.4969$$

Both indices are less than 0.9, indicating that the initial measurement model [cf. *Figure 9.8*] may not provide an acceptable fit. One shall not, however, draw any conclusion about acceptable fit until all the results have been reviewed.

**3. Step 3: Reviewing significance tests for factor loadings** In the procedure of CFA, a factor loading is equivalent to path coefficient from a latent factor to an indicator variable. Therefore, in practical research, such as this current research a non-significant factor loading means that the involved indicator variable is not adequately measuring the underlying factor. In such cases, if possible, it should be reassigned or dropped. The non-standardised factor loadings for the twenty-three endogenous variables (indicators) are presented in Appendix G7.1: Manifest variables Equations with Estimates, along with their corresponding standard errors (Std Err) and large-sample t value (t-Values).

In reviewing the significance of the factor loading, one analyses the results of the t tests. However, it is important to first verify that there are no near-zero standard errors (*Std Err*), such as .0003, among the estimates. If there are standard errors this low, it generally indicates that there maybe estimation problems in the model. These standard errors, appears in Appendix G7.1 [cf. G7.1 Manifest Variable Equations] as “*Std Err*”. There are no near-zero (such as .0003 standard errors in this Appendix, *Appendix G7.1*. From the evidence at hand, one is then able to proceed with the analysis of the t-tests. The t values in Appendix G2.3 represent large-sample t-tests of the null hypothesis that the factor loading is equal to zero in the population. The significance of the factor loadings may be determined from the following test criteria:

- t values greater than 1.960 are significant at  $p < .05$ ,
- t values greater than 2.576 are significant at  $p < .01$ , and
- t values greater than 3.291 are significant at  $p < .001$ .

The results in Appendix G7.1 show that all factor loadings are significant at  $p < .001$ .

The third check is to review the standardised loading. These are presented in *Appendix G8.1: Manifest variable Equations with Standardised coefficients*. In this Appendix [cf. *G8.1 Manifest Variable Equations with Standardized Estimates*], a given factor loading appears just above its name, that is, the standardised factor loading for manifest variable V21 on latent variable F3 is 0.9882. This appears just above the name of the path as *LV21F3*. The Standardised loadings in this Appendix range from a low of 0.6240 to a high of 0.9882. One is able to therefore, conclude that all loadings were very large.

**4. Step 4: Reviewing the residual matrix and normalised residual matrix** In the procedure of CFA, if the model provides a good fit to the data, entries in the raw residual matrix are expected to be zero or near-zero (Hatcher, 2002). The residuals in the raw residual matrix are difficult to interpret where the unit of measurement varies much from one indicator variable to the next, as is the case in this research. One therefore chooses the much easier option instead, that of reviewing the asymptotically standardised residual matrix. The literature informed us that normalised residuals over 2.00 are generally considered large, and therefore problematic for further analysis (Hatcher, 2002). The raw residual matrix, the asymptotically standardised residuals matrix, and the distribution of asymptotically standardised residuals are presented in Appendix G6: Residuals.

The researcher starts the analysis, of *Appendix G6.5*, by first reviewing the *Distribution of asymptotically standardised residuals*. This appendix summarises the number of residuals that fall into the interval from 0.00 to 0.25, the number that fall in the interval from 0.25 to 0.50, and so forth. If a model provides a *good fit* to the data, one expects to see that the distribution:

- is centred on zero,
- is symmetrical, and
- contains no or few residuals.

In this appendix, [cf. *G6.5 Distribution of Asymptotically Standardised Residuals*], the residual summary table is not centred on zero, but is skewed to the lower half of the table, between the range of: 0 to 0.93656. The table is not perfectly symmetrical. The bars on the lower half of the table represent the number of positive residuals. They are longer than those on the upper half of the table - representing the negative residuals.

The asymptotically standardised residuals appear in Appendix G6.3: *Asymptotically Standardised Residual Matrix*. The rank order of the largest asymptotically Standardised residuals appear in Appendix G6.4 [cf. *G6.4 Rank Order Matrix*]. In most cases, only this appendix will have to be reviewed (Hatcher, 2002). This is the approach this researcher adopts for this research. All ten residuals are greater than two, the criterion recommended by Hatcher (2002:301). These are presented in Appendix G6.4: *Rank Order of the 10 Largest Asymptotically Standardised Residuals*. It is interesting to note that there are no residuals over 2.00 in the appendix [cf. *G6.4 Rank Order Matrix*].

In determining the reason for the large standardised residuals in the rank order table, one compares the corresponding entries from the actual covariance matrix [cf. *G3.3 Covariances*] and the predicted model matrix [cf. *G5.1 Predicted Model Matrix*], respectively.

From the analysis of the standardised rank order matrix, [cf. *G6.4 Rank Order Matrix*] one obtained four groups of large residuals. These are:

1. V94 and V86 which were predicted to load on F4 and F1 respectively,
2. S12 and S13 both predicted to load on F5,
3. S9 and S8 both predicted to load on F4,
4. The following are composite variables:
  - S13 and S5 which were predicted to load on F5 and F2 respectively;
  - S9 and S5 which were predicted to load on F4 and F2 respectively,
  - S11 and S5 which were predicted to load on F5 and F2 respectively;
  - S5 and V21 which were predicted to load on F2 and F3 respectively;
  - S10 and S5 which were predicted to load on F4 and F2 respectively,

- S4 and S1 both predicted to load on F1; and, S4 and V42, which were predicted to load on F1 and F4 respectively.

Five of these large residuals involve the manifest variable S5, which is predicted to load on F2.

The fact that all the predicted covariances are smaller than the actual covariances suggest that our CFA model under predicts the strength of the relationship between each pair of manifest variables, say V94 and V86. In the case of S5, there is a possibility that the variable (S5) is influenced by the latent factor F3, F4, and F5, respectively, and which in turn affect the manifest variables V21, S9 and S10, and S11 and S13 respectively. The decision criterion for this researcher is whether S5 should be reassigned. This would involve dropping the path from F2 to S5, and adding a new path from F3, or F4, or F5 to S5 respectively. This would not give an acceptable solution, since the factor loading (standardised coefficients) of S5 on F2 is reasonably high at 0.6706, [*cf. G8.1 Manifest Variable Equations with Standardized Estimates*]. Additionally, the path from S5 to F2, *LS5F2*, is statistically significant at  $t > 3.291$ ,  $p < .001$  [*cf. G7.1 Manifest Variable Equations*]. Hatcher (2002:305) recommends that another approach one could take is to consider that S5 is a complex variable that is affected by F2 and each of F3, F4 and F5 respectively. He further, recommends that to improve the model's fit, one should modify it so that there is a path from each of the latent factors of F3, F4 and F5, to the indicator variable S5, as well as a path from F2 to S5:

... but this is generally undesirable when performing path analysis with latent variables, as you usually desire to use factorially simple indicators: indicators that measure only one factor [Hatcher, 2002:305].

The better choice would therefore be to drop S5 completely from the analysis. This, however, would be premature, at this stage. One must first review the modification indices before making the final decisions about the fate of S5, and for that matter, the other manifest variables from Table 9.7.

Anderson and Gerbing [1988, as cited in Hatcher, 2002:305] cite other procedures that may be used to identify specification errors in a multiple-indicator measurement model [*cf. Figure 9 8 The initial measurement model*]. Of particular interest, if a measurement model includes multiple factors, each with multiple indicators, as in this research, and with no reverse-coded items. Anderson and Gerbing (1988) suggest that residuals from such data set may be reviewed to identify the following misspecifications:

Table 9.7: Comparison of actual covariances and predicted covariance

Variable pairs	Loads on Factors	Covariances	Predicted model	Strength of relationship
V94 and V86	F4 and F1	0.24	0.132	Under predicts
S12 and S3	F5 and F1	0.2268	0.0994	Under predicts
S9 and S8	F4 and F1	0.318	0.261	Under predicts
S13 and S5	F5 and F2	0.316	0.142	Under predicts
S9 and S5	F4 and F2	0.357	0.214	Under predicts
S11 and S5	F5 and F2	0.293	0.109	Under predicts
S5 and V21	F2 and F3	0.453	0.217	Under predicts
S10 and S5	F4 and F2	0.301	0.184	Under predicts
S4 and S1	F1 (both)	0.331	0.325	Under predicts
S4 and V42	F1 (both)	0.400	0.238	Under predicts

1. **An indicator variable is assigned to the wrong factor.** If, for example, the indicator variable (S5) was incorrectly assigned to factor F2, it should demonstrate large negative standardized residuals with the other indicator variables that were correctly assigned to F2. On the other hand, if the model contains another factor (in this case F3, F4 and F5) that the indicator variable S5 should then display large positive residuals for the variables which were correctly assigned to this factor.
2. **An indicator variable is multidimensional.** If an indicator is actually influenced by more than one factor, it should often display large standardized residuals for the indicator variables of more than one factor. In general, these should be the only large standardized residuals that are displayed by the other manifest variables.

It is instructive to note that in the case of this research, the standardised residuals did not fully display a pattern of residuals, which fit perfectly into the scenario of (1) and (2) above. This is although, S5, being a composite variable, is not a reverse-coded indicator-variable. The same is true for the other indicator variables in Table 9.7. Here, S4 and S5 are multidimensional variables, being influenced by F3, F4, and F5 besides Factors F2 and F1, respectively. One is able to decide, however, to proceed with reviewing the modification indices, to see which specific modifications are necessary to best improve the model's fit.

#### 9.4.3 Modifying the measurement model

The procedure of CFA requires the modification of the model if the indices in the first four steps of reviewing the model's fit were not satisfactory. As such, the results obtained so far,

from the analysis of the model's fit are not conclusive. First, the chi-square test was significant, which suggest that one should reject the measurement model. However, as indicated elsewhere in this chapter, a significant chi-square alone should not be used as evidence of a poor fit. Additionally, the chi-square/df ratio, the CFI and the NNFI are all outside the acceptable range of at most two for the chi-square/df ratio, and 0.90 for both the CFI and the NNFI indices, respectively. However, the significance tests revealed that all factor loadings were significantly different from zero. In addition, to the problem with the chi-square/df ratio, the CFI and the NNFI indices, the standardised residuals provide sufficient reasons to attempt to improve the fit of the measurement model, and therefore justify the decision of reviewing the modification indices.

The **modification** option in the *Proc Calis* statement, **Appendix G1.2**, requests that two modification indices be completed. The first modification index is the Wald test, which identifies parameters that should possibly be dropped from the model. The second modification index is the Lagrange multiplier, which identifies parameters that should possibly be added [Hatcher, 2002].

1. *The Wald test.* The Wald test estimates the change in the model's chi-square that would result from fixing a given parameter at zero. The importance of this test is that it estimates the change that will result in the chi-square if a particular path or covariance were eliminated from the model. The parameters of the Wald's test are the covariances among the exogenous variables, in Table G7.3. There are no non-significant t-values among the pair of parameters, as reported earlier. Furthermore, the results of the correlations among the exogenous variables of Table G8.3 showed that the correlations between the pairs of variables are very high and positive, ranging from 0.53 to 0.87.
2. *The Lagrange multiplier test.* The Lagrange multiplier test estimates the reduction in model chi-square that would result from freeing a fixed parameter and allowing it to be estimated (Hatcher, 2002). Therefore, in terms of a CFA, the Lagrange multiplier estimates the degree to which the chi-square would improve if a new factor loading or covariance parameter, were added to the measurement model. The Lagrange multiplier indices are presented here, in Appendix G9, Tables G9.1 to G9.2. The phi-matrix contains indices for every possible combination of latent factors (the F variable) and the residual terms (the E terms) [Hatcher, 2002].



In this research, one's interest is the Lagrange multipliers that demonstrate whether a new path should be added from a particular latent factor (F variable) to a particular indicator variable. The information for these tests appears in the second matrix of the Lagrange multiplier, the gamma matrix, which is presented in **Table G9.3**.

The rank order of the 10 largest Lagrange multipliers appears in **Table G9.4**, as *Rank Order of 10 Largest Lagrange Multipliers in GAMMA* – . The largest index was for the S5:F4 (OL), S5:F5 (HK), S5:F3 (SC) relationships, and so on. The values of the Lagrange multiplier are 896.80, 786.16, and 514.24 respectively. This means that the model chi-square is expected to decrease by a value of 896.80, 7886.16 or 514.24, respectively, if a path is added from F4 (OL) to S5, F5 (HK) to S5, or F3 (SC) to S5, respectively.

These findings are consistent with the pattern of large residuals observed earlier in this chapter. Those residuals showed that the initial measurement model [*cf. Figure 9.8: The initial measurement model*] under-predicted the relationship between S13 and S5, S9 and S5, S11 and S5, S5 and V21, and S10 and S5. A conclusion, which one can draw from this pattern of relationship, is that S5 may be influenced by the same factors that affect S13, S9, S11, S10, and V21. The factors in this case are F3 (SC), F4 (OL) and F5 (HK), respectively. Interestingly there is no conflict with either F2 (AG), or F1 (BI). This seems to suggest that the initial measurement model correctly predict the relationship between these factors (latent variables), and their indicator variables.

#### 9.4.4 The final measurement model

##### Revising the final measurement model

These results suggest that there is a problem with this model's fit. The pattern of large normalized residuals, parameter significance tests, and Lagrange multiplier tests showed that the manifest indicator, S5, was causally affected by the SC construct (F3), the OL construct (F4), and the HK construct (F5), respectively, as well as the construct that it was expected to be affected by (AG, F2). Because S5 was apparently a multidimensional variable, it was eliminated from the measurement model, and the measurement model was re-estimated.

The current model was modified in 27 iterations until an unacceptable model fit was achieved. Each of the iteration used the tests in the four-step procedure, described previously, to assess

Table 9.8: Iteration for goodness of fit

Iter	$\chi^2$	df	$\chi^2/df$	GFI	RMR	RMSEA	CFI	NNFI	NFI	$\varepsilon$	REMARKS
1	17028.59	199	85.57	.5011	.0487	—	.6099	.5472	—	yes	Poor Fit
2	13043.19	160	81.52	.5458	.0445	—	.6395	.5719	—	Yes	Poor Fit
3	11777.19	142	82.94	.5634	.0611	—	.6392	.5655	—	Yes	Poor Fit
4	9469.74	125	75.76	.5939	.0508	—	.6633	.5879	—	Yes	Poor Fit
5	6540.20	94	69.58	.6463	.0470	—	.7229	.6463	—	Yes	Poor Fit
6	6178.1	94	65.72	.6795	.0419	—	.7290	.6540	—	Yes	Poor Fit
7	5671.83	81	70.02	.6906	.0561	—	.7202	.6373	—	Yes	Poor Fit
8	4695.31	81	57.97	.7173	.0336	—	.7691	.7007	—	Yes	Poor Fit
9	4498.99	81	55.54	.7328	.0314	—	.7789	.7134	—	Yes	Poor Fit
10	3625.13	68	53.31	.7679	.0296	—	.7705	.6928	—	Yes	Poor Fit
11	6664.79	109	61	.6671	.0359	.2217	.7610	.7018	.7583	Yes	Poor Fit
12	5092.33	94	54.17	.7135	.0337	.2084	.7988	.7431	.7960	Yes	Poor Fit
13	3999.45	80	49	.7297	.0300	.2001	.8282	.7745	.8255	Yes	Poor Fit
14	2584.84	48	53.85	.7664	.0309	.2078	.8689	.8060	.8567	Yes	Poor Fit
15	2016.78	38	53.07	.8028	.0271	.2063	.8813	.8283	.8795	Yes	Poor Fit
16	1015.01	29	35	.8738	.0173	.1667	.9236	.8815	.9217	Yes	Poor Fit
17	469.24	21	22.37	.9251	.0148	.1321	.9479	.9107	.9457	Yes	Poor Fit
18	343.43	14	24.53	.9360	.118	.1387	.9529	.9057	.9057	Yes	Poor Fit
19	128.14	8	16.02	.9716	.0085	.1108	.9764	.9382	.9750	No	Good Fit
20	119.10	4	29.78	.9733	.0098	.1533	.9729	.8579	.9721	No	Good Fit
21	168.55	10	16.86	.9662	.0095	.1138	.9749	.9298	.9734	No	Good Fit
22	330.52	17	19.44	.9412	.0099	.1227	.9605	.9164	.9586	No	Good Fit
23	700.62	25	28.02	.9061	.0112	.1486	.9295	.8700	.9273	Yes	Poor Fit
24	1032.29	34	30.36	.8788	.0157	.1549	.9250	.8786	.9227	Yes	Poor Fit
25	1137.61	44	28.13	.8617	.0160	.1489	.9244	.8865	.9219	Yes	Poor Fit
26	641.06	34	18.85	.9142	.0152	.1208	.9468	.9140	.9441	Yes	Poor Fit
27	617.24	34	18.15	.9166	.0138	.0118	.9489	.9174	.9462	Yes	Poor Fit

Note:1. Iter = Number of iterations, 2.  $\varepsilon$  = residuals

the model fit. One only presents the goodness of fit indices for each of the 27 iterations, here, but all the criteria for assessing model fit were analysed, (see Table 9.8.

### The Good of Fit Indices are set out next:

1. *Iteration 1:* S5 is dropped from the model.

Absolute normalised residuals > 2?, Yes. The indices indicate that the iteration did not provide a good fit of the data.

2. *Iteration 2:* S4 and S9 are dropped from F1 and F4, respectively, of the model.

Absolute normalised residuals > 2?, Yes. The indices indicate that the iteration did not provide a good fit of the data.

3. *Iteration 3:* S13 is dropped from F2 of the model.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data.

4. *Iteration 4:* V86 is dropped from F1 of the model.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data.

5. *Iteration 5:* V42 and V94 are dropped from F5 of the model.

Absolute normalised residuals  $> 2?$  Yes. The indices indicate that the iteration did not provide a good fit of the data.

6. *Iteration 6:* The researcher dropped variables S4 and V86 from F1; S5 from F2; V24 from F3; S9 and V94 from F4; and S13 from F5, of the model.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data.

7. *Iteration 7:* The researcher dropped variables S4 and V86 from F1; S5 from F2; V24 from F3; S9, S10 and V94 from F4; and S13 from F5, of the model.

Absolute normalised residuals  $> 2?$ . Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model may be improved by reassigning variable S1 from F1 to F4, and S11 to F5. This results in an improvement to the model, as is shown in iteration 8.

8. *Iteration 8:* The researcher dropped the same variables as in iteration 7.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 267.46, if one reassigns variable S3 from F1 to F5. This results in an improvement to the model, as is shown in iteration 9.

9. *Iteration 9:* The researcher dropped the same variables as in iteration 7.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 119.89, if one reassigns variable V21 from F3 to F5. This results in an improvement to the model, as is shown in iteration 10. .

10. *Iteration 10:* Only 14 of the 23 variables were used in this iteration. The nine which were dropped, are S4, V86, V21, V24, S9, V29, V94, S10, and S13

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 116.02, if one reassigns variable S12 from F5 to F2. This results in an improvement to the model, as is shown in iteration 11

11. *Iteration 11:* Only 17 of the 23 variables were used in this iteration. The six which were dropped, are, V24, V42, V86, S5, S10, and S12.

Absolute normalised residuals  $> 2?$ , Yes. The study now includes the root mean square estimate (RMSEA) and the normed fit index (NFI). The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 256.6, if one reassigns variable S11 from F5 to F1. One chooses to drop S11 from the model, rather than reassign it, because it had a large and significant factor loading of 0.7841, on F5. This results in an improvement to the model, as is shown in iteration 12.

12. *Iteration 12:* Only 16 of the 23 variables were used in this iteration. The seven which were dropped, are, V24, V42, V86, S5, S10, S11, and S12.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 181.53, if one reassigns variable S3 from F5 to F1. One, however, chooses to drop S3 from the model, rather than reassign it, because it had a large and significant factor loading of 0.6754, on F5. This results in an improvement to the model, as is shown in iteration 13.

13. *Iteration 13:* Only 15 of the 23 variables were used in this iteration. The eight variables which were dropped, are, V24, V42, V86, S3, S5, S10, S11, and S12.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 216.22, if one reassigns variable V25 from F3 to F5. One, however, chooses to drop V25 from the model, rather than reassign it, because it had a large and significant factor loading of 0.9819, on F3. This results in an improvement to the model, as is shown in iteration 14.

14. *Iteration 14:* Only 12 of the 23 variables were used in this iteration. The 11 variables which were dropped, are, V24, V29, V42, V86, V94, S3, S5, S10, S11, S12, and S13. The researcher also dropped the F5 construct: HK, from the model.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 141.13 if one reassigns variable S1 from F1 to F4. One, however, chooses to drop V41 from F4 of the model, rather than reassign S1, because it had a large and significant factor loading of 0.9903, on F1. This results in an improvement to the model, as is shown in iteration 15.

15. *Iteration 15:* Only 11 of the 23 variables were used in this iteration. The 12 variables which were dropped, are, V24, V29, V41, V42, V86, V94, S3, S5, S10, S11, S12, and S13.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 140.41, if one reassigns variable S1 from F1 to F4. One, however, chooses to drop S1 from the model, rather than reassign it, because it had a large and significant factor loading of 0.989, on F1. This results in an improvement to the model, as is shown in iteration 16.

16. *Iteration 16:* Only 10 of the 23 variables were used in this iteration. The 13 variables which were dropped, are, V24, V29, V41, V42, V86, V94, S1, S3, S5, S10, S11, S12, and S13. On also reassigned S7 from F2 to F4.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 88.74, if one reassigns variable V21 from F3 to F1. One, however, chooses to drop V21 from the model, rather than reassign it, because it had a large and significant factor loading of 0.995, on F3. This results in an improvement to the model, as is shown in iteration 17.

17. *Iteration 17:* Nine of the 23 variables were used in this iteration. The 14 variables which were dropped, are, V21, V24, V29, V41, V42, V86, V94, S1, S3, S5, S10, S11, S12, and S13. The researcher also reassigned S7 from F4, back to F2.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices

suggest that the model chi-square will reduce by 60.18, if one reassigns variable V25 from F3 to F4. one, however, chooses to drop V25 from the model, rather than reassign it, because it had a large and significant factor loading of 0.9196, on F3. This results in an improvement to the model, as is shown in iteration 18.

18. *Iteration 18:* Eight of the 23 variables were used in this iteration. The 15 variables which were dropped, are, V21, V24, V25 V29, V41, V42, V86, V94, S1, S3, S5, S10, S11, S12, and S13.

Absolute normalised residuals  $> 2?$ , Yes. the pair S8:S6 is the only pair of residuals, it has a value of -3. The indices indicate that the iteration did not provide a poor fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 29.61, if one reassigns variable S6 from F2 to F1. One, however, chooses to drop S6 from the model, rather than reassign it, because it had a large and significant factor loading of 0.9215, on F2. This results in an improvement to the model, as is shown in iteration 19.

19. *Iteration 19:* Seven of the 23 variables were used in this iteration. The 16 variables which were dropped, are, V21, V24, V25 V29, V41, V42, V86, V94, S1, S3, S5, S6, S10, S11, S12, and S13.

Absolute normalised residuals  $> 2?$ , No. The indices indicate that the iteration provides an acceptable fit of the data. Although the SAS log did not report any identification problems, the fact, though, that all the factors are measured by less than three manifest variables, is the main reason for not choosing to accept this as the final measurement model. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 16.42, if one reassigns variable S4 from F1 to F3. One, however, chooses not to do so, but rather to re-specify the model. The researcher reassigned V27 from F3 to F1, dropped S7 from F2, and S9 from F4, respectively. The researcher also added S5 to F3, and V29 to F5, respectively. This results in an improvement to the model, as is shown in iteration 20.

20. *Iteration 20:* Seven of the 23 variables were used in this iteration The 16 variables which were dropped, are, V21, V24, V25, V41, V42, V86, V94, S1, S3, S6, S7, S9, S10, S11, S12, and S13.

Absolute normalised residuals  $> 2?$ , No. The indices indicate that the iteration provides an acceptable fit of the data. Although the SAS log did not report any identification

problems, the fact, though, that all but one of the factors are measured by less than three manifest variables, is the main reason for not choosing to accept this as the final measurement model. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 47.92 if one reassigns variable S4 from F1 to F4. One, however, chooses not to do so, but rather to re-specify the model. One added S9 to F4. This results in an improvement to the model, as is shown in iteration 21.

21. *Iteration 21:* Eight of the 23 variables were used in this iteration. The 15 variables which were dropped, are, V21, V24, V25 V29, V41, V42, V86, V94, S1, S3, S6, S10, S11, S12, and S13.

Absolute normalised residuals  $> 2?$ , No. The indices indicate that the iteration provides an acceptable fit of the data. Although the SAS log did not report any identification problems, the fact, though, that all but one of the factors are measured by less than three manifest variables, is the main reason for not choosing to accept this as the final measurement model. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 42.04 if one reassigns variable S2 from F1 to F2. One, however, chooses not to do so, but rather to re-specify the model. The researcher added S6 to F2. This results in an improvement to the model, as is shown in iteration 22.

22. *Iteration 22:* Nine of the 23 variables were used in this iteration. The 14 variables which were dropped, are, V21, V24, V25 V29, V41, V42, V86, V94, S1, S3, S10, S11, S12, and S13.

Absolute normalised residuals  $> 2?$ , No. The indices indicate that the iteration provides an acceptable fit of the data. Although the SAS log did not report any identification problems, the fact, though, that all but one of the factors are measured by less than three manifest variables, is the main reason for not choosing to accept this as the final measurement model. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 25.17 if one reassigns variable S2 from F1 to F2. One, however, chooses not to do so, but rather to re-specify the model. The researcher added S7 to F2. This results in an improvement to the model, as is shown in iteration 23.

23. *Iteration 23:* Ten of the 23 variables were used in this iteration. The 13 variables which were dropped, are, V21, V24, V25, V41, V42, V86, V94, S1, S3, S10, S11, S12, and S13.

Absolute normalised residuals  $> 2?$ , Yes, only the pair S8:S6 has a value of -3. The indices indicate that the iteration provides an acceptable fit of the data. Although the

SAS log did not report any identification problems, the fact, though, only two factors, F1:Bi, and F2:AG, are measured by less than three manifest variables, is the main reason for not choosing to accept this as the final measurement model. The researcher re-specified the model by adding V21 and V25 to F3; and dropped S5 from F3. This results in an improvement to the model, as is shown in iteration 24.

24. *Iteration 24:* Only 11 of the 23 variables were used in this iteration. The 12 which were dropped, are, V24, V41, V42, V86, V94, S1, S3, S5, S10, S11, S12, and S13.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide a good fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 53.25, if one reassigns variable V27 from F1 to F3. One, however, chooses not to do this but rather add S13 to F5, This results in an improvement to the model, as is shown in iteration 25.

25. *Iteration 25:* Only 12 of the 23 variables in this iteration. The 11 which were dropped, are, V24, V41, V42, V86, V94, S1, S3, S5, S10, S11, and S12.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide an acceptable fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 112.90 if one reassigns variable V25 from F3 to F5. One, however, chooses to drop V25 from the model, rather than reassign it, because it had a large and significant factor loading of 0.9938, on F3. This results in an improvement to the model, as is shown in iteration 26.

26. *Iteration 26:* Only 11 of the 23 variables were used in this iteration. The 12 which were dropped, are, V24, V41, V42, V86, V94, S1, S3, S5, S10, S11, S12, and S13.

Absolute normalised residuals  $> 2?$ , Yes. The indices indicate that the iteration did not provide an acceptable fit of the data. The GAMMA index of the Lagrange multiplier indices suggest that the model chi-square will reduce by 48.74 if one reassigns variable S2 from F1 to F5. One, however, chooses to retain S2, rather than reassign it, because it had a large and significant factor loading of 0.8055, on F1. This results in an improvement to the model, as is shown in iteration 27.

27. *Iteration 27: Final measurement model:* Only 11 of the 23 variables were used in this iteration. The 12 which were dropped, are, V24, V25, V41, V42, V86, V94, S1, S3, S5, S10, S11, and S12.



Absolute normalised residuals  $> 2$ ?, Yes. The indices indicate that the iteration provides an acceptable fit of the data. Although the SAS log did not report any identification problems, the fact, though, that only one factor, F2: AG, is measured by three manifest variables, is of some concern, however, the other four factors are measured by composite indicator variables [cf. Figure 9.9 : Final (revised) measurement model]. In the case of F1: BI, it is measured by: S2: which comprises variables V16 and V17, and S4: which comprises variables V43 and V44. In the case of F3:SC, it is measured by V21 and V27, and in the case of F4: OL, it is measured by the composite variables: S8: which comprises V8, V9, V10, V11, V12, and V13, and S9, comprises V14, V16, V18 and V20, and in the case of F5: HK, it is measured by: V29, and S13 comprises V32, and V35, respectively.

In summary, iteration 27 met most of the goodness of fit criteria for an acceptable model fit.

- Not all ratio of  $\chi^2/\text{df}$  were  $< 2$
- The GFI  $> 0.8$
- CFI and NNFI are both  $> 0.9$
- There are only a few normalised residuals with absolute value  $> 2$
- The distribution of normalised residuals met all the criteria of normal distribution, This is evident from Table 9.8.

The researcher opts to accept this as the final measurement model, which is illustrated in Figure 9.9.

The SAS syntax used in the final measurement is presented in Table 9.9.

### **The final (revised) measurement model**

The overall goodness of fit indices for the final (revised) measurement model is presented in Table 9.10.

The revised measurement model indicated a good fit with the data. The model  $\chi^2$  is 617.24 with 34 degrees of freedom. This value is still statistically significant ( $p < .001$ ). However,

Table 9.9: Syntax code for final measurement model

```

PROC CALIS COVARIANCE CORR RESIDUAL MODIFICATION ;
  LINEQS
/*----- BI = Factor 1 (F1) -----*/
/*S1   = LS1F1   F1 + E1,*/ S2 = LS2F1   F1 + E2,
/*S3   = LS3F3   F3 + E3,*/ S4 = LS4F1   F1 + E4,
/*V86   = L86F1   F1 + E86,*/
/*----- AG = Factor 2 (F2) -----*/
/* S5   = LS5F2   F2 + E5, */ S6 = LS6F2   F2 + E6,
S7 = LS7F2   F2 + E7, /*V41 = LV41F2   F2 + E41,
*/ V55 = LV55F2   F2 + E55,
/*-----SC = Factor 3 (F3) -----*/
V21 = LV21F3   F3 + E21, /*V24 = LV24F3   F3 + E24,*/
/*V25 = LV25F3   F3 + E25,*/ V27 = LV27F3   F3 + E27,
/*-----OL = Factor 4 (F4) -----*/
S8 = LS8F4   F4 + E8, S9 = LS9F4   F4 + E9,
/*S10 = LS10F4   F4 + E10,*/ /*V42 = LV42F4   F4 + E42,*/
/*V94 = LV94F4   F4 + E94,*/
/*-----HK= Factor 5 (F5) -----*/
/*S11 = LS11F5   F5 + E11,*/ /*S12 = LS12F5   F5 + E12,*/
S13 = LS13F5   F5 + E13, V29 = LV29F5   F5 + E29;

STD /* ----- VARIANCE ESTIMATES ----- */

F1 = 1, F2 = 1, F3 = 1, F4 = 1, F5 = 1, /* FACTOR 1 - F1
*/ /*E1=VARE1,*/ E2 = VARE2, E4 = VARE4, /*E3 = VARE3,*/ /*E86 =
VARE86,*/ /* FACTOR 2 - F2 */ /* E5=VARE5 */ E6=VARE6, E7 = VARE7,
/*E41 = VARE41,*/ E55 = VARE55, /* FACTOR 3 - F3 */ E21 = VARE21,
/*E24=VARE24,*/ /*E25 = VARE25,*/ E27 = VARE27, /* FACTOR 4 - F4 */
E8=VARE8, E9=VARE9, /*E10=VARE10,*/ /*E42 = VARE42,*/ /*E94 =
VARE94,*/ /* FACTOR5 - F5 */ /*E11-E12 = VARE11-VARE12 */ E13 =
VARE13, E29 = VARE29;

COV /* ----- COVARIANCES ----- */

F1 F2 = CF1F2, F1 F3 = CF1F3, F1 F4 = CF1F4, F1 F5 = CF1F5, F2 F3 =
CF2F3, F2 F4 = CF2F4, F2 F5 = CF2F5, F3 F4 = CF3F4, F3 F5 = CF3F5,
F4 F5 = CF4F5;

OPTIONS LINESIZE=80 PAGESIZE=60; /* VAR V21 V24 V25 V27 V29 V41 V42
V55 V86 V94 S1-S13; */ RUN;

```

Table 9.10: Goodness of Fit Indices for Final Measurement Model

Fit Function	0.5043
Goodness of Fit Index (GFI)	0.9166
GFI Adjusted for Degrees of Freedom (AGFI)	0.8381
Root Mean Square Residual (RMR)	0.0138
Parsimonious GFI (Mulaik, 1989)	0.5666
Chi-Square	617.2412
Chi-Square DF	34
Pr > Chi-Square	< .0001
Independence Model Chi-Square	11471
Independence Model Chi-Square DF	55
RMSEA Estimate	0.1184
RMSEA 90% Lower Confidence Limit	0.1103
RMSEA 90% Upper Confidence Limit	0.1267
ECVI Estimate	0.5571
ECVI 90% Lower Confidence Limit	0.4940
ECVI 90% Upper Confidence Limit	0.6263
Probability of Close Fit	0.0000
Bentler's Comparative Fit Index	0.9489
Normal Theory Reweighted LS Chi-Square	612.7197
Akaike's Information Criterion	549.2412
Bozdogan's (1987) CAIC	341.4775
Schwarz's Bayesian Criterion	375.4775
McDonald's (1989) Centrality	0.7882
Bentler and Bonett's (1980) Non-normed Index	0.9174
Bentler and Bonett's (1980) NFI	0.9462
James, Mulaik, and Brett (1982) Parsimonious NFI	0.5849
Z-Test of Wilson and Hilferty (1931)	20.2206
Bollen (1986) Normed Index Rho1	0.9130
Bollen (1988) Non-normed Index Delta2	0.9490
Hoelter's (1983) Critical N	98

Note: 1.The SAS System 14 22:00 Saturday, July 24, 2004

2. The CALIS Procedure Covariance Structure Analysis: MLE

3. WARNING: The central parameter matrix PHI has probably 2 negative eigenvalue(s).

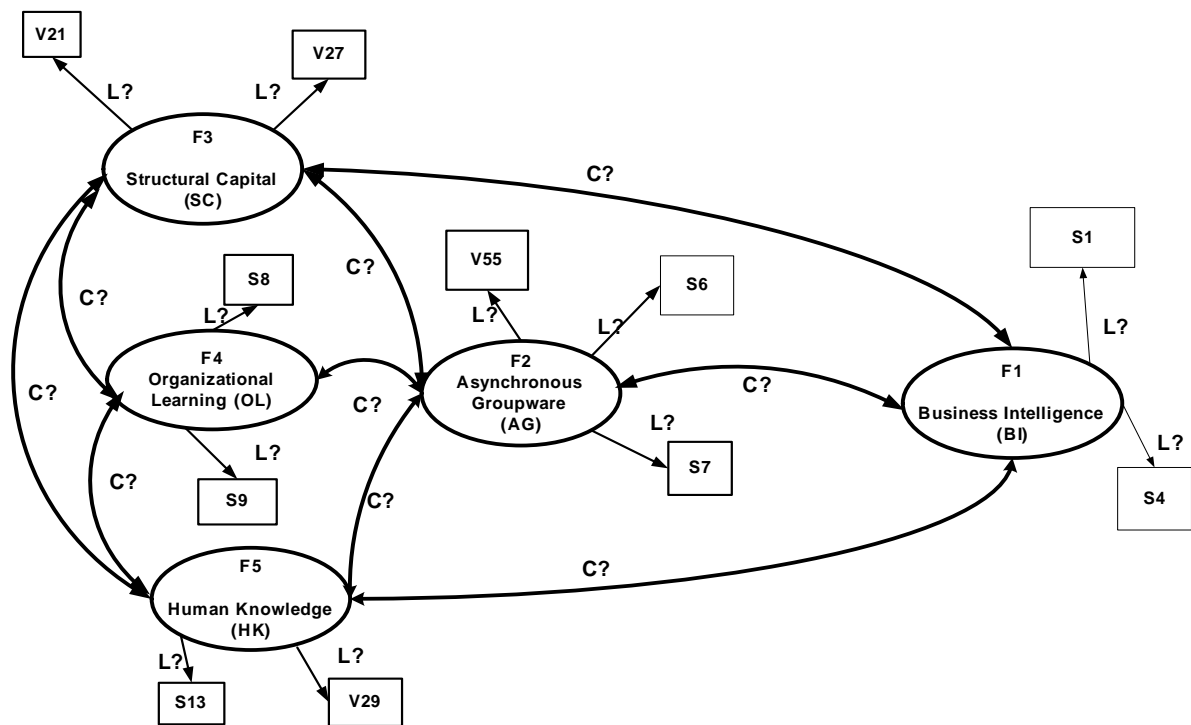


Figure 9.9: Final (revised) measurement model

this  $\chi^2$  value, of the revised measurement model, represents a substantial reduction from the observed  $\chi^2$  value of the initial measurement model of 20245.57 with 220 degrees of freedom. This results from removing the 12 indicator variables of F1: S1, S3 and V86; F2: V41 and S5; F3: V2 and V25; F4: V42, V94, and S10; and F5: S11 and S12, from the analysis. The model chi-square decreased by 19628.37, while the degrees of freedom decreased by 186. Hatcher (1994:316) advises that,

*Model modifications are generally more desirable if they can bring about a decrease in chi-square that is relatively large, compared to a change in degrees of freedom.*

This is the case in this analysis. It seems that it was the correct decision to eliminate the 12 indicator variables from the revised model. The  $\chi^2/\text{df}$  ratio for the revised model is now 18.15, instead of 92.03 for the observed initial model. This is not an acceptable ratio, given the informal criterion that the ratio should be at least 2 [Hatcher, 1994:290]. However, Hatcher (2002:290) cautions

*... that this criterion be used only as a very rough rule of thumb, if at all, and be supplemented with other criteria that are not affected by sample size.*

Given the initial small number of indicator variables, 23, used in the analysis, the  $\chi^2/\text{df}$  ratio

was not used any further in the analysis for the good of fit of the revised model, as it was believed that it was being affected by the sample size [Marsh, Balla, and McDonald, 1998].

The Bentler's Comparative Fit Index (CFI), and the Bentler and Bonett's non-normed index (NNFI) appear on the 18<sup>th</sup> and 24<sup>th</sup> lines, respectively of Output 9.1. The output shows that the CFI and the NNFI for the revised model are .948, and .917, respectively. These indices are both acceptable, see iteration 27, and significantly higher than those observer with the initial model, which were .574, and .510, respectively [cf. G5.2 Fit Statistics].

The t tests that test the significance of the factor loading appears in *Output 9.1*. From Step 3 [cf. *Step 3: Reviewing significance tests for factor Loadings*] The current analysis seems to remind one that these tests are significant if the observed t value is greater than 1.96. From the output, starting with *LV21F3*, the t-value is 41.94, and all of the other ten are significantly different from zero.

The next test of significance is that of the standardised factor loading. These factor loadings appear in *Output 9.3*. It can be seen that all standardised loadings are greater than .60. It may therefore be concluded that all loading are significantly large. The first standardised coefficient, *LV21F3*, is 0.9676.

Attention is next turned to reviewing the normalised residuals of the revised model [cf. *Step 4: Reviewing the residual matrix and normalised residual matrix.*], which appear in Output 9.3. In this output, ideally one expects normalised residuals that do not exceed 2.00. However, this is affected by sample size, and is an ideal criterion, which at times is difficult to obtain in practice. In the process of modifying the measurement model, normalised residuals of at least 2.00 were obtained in iterations 18 through to 23. Neither of these iterations were selected as the final (revised) measurement model, because of the effect of model identification.

Next the *Distribution of Normalised Residuals* is presented in *Output 9.5*. In this distribution, each asterisk represents a residual, so each bar identify the intervals in which the residuals appear. One can see that in this output the residuals are fairly symmetrical, and is centered around zero. There is, however, one outlier residual on each tail of the distribution, between the range 8.865 and 9.220, and -8.865 and -8.511, respectively.

In summary, the preceding output suggests that the final (revised) measurement model:

## Output 9.1: Manifest Variables with Estimates

```

The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation
  Manifest Variable Equations with Estimates
V21      =  0.9515*F3      +  1.0000 E21
Std Err   0.0227 LV21F3
t Value  41.9428
V27      =  0.3974*F3      +  1.0000 E27
Std Err   0.0158 LV27F3
t Value  25.1880
V29      =  0.3496*F5      +  1.0000 E29
Std Err   0.0145 LV29F5
t Value  24.0665
V55      =  0.5348*F2      +  1.0000 E55
Std Err   0.0136 LV55F2
t Value  39.3532
S2       =  0.5249*F1      +  1.0000 E2
Std Err   0.0156 LS2F1
t Value  33.5632
S4       =  0.5143*F1      +  1.0000 E4
Std Err   0.0147 LS4F1
t Value  35.0654
S6       =  0.5318*F2      +  1.0000 E6
Std Err   0.0128 LS6F2
t Value  41.5440
S7       =  0.4359*F2      +  1.0000 E7
Std Err   0.0120 LS7F2
t Value  36.2461
S8       =  0.4360*F4      +  1.0000 E8
Std Err   0.0142 LS8F4
t Value  30.6393
S9       =  0.7304*F4      +  1.0000 E9
Std Err   0.0138 LS9F4
t Value  53.0137
S13      =  0.6607*F5      +  1.0000 E13
Std Err   0.0126 LS13F5
t Value  52.3312

```

## Output 9.2: Manifest Variables with Standardised Estimates

```

The SAS System          27          22:00 Saturday, July 24, 2004
                        The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation
Manifest Variable Equations with Standardized Estimates
    V21      =    0.9676*F3      +    0.2525 E21
                        LV21F3
    V27      =    0.6591*F3      +    0.7520 E27
                        LV27F3
    V29      =    0.6384*F5      +    0.7697 E29
                        LV29F5
    V55      =    0.8945*F2      +    0.4470 E55
                        LV55F2
    S2       =    0.8272*F1      +    0.5618 E2
                        LS2F1
    S4       =    0.8543*F1      +    0.5198 E4
                        LS4F1
    S6       =    0.9244*F2      +    0.3813 E6
                        LS6F2
    S7       =    0.8491*F2      +    0.5282 E7
                        LS7F2
    S8       =    0.7561*F4      +    0.6545 E8
                        LS8F4
    S9       =    1.0655*F4      +    1.0000 E9
                        LS9F4
    S13      =    1.1271*F5      +    1.0000 E13
                        LS13F5

```

## Output 9.3: Rank Order of the 10 Largest Asymptotically Standardized Residuals

```

Rank Order of the 10 Largest Asymptotically Standardized Residuals
    Row      Column      Residual
    S4       V27         8.93322
    S2       V21        -8.79755
    S8       S2          7.53523
    S2       V55         7.25151
    S9       V27        -6.16665
    V29      V21        -5.98115
    S8       S7          5.76249
    S13      V21        -5.43834
    S4       V21         5.40804
    S9       S7          4.92596

```

## Output 9.4: Distribution of Normalised Residuals

The SAS System 23 22:00 Saturday, July 24, 2004

## The CALIS Procedure

Covariance Structure Analysis: Maximum Likelihood Estimation

Distribution of Asymptotically Standardized Residuals

Each \* Represents 1 Residuals

-----Range-----		Freq	Percent	
-8.86538	-8.51077	1	1.52	*
-8.51077	-8.15615	0	0.00	
-8.15615	-7.80154	0	0.00	
-7.80154	-7.44692	0	0.00	
-7.44692	-7.09230	0	0.00	
-7.09230	-6.73769	0	0.00	
-6.73769	-6.38307	0	0.00	
-6.38307	-6.02846	1	1.52	*
-6.02846	-5.67384	1	1.52	*
-5.67384	-5.31923	1	1.52	*
-5.31923	-4.96461	0	0.00	
-4.96461	-4.61000	0	0.00	
-4.61000	-4.25538	0	0.00	
-4.25538	-3.90077	4	6.06	****
-3.90077	-3.54615	2	3.03	**
-3.54615	-3.19154	0	0.00	
-3.19154	-2.83692	1	1.52	*
-2.83692	-2.48231	1	1.52	*
-2.48231	-2.12769	1	1.52	*
-2.12769	-1.77308	0	0.00	
-1.77308	-1.41846	1	1.52	*
-1.41846	-1.06385	1	1.52	*
-1.06385	-0.70923	3	4.55	***
-0.70923	-0.35462	4	6.06	****
-0.35462	0	2	3.03	**
0	0.35462	16	24.24	*****
0.35462	0.70923	1	1.52	*
0.70923	1.06385	3	4.55	***
1.06385	1.41846	2	3.03	**
1.41846	1.77308	3	4.55	***
1.77308	2.12769	1	1.52	*
2.12769	2.48231	1	1.52	*
2.48231	2.83692	2	3.03	**
2.83692	3.19154	1	1.52	*
3.19154	3.54615	2	3.03	**
3.54615	3.90077	1	1.52	*
3.90077	4.25538	2	3.03	**
4.25538	4.61000	0	0.00	
4.61000	4.96461	2	3.03	**
4.96461	5.31923	0	0.00	
5.31923	5.67384	1	1.52	*
5.67384	6.02846	1	1.52	*
6.02846	6.38307	0	0.00	
6.38307	6.73769	0	0.00	
6.73769	7.09230	0	0.00	
7.09230	7.44692	1	1.52	*
7.44692	7.80154	1	1.52	*
7.80154	8.15615	0	0.00	
8.15615	8.51077	0	0.00	
8.51077	8.86538	0	0.00	
8.86538	9.22000	1	1.52	*



- provides an acceptable fit to the data (as indicated by the CFI and the NNFI). Both the CFI and the NNFI are  $> 0.9$  [cf. *Table 9.10: Goodness of Fit Indices for Final Measurement Model*],
- displays no nonsignificant factor loadings. All loadings are  $>.60$  [cf. *Output 9.2: Manifest Variables with Standardised Estimates*], and
- although, the model displays large absolute normalized residuals  $>2$  [cf. *Output 9.3: Rank Order of the 10 Largest Asymptotically Standardized Residuals*], the distribution of normalised residuals is fairly symmetrical, and is centered around zero [cf. *Output 9.4 : Distribution of Normalised Residuals*].

Thus, the distribution of normalised residuals meets all the criteria of normal distribution.

Combined, these findings provide support for the revised model. However, the researcher chooses to assess the reliability and validity of the latent factors (constructs) and manifest (indicators) variables before conclusively accepting it as the final measurement model. These tests are performed next.

### Assessing the reliability and validity of the Measurement Model

**1. Indicator Reliability.** The reliability of an indicator is defined as the square of the correlation between a latent factor and that indicator (Hatcher, 2002:325). This means that the reliability indicates the percent of variation in the indicator that is explained by the factor that it is supposed to measure (Long, 1983a, as cited in Hatcher, 2002:325). The reliability of an indicator may be computed either by squaring the standardised factor loading [cf. *Output 9.2 : Manifest Variables with Standardised Estimates*] or by directly using the *R-squared* value from *Output 9.5* [cf. *Output 9.5 : Squared Multiple Correlations*]. In *Output 9.2*, the loading that represents the path from F3 to V21 is “LV21F3”, and has a value of .9676. The square of which is .9362. This value coincides with first parameter in the column headed **Total R-squared** in *Output 9.5*. The R-squared indicates the percent of variances in each indicator that is accounted for by the common factor to which it was assigned. These  $R^2$  values are indicator reliabilities.

All five latent factors are measured by indicators which display very high reliabilities. These vary from a low of .408 to a high of 1.270. The latent factors Organisational Learning (F4),

Output 9.5: Squared Multiple Correlations

	Variable	Variance	Error Variance	Total R-Square
1	V21	0.06166	0.96704	0.9362
2	V27	0.20552	0.36342	0.4345
3	V29	0.17768	0.29992	0.4076
4	V55	0.07143	0.35739	0.8001
5	S2	0.12710	0.40263	0.6843
6	S4	0.09791	0.36240	0.7298
7	S6	0.04813	0.33099	0.8546
8	S7	0.07355	0.26359	0.7210
9	S8	0.14244	0.33256	0.5717
10	S9	-0.06353	0.46994	1.1352
11	S13	-0.09292	0.34363	1.2704

and Human Knowledge (F5), both have indicators with reliabilities in excess of 1, for the composite variables S9 and S13, respectively. These values are summarized in the third column of Table 9.11.

The review of the composite reliability is next, attention will be drawn to whether the composite reliabilities of latent factors F4 and F5 are significant or not.

**2. Composite Reliability.** The composite reliability index (adapted from Fornell and Larcker, 1981) reflects the internal consistency of the indicators measuring a given factor. It is analogous to the Cronbach's coefficient alpha (Cronbach, 1951) and is calculated in next.

The composite reliability and the variance extracted are given in Equations 9.2, and 9.3.

The foregoing, now allows the computation of the square sum of the standardised factor loading,  $(\sum L_i)^2$ , for each factor, using the data from Table 9.11.

$$\begin{aligned}
 F1: &= (S2 + S4)^2 = (.827 + .852)^2 = (1.681)^2 = 2.826 \\
 F2: &= (V55 + S6 + S7)^2 = (.895 + .924 + .849)^2 = (2.668)^2 = 7.118 \\
 F3: &= (V21 + V27)^2 = (.968 + .659)^2 = (1.627)^2 = 2.647 \\
 F4: &= (S8 + S9)^2 = (.756 + 1.066)^2 = (1.822)^2 = 3.320 \\
 F5: &= (S13 + V29)^2 = (.1127 + .638)^2 = (1.765)^2 = 3.115.
 \end{aligned}$$

The composite reliability indices and the variance extracted estimates for the final revised measurement model is given in Table 9.12.

Table 9.11: Information needed to compute composite reliability and variance extracted estimates

Constructs and Indicators	$L_i$	$L_i^2$	$1 - L_i^2$
Business Intelligence (F1)	-	-	-
S2	.827	.684	.316
S4	.854	.730	.270
Asynchronous Groupware (F2)	-	-	-
V55	.895	.800	.200
S6	.924	.855	.145
S7	.849	.721	.279
Structural Capital (F3)	-	-	-
V21	.968	.936	.064
V27	.659	.435	.565
Organisational learning (F4)	-	-	-
S8	.756	.572	.428
S9	1.066	1.135	-0.135
Human Knowledge (F5)	-	-	-
S13	1.127	1.270	-0.270
V29	.638	.408	.592

Note: 1.  $L_i$ : Standardised Loading. 2.  $L_i^2$ : Indicator reliability, which is calculated as the square of the standardised factor loading. 3.  $1 - L_i^2$ : Error variance. Calculated as 1 minus the indicator reliability.

Table 9.12: Properties of the Final (Revised) Measurement Model

Constructs and Indicators	$L_i$	$t^1$	Reliability	Variance <sup>2</sup>
<b>Business Intelligence (F1)</b>	-	-	<b>.828<sup>3</sup></b>	<b>.707</b>
S2	.827	33.56	.684	-
S4	.854	35.07	.730	-
<b>Asynchronous Groupware (F2)</b>	-	-	<b>.919</b>	<b>.792</b>
V55	.895	39.35	.800	-
S6	.924	41.54	.855	-
S7	.849	36.25	.721	-
<b>Structural Capital (F3)</b>	-	-	<b>.808</b>	<b>.686</b>
V21	.968	41.94	.936	-
V27	.659	25.19	.435	-
<b>Organisational learning (F4)</b>	-	-	<b>.919</b>	<b>.854</b>
S8	.756	30.64	.572	-
S9	1.066	53.01	1.135	-
<b>Human Knowledge (F5)</b>	-	-	<b>.906</b>	<b>.839</b>
S13	1.127	53.33	1.270	-
S29	.638	24.07	.408	-

Note: 1. All t tests were significant at  $p < 0.001$ ,  
2. Variance extracted estimate, 3. Denotes composite reliability

These results are then inserted in Equation ??, for the composite reliability, for each factor, thus giving the composite reliability:

- (F1: Business Intelligence): = 0.828
- (F2: Asynchronous Groupware): = 0.919
- (F3: Structural Capital): = 0.808
- (F4: Organisational Learning): = 0.919
- (F5: Human Resources): = 0.906

The acceptable composite reliability should be between .60 and .70, with .70 being the preferable level (Hatcher, 1994:329). In the case of the revised measurement model, all five latent factors have composite reliability in excess of .70. The reliabilities range from a low of .70 to a high of .92. Interestingly, latent factors F4 and F5 both have composite reliabilities over .90, thus confirming the indicator reliabilities, and that the indicators are indeed reliable are true measures of the constructs, F4 and F5, respectively.

**3. Variance extracted estimate.** The variance extracted estimate assess the amount of variance that is captured by an underlying factor in relation to the amount of variance due to measurement error. The formula is given in Equation 9.3.

Inserting the data from Table 9.12, into Equation 9.3, one obtains the following variance extracted estimates for each factor:

- BI – Business Intelligence (F1): = 0.707, or 71%, while only 29% is due to measurement error.
- AG – Asynchronous Groupware (F2): = 0.792, or 79%, while only 21% is due to measurement error
- SC – Structural Capital (F3): = 0.686, or 69%, while only 31% is due to measurement error.
- OL – Organisational Learning (F4): = 0.854, or 85%, while only 15% is due to measurement error, and

- HK – Human Resources (F5): = 0.839, or 84%, while only 16% is due to measurement error.

The variance captured by each of the five constructs except one, are in excess of 70%. Thus, attesting to the validity of the Revised Measurement Model, while the variance due to measurement error range from 15% to 31%. These variances exceed the 50% criteria recommended by Fornell and Larcker (1981).

**4. Convergent Validity.** Convergent validity is demonstrated when different instruments are used to measure the same construct, and the scores from these different instruments are strongly correlated. In this research, convergent validity is assessed by using the results of the t tests for the factor loadings. In general, if all factor loadings for the indicators measuring the same construct are statistically significant (greater than twice their standard error) this is viewed as evidence supporting the convergent validity of those indicators (Hatcher, 2002:332).

All the t tests for this research is statistically significant. The fact that all t tests are significant illustrates that all indicators are effectively measuring the same construct (Anderson and Gerbing, 1998). The standardised factor loadings and the t tests for these loadings are presented in Table 9.12. Taking note of the convergent validity of the three indicators measuring *AG: V55, S6, and S7*, one sees that the results show that the t values for these three indicators range from 36.25 to 41.54. These t values are all significantly different from zero at  $p < .001$ . This is because all three t values exceed the critical t of 3.29 for  $p = .001$ . Hence, one can confidently conclude that these results support the convergent validity of *V55, S6, and S7* as measures of AG. A review of the other indicators in Table 9.12 also demonstrate that all of have significant t values, supporting their convergent validity. Hence, the constructs in this revised measurement model is evidenced by the convergent validity of their respective indicator variables.

**5. Discriminant Validity.** Discriminant validity is demonstrated, in general, when different instruments are used to measure different constructs, and the correlations between the measures of these different constructs are relatively weak. A test displays discriminant validity when it is demonstrated that the test does not measure a construct that it was designed to measure which are used to measure different constructs are relatively weak [Hatcher, 2002:332].

One assessed the discriminant validity of the Revised Measurement Model though the use of the

following three procedures:

- The chi-square difference test,
- The confidence interval test, and
- The variance extracted test.

**i). Chi-square difference test.** The study starts the analysis with the chi-square difference test, where the discriminant validity of any two construct may be assessed by:

- estimating the standard measurement model in which all factors are allowed to covary,
- creating a new measurement model identical to the previous one, except that the correlation between the two factors of interest is fixed at 1, and
- computing the chi-square difference statistic for the two models.

Discriminant validity is demonstrated if the chi-square is significantly lower for the first model, as this suggests that the better model was the one in which the two constructs were viewed as distinct (but correlated) factors (Anderson and Gerbing, 1998; Bagozzi and Phillips, 1982).

This procedure is used to assess the discriminant validity of the constructs SC (F3), and OL (F4). **Output 9.6** presents the *Correlation among Exogenous Variables*. This output results from the SAS syntax code in **Table 9.9** [*cf. Table 9.9: Syntax code for Final Measurement Model*], and **Figure 9.9** [*cf. Figure 9.9 Final (revised) measurement model*] in which all factors were allowed to covary. Hence, **Output 9.6** shows that the correlation between F3 and F4 is .751.

The fact that this correlation is so strong raises two issues. Firstly, it implies that SC (F3) indeed has a positive casual effect on OL(F4). This correlation is consistent with the theoretical model.

In assessing the discriminant validity of F3 and F4, the researcher modifies the COV statement in the Proc Calis program of **Table 9.9**, so that the covariance between the two factors is fixed at 1. This change is reflected in **Output 9.7**.

Output 9.6: Correlation among Exogenous Variables

Var1	Var2	Parameter	Estimate
F1	F2	CF1F2	0.60653
F1	F3	CF1F3	0.80247
F2	F3	CF2F3	0.49656
F1	F4	CF1F4	0.63609
F2	F4	CF2F4	0.59667
F3	F4	CF3F4	0.75110
F1	F5	CF1F5	0.66212
F2	F5	CF2F5	0.46342
F3	F5	CF3F5	0.69704
F4	F5	CF4F5	0.66611

Output 9.7: Modified Cov statement for unidimensional model

```

COV /* ----- COVARIANCES ----- */

F1 F2 = CF1F2,

F1 F3 = CF1F3,

F1 F4 = CF1F4,

F1 F5 = CF1F5,

F2 F3 =CF2F3,

F2 F4 = CF2F4,

F2 F5 = CF2F5,

F3 F4 = 1,

F3 F5 = CF3F5,

F4 F5 = CF4F5;

```

Table 9.13: Unidimensional model fit statistics

Fit Function	0.7893
Goodness of Fit Index (GFI)	0.8869
GFI Adjusted for Degrees of Freedom (AGFI)	0.7867
Root Mean Square Residual (RMR)	0.0293
Parsimonious GFI (Mulaik, 1989)	0.5644
Chi-Square	966.1447
Chi-Square DF	35
Pr> Chi-Square	< .0001
Independence Model Chi-Square	11471
Independence Model Chi-Square DF	55
RMSEA Estimate	0.1474
RMSEA 90% Lower Confidence Limit	0.1395
RMSEA 90% Upper Confidence Limit	0.1555
ECVI Estimate	0.8405
ECVI 90% Lower Confidence Limit	0.7604
ECVI 90% Upper Confidence Limit	0.9268
Probability of Close Fit	0.0000
Bentler's Comparative Fit Index	0.9184
Normal Theory Reweighted LS Chi-Square	858.5896
Akaike's Information Criterion	896.1447
Bozdogan's (1987) CAIC	682.2704
Schwarz's Bayesian Criterion	717.2704
McDonald's (1989) Centrality	0.6838
Bentler and Bonett's (1980) Non-normed Index	0.8718
Bentler and Bonett's (1980) NFI	0.9158
James, Mulaik, and Brett (1982) Parsimonious NFI	0.5828
Z-Test of Wilson and Hilferty (1931)	25.4582
Bollen (1986) Normed Index Rho1	0.8676
Bollen (1988) Non-normed Index Delta2	0.9186
Hoelter's (1983) Critical N	65

Note: Covariance Structure Analysis: Maximum Likelihood Estimation

The resulting model fit statistics is presented in Table 9.13. The model created as a result of this modification is referred to here as the unidimensional model, while the model in which the correlation between F3 and F4 is a free parameter to be estimated is referred to as the standard measurement model.

From **Table 9.13**, the unidimensional model fit summary displayed a model chi-square of 966.14 with 35 df. The model fit summary of the standard model is presented in Table G5.2 [*cf. G5.2 Fit Statistics*] of *Appendix G*. The chi-square for that model (standard model) is 617.24 with 34 df. This information is used to calculate the difference in  $\chi^2$  between the two models as follows:



Table 9.14: Chi-square critical values

Prob*	0.250	0.100	0.050	0.025	0.010	0.005	0.001
v=1	1.32	2.71	3.84	5.02	6.63	7.88	10.8
2	2.77	4.61	5.99	7.38	9.21	10.6	13.8
3	4.11	6.25	7.81	9.35	11.3	12.8	16.3
4	5.39	7.78	9.49	11.1	13.3	14.9	18.5
5	6.63	9.24	11.1	12.8	15.1	16.7	20.5
6	7.84	10.6	12.6	14.4	16.8	18.5	22.5
7	9.04	12.0	14.1	16.0	18.5	20.3	24.3
8	10.2	13.4	15.5	17.5	20.3	22.0	26.1
9	11.4	14.7	16.9	19.0	21.7	23.6	27.9
10	12.5	16.0	18.3	20.5	23.2	25.2	29.6
11	13.7	17.3	19.7	21.9	24.7	26.8	31.3

Note: \*Prob – Probability, v = the number of degrees of freedom.

difference test =  $(966.14 - 617.24) = 248.90$

df difference =  $(35 - 34) = 1$

The critical values of  $\chi^2$  from **Table 9.14**. The researcher finds that, with 1 df, the critical values of are 3.841 at  $p = .05$ , 6.635 at  $p = .01$ , and 10.827 at  $p = .001$ . Since the observed  $\chi^2$  difference value is 248.9, the difference between the two models are clearly significant at  $p < .001$ . This suggest that the standard measurement model in which the factors were viewed as being distinct but yet correlated constructs provides a fit that was significantly better than the fit provided by the unidirectional model. It may be therefore concluded that this test supports the discriminant validity of F3 and F4.

From the present evidence, it was decided not to test the discriminant validity for every possible pair of F factors. This would require performing a series of tests, in which the covariance between just two factors is fixed at 1, the model is then estimated, and would require the resulting chi-square and the  $\chi^2$  for the standard measurement model. This would result in 10 different models, and consequently, 10 different tests. This is because there are 10 separate covariances between the five factors in the model.

In performing such a large number of tests would be untenable, since it would mostly lightly create problems with the significance level for the family of tests.

**ii). Confidence interval test.** The researcher also performed a confidence interval test to assess the discriminant validity of the two factors, F3 and F4. This test involves calculating a

Table 9.15: Discriminant validity of the final revised measurement model

Variables	Covariance	Est	Std Err	$(Std.Err)^2$	t-value	UB	LB
F1 F2	CF1F2	.607	.0224	.044	27.06	.563	.651
F1 F3	CF1F3	.802	.0165	.034	48.60	.768	.836
F2 F3	CF2F3	.497	.0241	.048	20.62	.449	.545
F1 F4	CF1F4	.636	.0188	.038	33.89	.598	.674
F2 F4	CF2F4	.597	.0183	.036	32.60	.61	.633
F3 F4	CF3F4	.751	.0151	.030	49.85	.721	.781
F1 F5	CF1F5	.662	.0184	.036	36.08	.626	.698
F2 F5	CF2F5	.463	.021	.042	22.06	.421	.505
F3 F5	CF3F5	.700	.018	.036	39.78	.664	.736
F4 F5	CF4F5	.670	.017	.034	40.10	.636	.704

Note: 1. Est. – Estimation 2. UB – Upper Bound 3. LB – Lower Bound

confidence interval of plus or minus two standard errors around the correlation between the two factors, and determining whether this interval includes 1.0. If it does not include 1.0, discriminant validity is demonstrated (Anderson and Gerbing, 1998, as cited in Hatcher, 2002:337).

The data in Table 9.15 were used to perform the confidence interval test of the revised measurement model. This output presents the covariances (correlations, in the case) between all latent factors, along with the standard errors for these correlations (Hatcher, 2002:338).

The discriminant validity is presented in Table 9.15

The correlation between between F3 F4 is .751 and the standard error for this estimate is .0151. This standard error, .0151, was multiplied by 2, so as to compute the confidence interval for the correlation,  $.751 : 2 \times .0151 = .0302$ .

Next the lower and upper boundary for the confidence interval were computed. In the case of the lower boundary, it will be two standard errors below the correlation, while in the case of the upper boundary, it will be two standard errors above the correlation.

*Lower boundary* =  $.751 - .0302 = .7203$  *Upper boundary* =  $.751 + .0302 = .7812$ . So the confidence interval for the relationship between F3 and F4 ranges from .7203 to .7812. This confidence interval does not include the value of 1.0, necessary that it is very unlikely that the actual population correlation between F3 and F4 is 1.0. This finding supports the discriminant validity of the measures.

iii). **Variance extracted test.** Finally, discriminant validity may also be assessed with a variance extracted test (Fornell and Larcker, 1981; Netemeyers et al. 1990, as cited in Hatcher, 2002:339). The approach for this test is to review the variance extracted estimates (*as was done previously in section 9.4.4*) for the two factors (constructs) of interest, and compare these estimates to the square of the correlation between the two factors. Discriminant validity is demonstrated if both variances extracted estimates are greater than this squared correlation.

In the chapter, the correlation between F3 and F4 is .7511. The square of this correlation is .564. One calculated the variance extracted estimates earlier in Table 9.12 [*cf. Table 9.12: Properties of the Final Revised Measurement Model*]. The variance extracted estimates for F3 is .686 and for F4 it is .854. These values are greater than the square of the correlation between F3 and F4, therefore discriminant validity is demonstrated. Overall the revised measurement model provide support for the discriminant validity, all three tests suggest that the 11 indicators are representative of the five latent factors, and that the model is an acceptable fit of the data for KM-BI model.

#### 9.4.5 The final revised measurement model

##### The revised measurement model.

Goodness of fit indices for the re-specified measurement model,  $M_m$ , are presented in Table 9.10. This table shows that the revised measurement model displayed values greater than .9 on the non-normed-fit index (NNFI) and the comparative fit index (CFI), indicative of an acceptable fit [Bentler and Bonnet, 1980; Bentler, 1989]. Therefore, model  $M_m$  was tentatively accepted as the research *final* measurement model, and a number of tests were conducted to assess its reliability and validity.

Standardized factor loadings for the indicator variables are presented in Table 9.11, and 9.12. The SAS System's CALIS procedure provides approximate standard errors for these coefficients which allow large-sample t tests of the null hypothesis that the coefficients are equal to zero in the population. The t scores obtained for the coefficients in Table 9.11 range from 6.99 through 18.78, indicating that all factor loadings were significant ( $p < .001$ ). This finding provides evidence supporting the convergent validity of the indicators [Anderson and Gerbing, 1988].

Table 9.11 also provides the reliabilities of the indicators (the square of the factor loadings),

along with the composite reliability for each construct. Composite reliability is a measure of internal consistency comparable to coefficient alpha [Fornell and Larcker, 1981]. All six scales demonstrated acceptable levels of reliability, with coefficients in excess of .70.

The final column of Table 9.12 provides the variance extracted estimate for each scale. This is a measure of the amount of variance captured by a construct, relative to the variance due to random measurement error [Fornell and Larcker, 1981]. All five of the six constructs demonstrated variance extracted estimates in excess of .50, the level recommended by Fornell and Larcker (1981).

Combined, these findings generally support the reliability and validity of the constructs and their indicators. The revised measurement model,  $M_m$ , was therefore retained as the research final measurement model against which other models will be compared.

In arriving at the final model one was guided by the eight characteristics discussed next in section 9.4.6.

#### 9.4.6 Characteristics of an *ideal fit* for the measurement model.

Hatcher (1994:339) gives eight conditions which must be met for a measurement model to provide an ideal fit to the data. The conditions are given below.

1. The p value for the model chi-square test should be non-significant, that is, it should be greater than 0.05. In the present model the p value is  $<0.0001$  which is highly significant. Hatcher (1994) does, however, argue that it is not possible to achieve non-significant p values for real life data and that a significant p value is not reason enough to reject a model. The researcher concurs with this view, given the heterogeneity, cultural diversity and geo-political divide of the sample used in this research.
2. The  $\chi^2/df$  ratio should be less than 2. This criterion is not met by the current model since the ratio = 18.06.
3. The comparative fit index (CFI) and the non-normed fit index (NNFI) should both exceed 0.90, the closer to 1.00, the better. This criterion is met by the current model.
4. The absolute value of the t statistics for each factor loadings should exceed 1.96. The criterion is met.

5. The distribution of normalised residuals should be symmetrical and centred on zero, and relatively few (or no) normalised residuals should exceed 2.0 in absolute value.
6. Composite reliabilities for the latent factors should exceed .70 (.60 at the very least). The criterion is met where the five latent factors have composite reliabilities ranging from .81 to .92, respectively.
7. Variance extracted estimates for latent factors should exceed .50. This criterion is met, where the five latent factors have variance extracted estimates ranging from .69 to .85, respectively.
8. Discriminant validity for questionable pairs of factors should be demonstrated through the chi-square difference test, the confidence interval test, or the variance extracted test. This criterion is met. Table 9.15 supports this criterion.

## 9.5 The Structural Model

### Path Analysis with Latent Variables

The final revised measurement model,  $M_m$ , set out in Figure 9.9, is a factor analytical model which was used to identify the latent constructs and the observed variables that measure each latent construct. Casual relationships were not specified and as such, each construct was allowed to covary with every other construct.

#### 9.5.1 The initial theoretical casual model

In this section the current investigation proceeds to the second step of Anderson and Gerbing's (Anderson and Gerbing, 1988) two step procedure. Here, one will modify the final (revised) measurement model, of Figure 9.9, so that it specify casual relationship between the latent factors (constructs) of the KM-BI model. One also will review a number of procedures and indices that may be used to determine whether the resulting theoretical model provides an acceptable and parsimonious fit to the data. This, then will become the theoretical casual model that is to be tested. The theoretical model consists of two components:

- A measurement model that specifies the relationships between the latent constructs, and

- A structural model that specifies casual relationships between the latent constructs.

Finally, one will also use modification indices to achieve a better model fit, if this is proved necessary.

Figure 9.10 gives the initial theoretical casual model to be studied. The SAS Proc Calis program is illustrated in *Appendix H*.

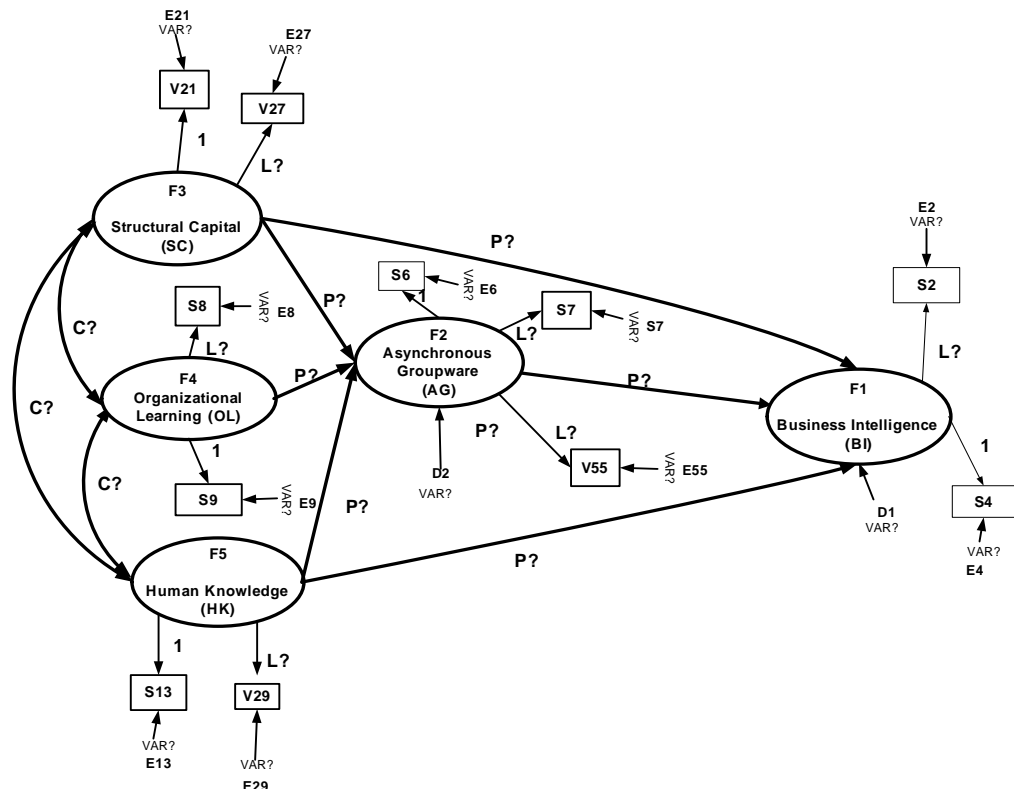


Figure 9.10: The initial hypothesized – theoretical model for KM-BI

The following differences are noted when compared to the measurement model:

1. The initial theoretical model includes the following casual relationships:

- $F2 \rightarrow F1$
- $F3 \rightarrow F1$
- $F5 \rightarrow F1$
- $F3 \rightarrow F2$
- $F4 \rightarrow F2$

- $F5 \rightarrow F2$

In other words, factors F2:AG, F3:SC, and F5:HK, exert casual influence on the factor F1:BI. While, factors F3:SC, F4:OL, and F5:HK, exert casual influence on the factor F1:BI.

The symbol  $P?$ , denotes the casual path coeficent between the factors.

2. The variance of the factors must now be estimated; this is indicated by the symbol  $VAR?$  (in the measurement model, the variance of the factors was fixed at 1).
3. The path loading of one manifest variable for each factor has been fixed at 1. Thus:

- $LV21F3 = 1$
- $LS9F4 = 1$
- $LS13F5 = 1$
- $LS7F2 = 1$
- $LS4F1 = 1$

4. A residual error term has been added to the endogenous variables Factor 1 (BI) and Factor 2 (AG), and their variances will be estimated (they are indicated by the symbols, D1, and D2,  $VAR?$ , respectively).

### 9.5.2 Assessing the fit between model and data

For the structural portion of this research one evaluates the model fit with the data by following a nine step procedure. The present investigation now proceed, in step 1, to review the goodness of fit of the  $\chi^2$  test, then the CFI and the NNFI, in step 2, and so on to step 9, where one reviews the nomological validity of the theoretical model,  $M_t$ , and the measurement model,  $M_m$ . The starting point is Table 9.16.

**1. Step 1: Reviewing the chi-square test.** This table, (Table 9.16) shows that the model  $\chi^2$  value for the theoretical model was 632.11, with 35  $df$  ( $p < .0001$ ). The ratio of  $\chi^2$  to  $df = 18.06$ . This ratio is greater than 2, and as such is not acceptable, according to the informal criterion, recommended by Hatcher (2002) and articulated in characteristic two in section 9.4.6.

Table 9.16: Goodness of fit indices for the initial structural model

Fit Function	0.5164
Goodness of Fit Index (GFI)	0.9137
GFI Adjusted for Degrees of Freedom (AGFI)	0.8372
Root Mean Square Residual (RMR)	0.0141
Parsimonious GFI (Mulaik, 1989)	0.5814
Chi-Square	632.1067
Chi-Square DF	35
Pr> Chi-Square	< .0001
Independence Model Chi-Square	11471
Independence Model Chi-Square DF	55
RMSEA Estimate	0.1181
RMSEA 90% Lower Confidence Limit	0.1101
RMSEA 90% Upper Confidence Limit	0.1262
ECVI Estimate	0.5676
ECVI 90% Lower Confidence Limit	0.5037
ECVI 90% Upper Confidence Limit	0.6376
Probability of Close Fit	0.0000
Bentler's Comparative Fit Index	0.9477
Normal Theory Reweighted LS Chi-Square	636.2375
Akaike's Information Criterion	562.1067
Bozdogan's (1987) CAIC	348.2323
Schwarz's Bayesian Criterion	383.2323
McDonald's (1989) Centrality	0.7837
Bentler and Bonett's (1980) Non-normed Index	0.9178
Bentler and Bonett's (1980) NFI	0.9449
James, Mulaik, and Brett (1982) Parsimonious NFI	0.6013
Z-Test of Wilson and Hilferty (1931)	20.4564
Bollen (1986) Normed Index Rho1	0.9134
Bollen (1988) Non-normed Index Delta2	0.9478
Hoelter's (1983) Critical N	98

Note: Covariance Structure Analysis: Maximum Likelihood Estimation. WARNING: The central parameter matrix PHI has probably 2 negative eigenvalue(s).



**2. Step 2: Reviewing the non-normed index and comparative fit index.** Table 9.16 shows that the comparative fit index (CFI) was .9477, which is slightly lower than the CFI of .9489, observed for the measurement model,  $M_m$ , but still in the acceptable range. The non-normed fit index (NNFI) for the theoretical model,  $M_t$ , is .9477, whereas the NNFI for the measurement model,  $M_m$ , was .9174. Additionally, the GFI is .9137, which is acceptable.

**3. Step 3: Reviewing the significance tests for factor loadings and path coefficients.**

One reviews the standard errors for the factor loadings and path coefficients, to ascertain that there is no near-zero standard errors in the model, because near-zero standard errors may indicate estimation problems. These parameters appear in Output 9.8, and none of the standard errors appears to be unacceptably small. It represents the non-standard factor loadings, of the theoretical model.

Furthermore, the results of factor loadings, say  $LS2F1$ ,  $LS4F1$ ,  $\dots$ ,  $LV29F5$ , show that all have t value greater than 1.96, and are therefore significantly different from zero. *Output 9.8* also includes the results for path coefficients. These are represented with the “P” prefix (such as  $PF1F2$ ). All the path coefficients are significant except for the path from F3 (SC) to F2 (AG), which displayed a nonsignificant t value of 1.56. Consistent with this, the standardised path coefficients for the latent variable equations presented in *Output 9.9*, show that the standardised path coefficient for the path from F3 to F2 was rather small at .0591. This finding is important in that if one needs to modify the model further, then deleting the path from F3 to F2 would perhaps be the starting point in this modification.

**4. Step 4: Reviewing R2 values for latent endogenous variables.** The R2 values for the structural models’ endogenous variables are presented in *Output 9.10* [*cf. Output 9.10 Variance of endogenous variables*]. Of particular interest are the R2 Values for the structural model’s latent endogenous variables F1 (BI), and F2 (AG). The results in *Output 9.10* show that the independent F variables accounted for 69% of the variance in BI, and 37% of the variance in AG.

**5. Step 5: Reviewing the residual matrix and normalised residual matrix.** The researcher analyses the actual covariances, predicted covariances, residual matrix, normalised residual matrix, and the distribution of normalised residuals, which is presented in *Appendix H*.

## Output 9.8: Manifest variable equations

The CALIS Procedure

Covariance Structure Analysis: Maximum Likelihood Estimation

## Manifest Variable Equations with Estimates

## Manifest Variable Equations with Estimates

```

S2      =  1.0270*F1      +  1.0000 E2
Std Err   0.0319 LS2F1
t Value  32.2427
S4      =  1.0000 F1      +  1.0000 E4
S6      =  1.0000 F2      +  1.0000 E6
S7      =  0.8190*F2      +  1.0000 E7
Std Err   0.0191 LS7F2
t Value  42.8454
S8      =  0.6002*F4      +  1.0000 E8
Std Err   0.0165 LS8F4
t Value  36.3770
S9      =  1.0000 F4      +  1.0000 E9
S13     =  1.0000 F5      +  1.0000 E13
V21     =  1.0000 F3      +  1.0000 E21
V27     =  0.4000*F3      +  1.0000 E27
Std Err   0.0156 LV27F3
t Value  25.6374
V29     =  0.5173*F5      +  1.0000 E29
Std Err   0.0225 LV29F5
t Value  23.0230
V55     =  1.0046*F2      +  1.0000 E55
Std Err   0.0211 LV55F2
t Value  47.6167

```

## Latent Variable Equations with Estimates

```

F1      =  0.2541*F2      +  0.2738*F3      +  0.1479*F5
Std Err   0.0251 PF1F2      0.0181 PF1F3      0.0192 PF1F5
t Value  10.1198      15.1413      7.7076

      +  1.0000 D1

F2      =  0.0323*F3      +  0.3618*F4      +  0.0707*F5
Std Err   0.0207 PF2F3      0.0271 PF2F4      0.0189 PF2F5
t Value   1.5595      13.3662      3.7387

      +  1.0000 D2

```

## Output 9.9: Standardised path coefficients

The CALIS Procedure  
Covariance Structure Analysis: Maximum Likelihood Estimation

## Manifest Variable Equations with Standardized Estimates

```

S2      =  0.8298*F1    +  0.5580 E2
              LS2F1
S4      =  0.8517 F1    +  0.5241 E4
S6      =  0.9251 F2    +  0.3797 E6
S7      =  0.8490*F2    +  0.5284 E7
              LS7F2
S8      =  0.7582*F4    +  0.6521 E8
              LS8F4
S9      =  1.0626 F4    +  1.0000 E9
S13     =  1.1376 F5    +  1.0000 E13
V21     =  0.9896 F3    +  0.1439 E21
V27     =  0.6457*F3    +  0.7636 E27
              LV27F3
V29     =  0.6299*F5    +  0.7767 E29
              LV29F5
V55     =  0.8944*F2    +  0.4473 E55
              LV55F2

```

## Latent Variable Equations with Standardized Estimates

```

F1      =  0.2638*F2    +  0.5196*F3    +  0.1924*F5    +  0.5561 D1
              PF1F2              PF1F3              PF1F5
F2      =  0.0591*F3    +  0.4951*F4    +  0.0886*F5    +  0.7969 D2
              PF2F3              PF2F4              PF2F5

```

## Output 9.10: Variance of endogenous variables

## Squared Multiple Correlations

	Variable	Error Variance	Total Variance	R-Square
1	S2	0.12538	0.40263	0.6886
2	S4	0.09955	0.36240	0.7253
3	S6	0.04771	0.33099	0.8558
4	S7	0.07359	0.26359	0.7208
5	S8	0.14140	0.33256	0.5748
6	S9	-0.06063	0.46994	1.1290
7	S13	-0.10105	0.34363	1.2941
8	V21	0.02002	0.96704	0.9793
9	V27	0.21189	0.36342	0.4169
10	V29	0.18094	0.29992	0.3967
11	V55	0.07151	0.35739	0.7999
12	F1	0.08129	0.26286	0.6908
13	F2	0.17989	0.28328	0.3650

*Table H1.1 of Appendix H.* One checks to see if the model provides a good fit but ascertaining whether the distribution of the normalised residuals are symmetrical and centred around zero. This distribution is represented here as *Output 9.151*

This output does not show this pattern. The residuals are not centred fully around zero, but is skewed to the right on “0 – 0.360” with a frequency of 13 with 13 residuals, and the distribution is further asymmetrical with one outlying residual each at the bottom and top of the output in the intervals from 9.719 to 10.079, and -8.279 to -7.919. Additionally, *Output 9.12* provides the rank order of the 10 largest normalised residuals. The results show that the four largest residuals involve the relationship between S2 (an indicator of F1: BI) and V21, and V55 (indicators of F3: SC and F2: AG, respectively), while S4 (an indicator of F1: BI) and V21, and V27 (all indicators of F3: SC).

This may require reassessing the paths from F3 to F1 and from F3 to F2, respectively. However, it is too early to do this at this stage of the analysis, since the modification indices must first be analyzed.

**6. Step 6: Reviewing the parsimony ratio and the parsimonious normed index.** In this step, from the evidence at hand, one assumes that the most desirable theoretical model is the most parsimonious model, given that all other factors/parameters are held constant. The parsimony of a model refers to its simplicity. In this vain, Hatcher (2002:382) states

... the principles of parsimony is when several theoretical explanations are equally satisfactory in accounting for some phenomenon, the preferred explanation is the one that makes the fewest assumptions.

In the present analysis, the concept of parsimony relates well to the concept of casual modelling. The theoretical model presented in Figure 9.10 attempts to explain variability in asynchronous groupware and business intelligence in transferring and collaborative interactions of KM. The model also identifies three exogenous variables.

These being SC, OL, and HK, which casually determine the levels and interactions of AG and BI. The model further posits that the relationships between these constructs can be accounted for with six casual paths: one each from AG (F2), SC (F3), and HK (F5), to BI (F1); and three from SC (F3), OL (F4) and HK (F5) to AG (F2). The model is very representative of the data by accounting for the high CFI and NNFI of .948 and .918, respectively.

## Output 9.11: Distribution of normalised residuals of the structural model

The CALIS Procedure Covariance Structure Analysis: Maximum  
Likelihood Estimation

## Distribution of Asymptotically Standardized Residuals

Each \* Represents 1 Residuals

-----Range-----		Freq	Percent	
-8.27930	-7.91934	1	1.52	*
-7.91934	-7.55937	0	0.00	
-7.55937	-7.19940	0	0.00	
-7.19940	-6.83943	0	0.00	
-6.83943	-6.47946	0	0.00	
-6.47946	-6.11949	0	0.00	
-6.11949	-5.75952	0	0.00	
-5.75952	-5.39955	0	0.00	
-5.39955	-5.03958	0	0.00	
-5.03958	-4.67961	2	3.03	**
-4.67961	-4.31964	2	3.03	**
-4.31964	-3.95967	2	3.03	**
-3.95967	-3.59970	2	3.03	**
-3.59970	-3.23973	2	3.03	**
-3.23973	-2.87976	1	1.52	*
-2.87976	-2.51979	3	4.55	***
-2.51979	-2.15982	1	1.52	*
-2.15982	-1.79985	0	0.00	
-1.79985	-1.43988	0	0.00	
-1.43988	-1.07991	1	1.52	*
-1.07991	-0.71994	1	1.52	*
-0.71994	-0.35997	4	6.06	****
-0.35997	0	3	4.55	***
0	0.35997	13	19.70	*****
0.35997	0.71994	2	3.03	**
0.71994	1.07991	1	1.52	*
1.07991	1.43988	3	4.55	***
1.43988	1.79985	5	7.58	*****
1.79985	2.15982	0	0.00	
2.15982	2.51979	2	3.03	**
2.51979	2.87976	2	3.03	**
2.87976	3.23973	2	3.03	**
3.23973	3.59970	0	0.00	
3.59970	3.95967	2	3.03	**
3.95967	4.31964	1	1.52	*
4.31964	4.67961	1	1.52	*
4.67961	5.03958	1	1.52	*
5.03958	5.39955	0	0.00	
5.39955	5.75952	1	1.52	*
5.75952	6.11949	2	3.03	**
6.11949	6.47946	0	0.00	
6.47946	6.83943	0	0.00	
6.83943	7.19940	0	0.00	
7.19940	7.55937	2	3.03	**
7.55937	7.91934	0	0.00	
7.91934	8.27930	0	0.00	
8.27930	8.63927	0	0.00	
8.63927	8.99924	0	0.00	
8.99924	9.35921	0	0.00	
9.35921	9.71918	0	0.00	
9.71918	10.07915	1	1.52	*

Output 9.12: Output 9.12 Rank Order of the 10 Largest Asymptotically Standardized Residuals

Row	Column	Residual
V27	S4	9.91061
V21	S2	-8.08788
V55	S2	7.36127
V21	S4	7.34564
S8	S2	6.10075
V27	S2	5.86870
S8	S7	5.68867
S9	S7	5.00168
V29	V21	-4.85529
V21	S13	-4.76281

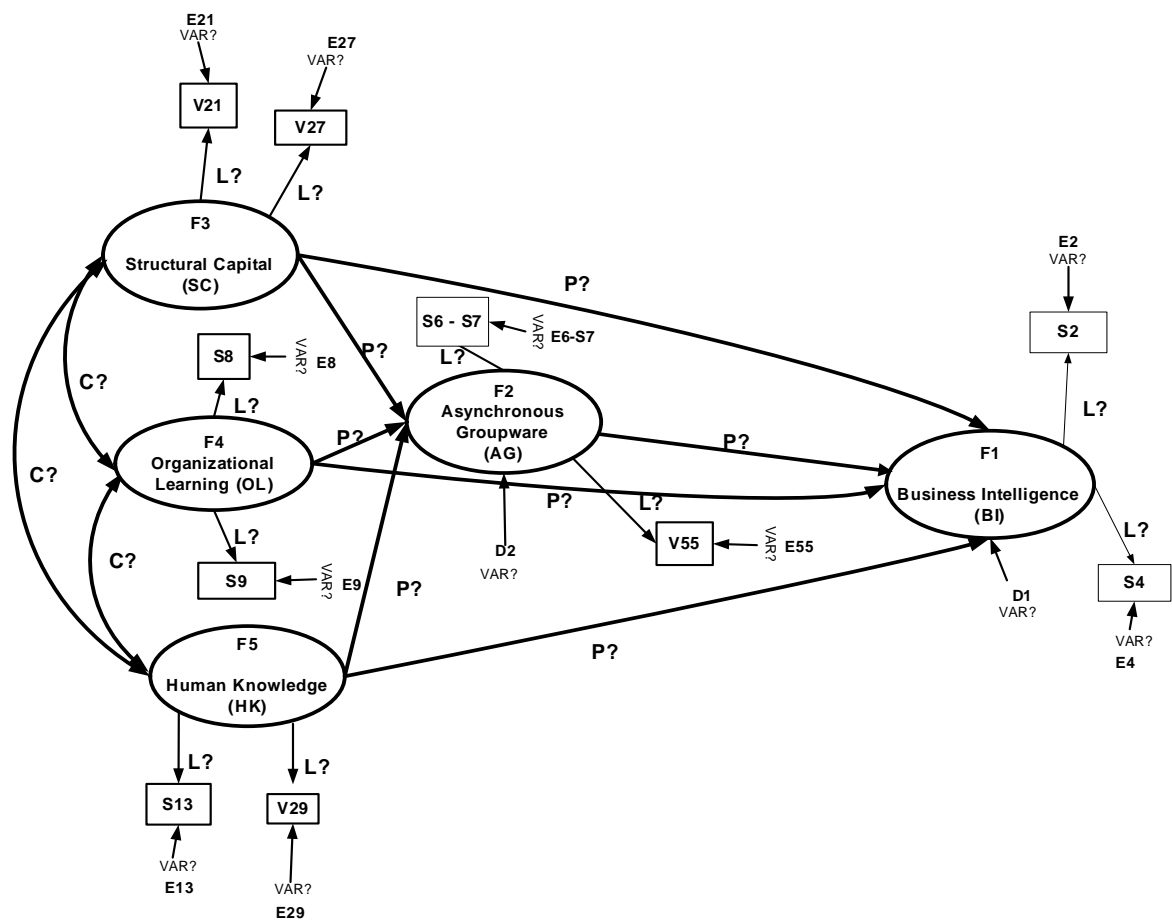


Figure 9.11: Theoretical (hypothetised) model (with added path from OL to BI)

These fit indices could be increased if the model observed covariances were made more complicated. This would require connecting the five latent factors to each other by either a covariance (a curved arrow) or a casual path (a straight arrow). Such a model would be similar to Figure 9.11. This model would be therefore less parsimonious than the initial theoretical model, in Figure 9.10.

The concept of parsimony is very important in predicting a model's level of parsimony. It is with this in mind that the parsimony ratio proposed by James, Mulaik and Brett (1982) is used as an index to calculate the model's level of parsimony. The parsimony ratio (PR) (James et al., 1982) is given as:

$$PR = \frac{df_j}{df_0} \quad (9.4)$$

where:

$df_j$  = the degrees of freedom for the model being studied (the initial structural model), and  $df_0$  = the degrees of freedom for the null (independence) model. Thus the  $PR = 0.636$ .

The independence model is a model that predicts no relationship between any of the variables of the research. In such as case, the model (null model) all paths and covariances between all the variables of the research are deleted. The SAS program, Proc Calis computes the independence model chi-square along with the other goodness of fit indices. This is presented in Table 9.16 as:

Independence Model Chi-Square	11471
Independence Model Chi-Square DF	55

Whilst the values for the current model's chi-square is given as:

Chi-Square	632.1067
Chi-Square DF	35
Pr > Chi-Square	< .0001

The respective  $\chi^2$  df are then used to computed the parsimony ratio (PR), for the theoretical model, which is .636. This is acceptable, given that the lowest possible value for the parsimony

ratio is zero. A value of zero may be obtained when the model is fully saturated (Hatcher, 2002) that is if every indicator variable (V and S variables) are connected to each other by either a covariance or a casual path. In such a case, the model, fully-saturated, would be the least parsimonious system possible. On the other hand, the upper limit on the PR is 1.0. This value may be obtained for the independent (null) model itself (Hatcher 2002): *the model that hypothesizes no relationships between any variables, and thus the most parsimonious system*(p. 384).

The present study uses the PR further to compute the parsimonious normed-fit index(PNFI) (James et al., 1982). This index uses both the PR and the NFI to reflect both the parsimony and the fit of the model simultaneously.

$$PNFI = (PR)(NFI) \quad (9.5)$$

where:

PR = parsimony ratio

NFI = normed fit index [cf. Table 9.16: Goodness of fit indices for the initial structural model].

Thus the PNFI =  $(0.636) \times (0.945) = 0.601$

The above calculation is not, however, necessary since this index is given in Table 9.16 as:

James, Mulaik, and Brett (1982) Parsimonious NFI	0.6013
--	--------

The PNFI is similar to the NFI, in that higher values indicate a more desirable model. In general, the PNFI is useful in selecting *a best model*, when there are more than one model with an acceptable fit to the data. The same is true for the PR. Additionally, there is no clear criterion from the literature, as to how large the PNFI should be for the model to be deemed acceptable. It has been suggested that a PNFI of 0.60 may be used as an ad-hoc criterion [Netemeyer et al., 1990; Williams and Hazur, 1986], while Mulaik et al., 1989 as cited in Hatcher (2002) indicates that it is possible to have acceptable models with PNFI in the 0.50s. Hence, the observed PNFI of .6013 for the initial theoretical model may be considered as being acceptable.



**7. Step 7: Reviewing the relative normed fit index.** The analysis up to this point has focussed on the theoretical model with its two components. These being the measurement model and the structural model combined. In the theoretical model it was hypothesized that the model describes the relationships between the latent variables and their indicators. In the structural model, on the other hand, the model describes the casual relationships between the latent variables themselves. As a consequence of this, all the goodness of fit indices presented so far in this chapter sought to reflect the overall fit of the measurement model and the structural model combined.

This approach can be problematic at times. In that in most theoretical models, the measurement model consist of a relatively small number of latent variables (five) compared to a relatively large number of indicator variables (initially 23). This results in the measurement portion of the model having more parameters to be estimated than in the structural portion of the model. In this analysis, the final (revised) measurement model has a large number [*cf. Output 9.2 Manifest Variables with Standardised Estimates*] of factor loadings are estimated, while only a few [*cf. Output 9.9 Standardised path coefficients*] are estimated. Hence, the indices of overall model fit, such as NNFI and CFI, are casually more influenced by the fit of the measurement portion of the theoretical portion (Hatcher, 2002). The major problem is that, the measurement model may provide a good fit, and as a consequence, the overall model may then produce very high NNFI and CFI values, although there are serious misspecifications in the structural portion of the model [Mulaik et al., 1989].

This caused some concerns for us, since one of the main objectives of this research was to review the casual relationship between KM and BI, as facilitated through the impact of asynchronous groupware [*cf. section 1.2*]. This is hypothesized to be analysed through the fit of the structural model, rather than through the fit of the measurement model. The hypothesized-theoretical research model, in Figure 9.2 is relevant. Mulaik et al. (1989) advise that this problem may be resolved by using the results of the analysis to calculate a relative normed-fit index (RNFI). This index reflects the fit in just the structural portion of the model, and is not influenced by the fit of the measurement model. The RNFI is interpreted similar to the NFI, where the higher values (nearer to 1.0) indicate that the hypothesized casual relations between the structural variables provide a good fit to the data [Hatcher, 2002].

The formula for the RNFI is as follows:

Table 9.17: Goodness of fit indices: Combined Model

Model	<i>Measurement Structural Component</i>							<i>Structural Model</i>		
	$\chi^2$	df	NFI	NNFI	CFI	PR	PNFI	RNFI	RPR	RPFI
$M_0$	11471	55	-	-	-	-	-	-	-	-
$M_u$	5704.4	54	.6400	.5623	.6419	.982	.5236	.0000	1.000	.0000
$M_t$	632.1	35	.9449	.9178	.9477	.636	.6013	.9973	.0500	.05
$M_{r1}$	635.46	37	.9446	.9221	.9476	.673	.636	.9964	.150	.150
$M_{r2}$	633.26	36	.9448	.9201	.9477	.655	.619	.9968	.10	.10
$M_m$	617.2	34	.9462	.9174	.9489	.618	.5849	1.000	.000	.000

Note: N = 1225,  $M_0$ =null model;  $M_u$  = uncorrelated factor;  $M_t$  = initial theoretical model;  $M_m$  = measurement model; df = degrees of freedom; NFI = normmed fit index; NNFI = non-normed fit index; CFI = comparative fit index; PR = parsimony ratio; PNFI = parsimonious normed-fit index; RNFI = relative-normed-fit index; RPR = relative parsimony ratio; RPFI = relative parsimonious fit index.

$$RNFI = \frac{F_u - F_j}{F_u - F_m - (df_j - df_m)} \quad (9.6)$$

where:

$F_u$  = model chi-square for the uncorrelated variables model,  $F_j$  = model chi-square for the model of interest (the theoretical model),  $F_m$  = model chi-square for the measurement model,  $df_j$  = degrees of freedom for the model of interest,  $df_m$  = degrees of freedom for the measurement model.

There are three models being considered in this formula. Firstly, the model of interest is the initial theoretical KM-BI model,  $M_t$ , which is presented in Figure 9.10 [*cf. Figure 9.10: The initial hypothesized – theoretical model for KM-BI*]. Secondly, the final (revised) measurement model  $M_m$ , which is the confirmatory factor analysis in which all F variables are allowed to covary. In Figure 9.9 [*cf. Figure 9.9: Final (revised) measurement model*] one sees that each latent F variable is connected to every other latent F variable by a curved, doubled-headed arrow. The third model, which is being introduced here for the first time, is the uncorrelated factor model,  $M_u$ . This model is identical to the final measurement model,  $M_m$ , except none of the F variables are allowed to covary. This means that none of the latent F variables is connected to any of the other latent, F, variables by a curved or straight arrow. This model predicts that all of the F variables are mutually uncorrelated.

At this juncture the researcher summarises the various indices of the different models in **Table 9.17**.

The first row of Table 9.17 presents information about the null model. The null model is a model in which all variables are completely uncorrelated to all other variables. The results are automatically printed by the *Proc Calis* program as illustrated in the Goodness of Fit Summary, of Table 9.17 [cf. Table 9.17: Goodness of fit indices for the initial structural model] as the independence model chi-square (Null model). The  $\chi^2$  for the null model is 11471 with 55 df. The second row of Table 9.17 presents the results for the uncorrelated factor model. The *Proc Calis* program code is presented in Appendix I.1 [cf. *I1.1 Syntax Code for the Uncorrelated Factor Model*]. These results are obtained by estimating a model in which the covariances between all latent variables have been fixed at zero. The  $\chi^2$  for the uncorrelated factor uncorrelated factor model is 5704.37 with 54 df [cf. *I1.2 Model Fit Summary for the Uncorrelated Factor Model*]. The *CFI* of .642 shows that this model does not provide an acceptably good fit to the data. The third row of the theoretical model, and the last row of the table summarises results for the (final) measurement model.

Having estimated all three models, the appropriate values from these models may now be substituted in the formula, Equation 9.6 to compute the relative normed-fit index *RNFI* for the theoretical model. From the formula, Equation 9.6 of the *RNFI* one obtains 0.9973 for the theoretical model. This index indicates the fit demonstrated by just the structural portion of the theoretical model,  $M_t$ , irrespective of how well the latent variables were measured by their indicators. The *RNFI* of 0.9973 indicates an outstandingly acceptable fit.

**8. Step 8: Reviewing the relative parsimony ratio and the relative parsimonious fit index.** Having reviewed the fit of the structural portion of the model, the researcher was then able to closely investigate the parsimony of this part of the model. The structural portion of the model needs to be saturated. It is instructive to recall that the literature reminds us that a model is saturated if every F variable is connected to every other F variables, by either a covariance or casual path (Hatcher, 2002:389). Hatcher further advises that if the structural model is saturated, then it displays no parsimony and its explanatory power cannot be tested. A model may be made parsimonious by fixing some of the covariances and paths at zero, or by placing other constraints on its parameters (p. 389).

The formula for the relative parsimony ratio (*RPR*) is

$$RPR = \frac{df_j - df_m}{df_u - df_m} \quad (9.7)$$

where

$df_j$  = degrees of freedom for the model of interest (the theoretical model),  $df_m$  = degrees of freedom for the measurement model  $df_u$  = degrees of freedom for the uncorrelated factors model

This formula is used to compute the parsimony of the structural portion of the model (Mulaik et al., 1989).

The *RPR* for the structural portion of a model may range from 0.0 (for the measurement model,  $M_m$ , in which every F variable is related to every other F variable) to 1.0 for the uncorrelated factor model,  $M_u$ . The *RPR* for the present theoretical model,  $M_t$ , is .05. This value by itself does not indicate whether to accept or reject the theoretical model,  $M_m$ . However, where there is a number of models being tested, the model with the higher *RPR* may be the preferred model. The relative parsimonious fit index (*RPMI*) may now be computed, given that one has the values of the *RNFI*, see Equation 9.6, and the *RPR*, see Equation 9.7.

$$RPMI = (RNFI)(RPR) = (.9973) * (.05) = .0499. \quad (9.8)$$

At this juncture one felt compelled to discuss one's understanding of the various indices presented in this chapter. The researcher found that some indices reflect the fit of a model, while others reflect its parsimony, and some indices refer to the combined measurement and structural portions of a model, while others refer only to the structural portion. In an attempt to simplify an understanding of these indices, a framework is now presented for categorising these indices.

1. Indices for the combined model:

- Measures of fit:
  - Model  $\chi^2$  test
  - NFI: Normed-fit index
  - NNFI: Non-normed fit index
  - Comparative fit index
- Measure of parsimony:
  - PR: Parsimony ratio
- Measure that reflects both fit and parsimony:

- PNFI: Parsimonious normed fit index

2. Indices for the structural path of the model:

- Measures of fit:
  - RNFI: Relative normed-fit index
- Measure of parsimony:
  - RPR: Relative parsimony ratio
- Measure that reflects both fit and parsimony:
  - RRFI: Relative parsimonious fit index

In this framework a mnemonic device was used to further simplify matters, where an **R** is a relative index, and therefore pertains only to the structural portion of the model. These values and the remaining indices are for the combined model. Table 9.17 illustrates this convention.

**9. Step 9: Performing a chi-square difference test comparing the theoretical model to the measurement model.** The nomological validity of a theoretical model,  $M_t$ , can be tested by performing a  $\chi^2$  difference test in which the  $M_t$  is compared to the measurement model,  $M_m$ . This is the objective of step 9. A finding of no significant difference indicates that the  $M_t$  is successful in accounting for the observed relationships between the latent constructs (Anderson and Gerbing, 1988).

The  $\chi^2$  for the  $M_m$  is subtracted from the  $\chi^2$  for the  $M_t$  with the resulting:

$$\chi^2 \text{ difference} = M_t - M_m = 14.87 [632.11 - 617.24]$$

The degrees of freedom for the test are equal to the difference between the df for the two models, in this case:

$$df_t - df_m = 1 (35 - 34)$$

Here, the obtained  $\chi^2$  difference is 14.87, which is greater than the critical  $\chi^2$  value with 1 df at 10.83 ( $p < .001$ ). This  $\chi^2$  difference is therefore significant. This finding shows that the  $M_t$  is unsuccessful in accounting for the relationships between the latent constructs, and as such may contain some misspecifications. Combined, these results showed that the initial,  $M_t$ , did not provide an acceptable fit to the data.

This, therefore requires that the model ( $M_t$ ) be modified so as to provide a better fit to the data. As a consequence, a specification search was conducted so as to arrive at a better-fitting model.

### 9.5.3 Modifying the theoretical (revised) model

#### 9.5.4 The revised theoretical model 1

When conducting a specification search using data based on a relatively small sample (as in the present case, where  $N = 1225$ ), there is a danger that data-driven model modifications will capitalize on chance characteristics of the sample data and result in a final model that will not generalize to the population or to other samples [MacCallum, Roznowski, and Necowitz, 1992]. The researcher therefore began the search by attempting to identify parameters that could be dropped from the model without significantly hurting the model's fit, as it is generally safer to drop parameters than to add new parameters when modifying models [Bentler and Chou, 1987].

A Wald test [Bentler, 1989] suggested that it was possible to delete the path from SC to AG without a significant increase in model  $\chi^2$ . Therefore, this path was deleted, and the resulting model, revised model 1 ( $M_{r1}$ ) was then estimated. Fit indices for this model appear in Table 9.18. Once again, overall goodness of fit indices for the model were acceptable, with values on the NNFI and CFI in excess of .9. Table 9.19 shows that the path coefficients in ( $M_{r1}$ ) were statistically significant.

Dropping the **SC - AG** path would be acceptable only if it did not result in a significant increase in model  $\chi^2$ . A significant increase would indicate that  $M_{r1}$  provided a fit that was significantly worse than  $M_t$ . Therefore, a  $\chi^2$  difference test was conducted, comparing ( $M_t$ ) to  $M_{r1}$  (see **Table 9.19 for model  $\chi^2$  values**). The  $\chi^2$  difference for this comparison is equal to  $635.46 - 632.11 = 3.35$  which, with 2 df [ $df_{r1} - df_t : 37 - 35 = 2$ ].

The table of  $\chi^2$ , Table 9.14 shows the critical value of  $\chi^2$  with 2 df, as 13.8 with  $p > .001$  which is nonsignificant at  $p > .001$ .

The observed  $\chi^2$  difference value of 3.35 is less than this, which therefore allows us to conclude that there is not a significant difference between the fit provided by the  $M_t$ , and that provide by the  $M_{r1}$ .

Table 9.18: Goodness of fit indices for the revised model 1

The SAS System 14 18:22 Sunday, November 7, 2004

The CALIS Procedure

Covariance Structure Analysis: Maximum Likelihood Estimation

Fit Function	0.5192
Goodness of Fit Index (GFI)	0.9133
GFI Adjusted for Degrees of Freedom (AGFI)	0.8454
Root Mean Square Residual (RMR)	0.0152
Parsimonious GFI (Mulaik, 1989)	0.6144
Chi-Square	635.4604
Chi-Square DF	37
Pr > Chi-Square	<.0001
Independence Model Chi-Square	11471
Independence Model Chi-Square DF	55
RMSEA Estimate	0.1150
RMSEA 90% Lower Confidence Limit	0.1072
RMSEA 90% Upper Confidence Limit	0.1229
ECVI Estimate	0.5670
ECVI 90% Lower Confidence Limit	0.5030
ECVI 90% Upper Confidence Limit	0.6372
Probability of Close Fit	0.0000
Bentler's Comparative Fit Index	0.9476
Normal Theory Reweighted LS Chi-Square	638.7833
Akaike's Information Criterion	561.4604
Bozdogan's (1987) CAIC	335.3646
Schwarz's Bayesian Criterion	372.3646
McDonald's (1989) Centrality	0.7833
Bentler & Bonett's (1980) Non-normed Index	0.9221
Bentler & Bonett's (1980) NFI	0.9446
James, Mulaik, & Brett (1982) Parsimonious NFI	0.6355
Z-Test of Wilson & Hilferty (1931)	20.4657
Bollen (1986) Normed Index Rho1	0.9177
Bollen (1988) Non-normed Index Delta2	0.9477
Hoelter's (1983) Critical N	102

WARNING: The central parameter matrix \_PHI\_ has probably 2 negative  
and 1 zero  
eigenvalue(s).

Table 9.19: Standardised path coefficients

Dependent variables/ Independent variables	Theoretical Model	Revised Model 1	Revised Model 2
<b>BI (FI)</b>			
AG (F2)	.2638	.2772	.2708
SC (F3)	.5196	.5033	.5012
HK (F5)	.1924	.2042	.2039
<b>AG (F2)</b>			
SC (F3)	.0591	-	.0540
OL (F4)	.4951	.5296	.4964
HK (F5)	.0886	.1000	.0923

Note: N = 1225. All values significant at  $p < .001$ , except the pairs:AG(F2): SC(F3), which are nonsignificant.

Having passed this test,  $M_{r1}$ , is next compared to  $M_m$  to determine whether it successfully accounted for the relationships between the latent constructs. The  $\chi^2$  difference is calculated as 18.22 [ $\chi^2_{M_{r1}} - \chi^2_{M_m}$  635.46 – 617.24], which, with 3 df [ $df_{M_{r1}} - df_M : 37 - 34 = 3$ ], is statistically significant at  $p < .001$ ).

However, the critical test of the validity of the revised model,  $M_{r1}$ , is the  $\chi^2$  difference test comparing the revised model to the measurement model. A significant difference between these two models suggests that the revised models are not successfully accounting for the relationship between the latent F variables that contribute to the structural portion of the model. The critical value of  $\chi^2$  with 3 degrees of freedom is 16.3 at  $p < .001$ . The observed value of the  $\chi^2$  is greater than this, at 18.22, which indicates a significant difference between the  $\chi^2$  of the two models. In other words, revised model 1,  $M_{r1}$ , exhibits a fit to the data that is significantly worse than the fit displayed by the measurement model,  $M_m$ . This suggest that there is still a serious misspecification involving the relationships between the F variables in  $M_{r1}$ . Thus, the model failed to provide an acceptable fit, again.

The researcher, therefore, proceeded to explore options of modifying the models further. The result dictates that a second revision on the model, theoretical model 2. Consequently, this was done, and the resulting model is discussed next, in section 9.5.5



### 9.5.5 The revised theoretical model 2.

#### Reviewing the Wald Test

Wald tests conducted in the course of analyzing  $M_{r1}$ , indicates that the model  $\chi^2$  will improve if the VARE21 were removed. The value is moderately significant at 0.948, see **Output 9.13**, so the suggestion is taken to modify the model.

Output 9.13: Stepwise Multivariate Wald Test

Stepwise Multivariate Wald Test					
Parameter	-----Cumulative Statistics-----			--Univariate Increment--	
	Chi-Square	DF	Pr > ChiSq	Chi-Square	Pr > ChiSq
VARE21	0.94800	1	0.3302	0.94800	0.3302

The resulting model, revised model 2  $M_{r2}$ , was then estimated.

Fit indices for revised model 2 are presented in Table 9.20. It can be seen that the fit indices (i.e., the NNFI and CFI) were above .9, and in the case of the CFI was also higher than those displayed by revised model 1, and the initial theoretical model, in the case of the NNFI. A  $\chi^2$  difference test comparing  $M - r2$  to  $M_{r1}$ , revealed a significant difference value of 635.46- 633.26 = 2.2 (df = 1, p < .001). This finding shows that revised model 2 provided a fit to the data that was significantly better than the fit provided by revised model 1, thus justifying the deletion of VARE21 from the model, see Figure 9.12.

Table 9.19 and Figure 9.13 display standardized path coefficients for revised model 2, the Final Model. It can be seen that all coefficients were significant and in the predicted direction.  $R^2$  values, see **Output 9.14** showed that **AG**, **SC** and **HK** accounted for 68.3% of the variance in **BI**, while **SC**, **OL**, and **HK** accounted for 36.4% of the variance in **AG**.

The distribution of normalized residuals for revised model 2 is relatively symmetrical and centred on zero.

The *Proc Calis* procedure perform a detailed residual analysis. Large residuals may indicate misspecification of the model. In Output 9.16 for example, note the table for the 10 largest asymptotically standardized residuals. As the table shows, the specified model performs the

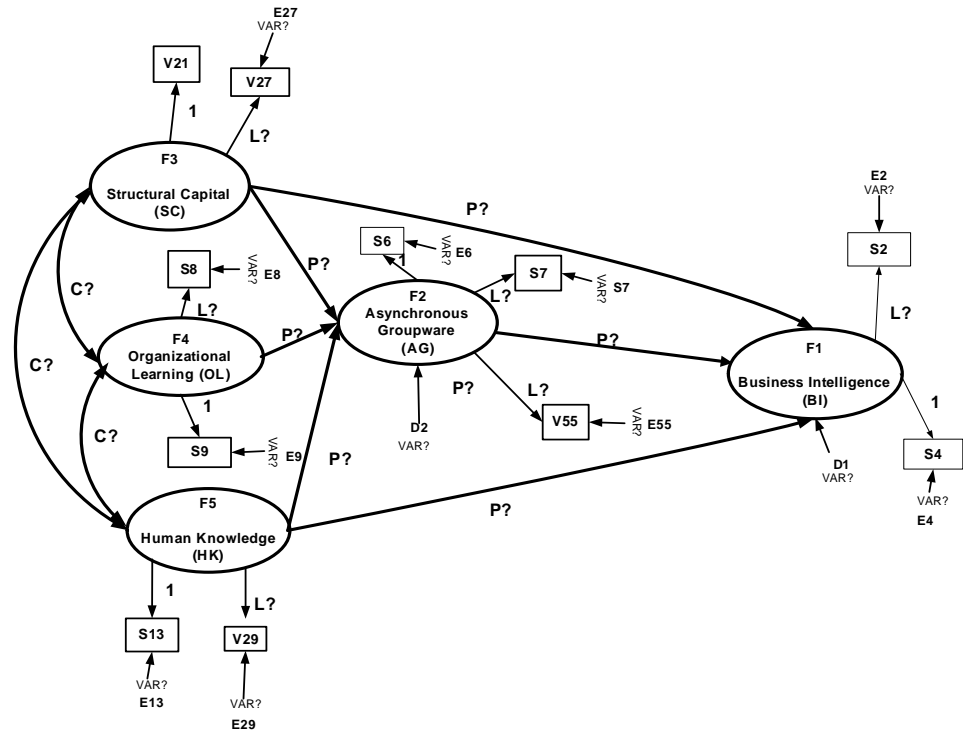


Figure 9.12: Revised model 2, KM-BI model, in which the VARE21 has been deleted

#### Output 9.14: Latent Variable Equations with Standardized Estimates

Covariance Structure Analysis: Maximum Likelihood Estimation

Latent Variable Equations with Standardized Estimates

$$\begin{array}{rcll}
 F1 & = & 0.2708 \cdot F2 & + \quad 0.5012 \cdot F3 & + \quad 0.2039 \cdot F5 & + \quad 0.5628 \cdot D1 \\
 & & PF1F2 & & PF1F3 & & PF1F5 \\
 F2 & = & 0.0540 \cdot F3 & + \quad 0.4964 \cdot F4 & + \quad 0.0923 \cdot F5 & + \quad 0.7972 \cdot D2 \\
 & & PF2F3 & & PF2F4 & & PF2F5
 \end{array}$$

Table 9.20: Goodness of fit indices for the revised model 2

The SAS System	55	18:22 Sunday, November 7, 2004
The CALIS Procedure		
Covariance Structure Analysis: Maximum Likelihood Estimation		
Fit Function	0.5174	
Goodness of Fit Index (GFI)	0.9135	
GFI Adjusted for Degrees of Freedom (AGFI)	0.8414	
Root Mean Square Residual (RMR)	0.0146	
Parsimonious GFI (Mulaik, 1989)	0.5979	
Chi-Square	633.2554	
Chi-Square DF	36	
Pr > Chi-Square	<.0001	
Independence Model Chi-Square	11471	
Independence Model Chi-Square DF	55	
RMSEA Estimate	0.1164	
RMSEA 90% Lower Confidence Limit	0.1086	
RMSEA 90% Upper Confidence Limit	0.1245	
ECVI Estimate	0.5669	
ECVI 90% Lower Confidence Limit	0.5029	
ECVI 90% Upper Confidence Limit	0.6370	
Probability of Close Fit	0.0000	
Bentler's Comparative Fit Index	0.9477	
Normal Theory Reweighted LS Chi-Square	637.3307	
Akaike's Information Criterion	561.2554	
Bozdogan's (1987) CAIC	341.2703	
Schwarz's Bayesian Criterion	377.2703	
McDonald's (1989) Centrality	0.7837	
Bentler & Bonett's (1980) Non-normed Index	0.9201	
Bentler & Bonett's (1980) NFI	0.9448	
James, Mulaik, & Brett (1982) Parsimonious NFI	0.6184	
Z-Test of Wilson & Hilferty (1931)	20.4523	
Bollen (1986) Normed Index Rho1	0.9157	
Bollen (1988) Non-normed Index Delta2	0.9478	
Hoelter's (1983) Critical N	100	
WARNING: The central parameter matrix _PHI_ has probably 2 negative and 1 zero eigenvalue(s).		

Output 9.15: Squared Multiple Correlations and Correlations Among Exogenous Variables

## Squared Multiple Correlations

	Variable	Error Variance	Total Variance	R-Square
1	S2	0.12514	0.40263	0.6892
2	S4	0.09977	0.36240	0.7247
3	S6	0.04776	0.33099	0.8557
4	S7	0.07360	0.26359	0.7208
5	S8	0.14172	0.33256	0.5738
6	S9	-0.06151	0.46994	1.1309
7	S13	-0.10069	0.34363	1.2930
8	V21	0	0.96704	1.0000
9	V27	0.21559	0.36342	0.4068
10	V29	0.18074	0.29992	0.3974
11	V55	0.07149	0.35739	0.8000
12	F1	0.08317	0.26263	0.6833
13	F2	0.18001	0.28323	0.3644

## Correlations Among Exogenous Variables

Var1	Var2	Parameter	Estimate
F3	F4	CF3F4	0.73266
F3	F5	CF3F5	0.66786
F4	F5	CF4F5	0.66193

## Output 9.16: Distribution of Asymptotically Standardized Residuals

## Distribution of Asymptotically Standardized Residuals

Each \* Represents 1 Residuals

-----Range-----		Freq	Percent	
-5.59814	-5.30350	1	1.52	*
-5.30350	-5.00886	0	0.00	
-5.00886	-4.71423	1	1.52	*
-4.71423	-4.41959	1	1.52	*
-4.41959	-4.12495	1	1.52	*
-4.12495	-3.83031	2	3.03	**
-3.83031	-3.53567	0	0.00	
-3.53567	-3.24103	1	1.52	*
-3.24103	-2.94639	1	1.52	*
-2.94639	-2.65175	0	0.00	
-2.65175	-2.35711	1	1.52	*
-2.35711	-2.06247	1	1.52	*
-2.06247	-1.76783	2	3.03	**
-1.76783	-1.47320	2	3.03	**
-1.47320	-1.17856	2	3.03	**
-1.17856	-0.88392	1	1.52	*
-0.88392	-0.58928	0	0.00	
-0.58928	-0.29464	2	3.03	**
-0.29464	0	3	4.55	***
0	0.29464	12	18.18	*****
0.29464	0.58928	1	1.52	*
0.58928	0.88392	0	0.00	
0.88392	1.17856	2	3.03	**
1.17856	1.47320	1	1.52	*
1.47320	1.76783	7	10.61	*****
1.76783	2.06247	4	6.06	****
2.06247	2.35711	2	3.03	**
2.35711	2.65175	0	0.00	
2.65175	2.94639	3	4.55	***
2.94639	3.24103	2	3.03	**
3.24103	3.53567	1	1.52	*
3.53567	3.83031	0	0.00	
3.83031	4.12495	2	3.03	**
4.12495	4.41959	0	0.00	
4.41959	4.71423	0	0.00	
4.71423	5.00886	0	0.00	
5.00886	5.30350	1	1.52	*
5.30350	5.59814	0	0.00	
5.59814	5.89278	2	3.03	**
5.89278	6.18742	1	1.52	*
6.18742	6.48206	0	0.00	
6.48206	6.77670	0	0.00	
6.77670	7.07134	1	1.52	*
7.07134	7.36598	1	1.52	*
7.36598	7.66062	0	0.00	
7.66062	7.95526	0	0.00	
7.95526	8.24989	0	0.00	
8.24989	8.54453	0	0.00	
8.54453	8.83917	0	0.00	
8.83917	9.13381	0	0.00	
9.13381	9.42845	1	1.52	*

poorest concerning the variable V27 and its covariance with S4, and S2; V55 with S2; and V21 with S4, S2, and S13. This may be the result of a misspecification of the model equation for S4, V55, and V21. However, because the model fit is quite good, such a possible misspecification may have no practical significance and is not a serious concern in the analysis.

### Output 9.17: Standardised Residuals

#### Rank Order of the 10 Largest Asymptotically Standardized Residuals

Row	Column	Residual
V27	S4	9.20820
V55	S2	7.13608
V21	S4	6.89609
S8	S2	5.96857
V27	S2	5.81795
S8	S7	5.63695
V21	S2	-5.52375
S9	S7	5.16547
V29	V21	-4.94868
V21	S13	-4.63489

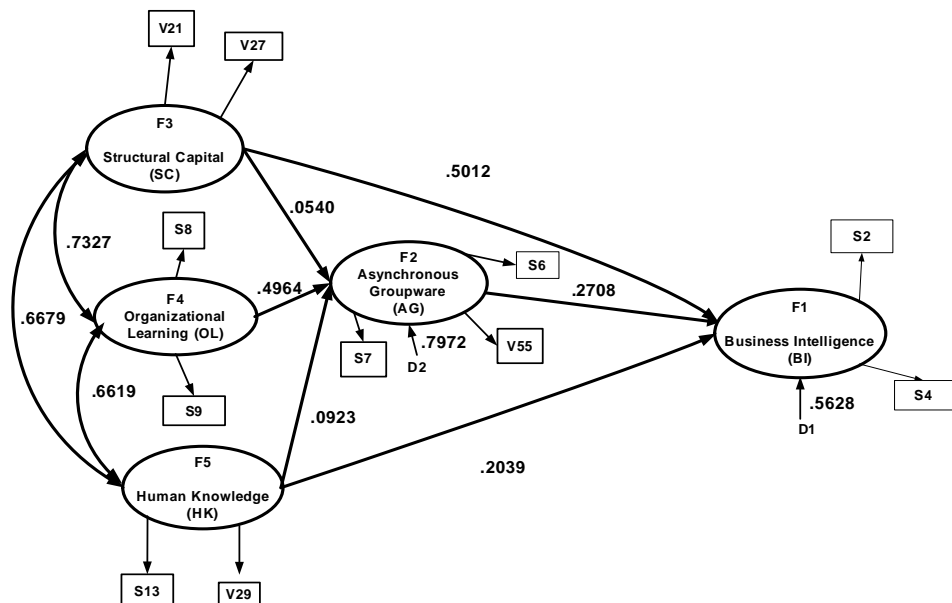


Figure 9.13: Revised model 2, KM-BI model- Final Model.

<sup>2</sup>Standardised path coefficients appear on single-headed arrows; Correlations appear on curved double-headed arrows. All values are significant at  $p < .001$ , except the path from F3 to F2.

### 9.5.6 Selecting the casual model of best fit

The parsimony indices for the two revised models were calculated to decide which casual model provides the best fit for the data. The indices are explained next.

- The model chi-square test;
- The normed-fit index (NFI);
- The non-normed fit index (NNFI), and
- The comparative fit index (CFI).

The parsimony ratio (PR) is a measure of the *simplicity* of the model fit for the combined model. The parsimonious normed-fit index (PNFI) measures both the fit and parsimony of the combined model.

The relative normed-fit index or RNFI measures the fit of only the structural portion of the model. The relative parsimony ratio measures the parsimony of the structural model and the relative parsimonious fit index (RPFI) measures both the fit and parsimony of the structural model. Table 9.17 is relevant.

Hatcher (2002) advises that when choosing between models that display an acceptable fit, the more desirable model is the one that has a higher parsimony ratio. From Table 9.17, the model with the highest parsimony ratio is revised model 1, where  $PR = .673$ . In this study it was decided to use the parsimony ratio of revised model 2, where  $PR = .655$ . The parsimony of a model reflects its *simplicity*.

The parsimonious normed-fit index (PNFI) is an index that reflects both the fit and the parsimony of the model simultaneously [Hatcher 2002] a higher PNFI reflects a better model. The table, Table 9.17, indicates that revised model 1 provides the higher PNFI than revised model 2 with PNFI of .636 and .619, respectively.

The relative normed-fit (RNFI) reflects the fit in just the structural portion of the model and is not influenced by the fit of the measurement model (Hatcher, 2002). The higher values indicate that the hypothesized casual relations between the structural variables provide a good fit of the data. From the table it is clear that Revised model 2 has a higher value for RNFI, at .9968, than Revised model 1, with RNFI at .9964.

The relative parsimony ratio (RPR) measures the parsimony of the structural portion of the model. From the table, it is clear that the RPR for the Revised model 1 is higher than that of Revised model 2, at .15 and .10, respectively.

The relative parsimonious-fit index (RPFI) is a single index that reflects both the fit and the parsimony in just the structural portion of the model simultaneously (Hatcher, 2002). From the table, Table 9.17 it can be seen that the RPFI for Revised model 1 is higher than Revised model 2 at .150.

The above indices show that:

- The model with the higher PR is Revised model 1,  $PR = .673$ ;
- Revised model 1 has a higher PNFI than Revised model 2, where  $PNFI = .636$ .
- Revised model 2 has a higher RNFI of .9968, than Revised model 1 at .9964.
- Revised model 1 has a higher RPR value of .15 than for Revised model 2, at .10.
- The RPFI for the second model revision is .10, while that of the first model is .15.

These indices are not conclusive. Revised model 2, however demonstrates that the parsimony ratio is high enough to indicate that the index reflects the model's simplicity, and that the relative parsimonious fit index (and index reflecting both the fit and the parsimony in just the structural portion of the model).

Notwithstanding this, however, one performs, as a final test, a chi-square difference test to compare the fit of  $M_{r2}$  with that of  $M_m$ . This comparison resulted in a difference value of  $633.26 - 617.24 = 16.02$ , which, with 3  $df$ , and the critical value of chi-square ( $p > .001$ ) for 3  $df$  is 16.3. The observed  $\chi^2$  difference value of 16.02 is less than this critical value. This means that there is no significant difference in the fit provided by the two models. This finding supports the validity of Revised model 2. One is able to therefore conclude that Revised model 2 provides a fit to the data that is essentially as good as the fit provided by the measurement model. Alternatively, one may say that the nonsignificant  $\chi^2$  value indicated that  $M_{r2}$  provided a fit that was not significantly worse than that provided by the measurement model in which all F (latent) variables were free to covary. In other words, this finding showed that the causal relationships described in revised model 2 were successful in accounting for the observed relationships between the latent constructs.



## 9.6 Summary

Some of the findings from this chapter are tabulated next.

- The  $p$  value for the Model  $\chi^2$  should be non-significant (i.e. it should be greater than .05); the closer to 1.00 the better. This is not the case in this research.
- The  $\chi^2/df$  ratio should be less than 2. This is not the case in this research.
- The CFI and the NNFI are all greater than .9, which is the recommended level for an acceptable fit.
- The absolute value of the  $t$  statistics for each factor loading and path coefficient all exceeded 1.96, and the the standardized factor loadings are all nontrivial (i.e. the absolute values all exceed .05).
- The  $R^2$  values for the latent endogenous variables are all relatively large.
- The distribution of normalised residuals are symmetrical and centered on zero, but there are a number of normalised residuals that exceed 2.0, in absolute value.
- Although the PR of .655 for Revised model 2 was somewhat lower than the PR of .673 observed for Revised model 1, the slight decrease in parsimony was offset by an increase in fit. This is reflected in the PNFI of .9448 of Revised model 2. These indices appear in Table 9.17.
- In the same way, the structural portion of  $M_{r2}$  is less parsimonious than the structural portion of  $M_{r1}$ , in that the RPR and RPF1 values are lower for  $M_{r2}$ . However,  $M_{r2}$  displayed a better fit in the structural portion of the model, as can be seen by the larger RNFI value of .9968 for  $M_{r2}$ . Table 9.17 illustrates these indices.

Finally, the researcher was able to conclude that, from a technical perspective, Revised model 2 does not provide an *ideal fit*, as described elsewhere in this chapter. The main reason being that the model  $\chi^2$  is still large at 633.26, and with  $\chi^2/df$  at 17.60, which greater than 2.

However, as noted elsewhere in this chapter, a good model will often demonstrate a significant chi-square with real-world data. Much of the results of this research, however, indicate that  $M_{r2}$  provides very acceptable levels of fit and parsimony. These results, coupled with the findings

that Revised model 2 provides a fit to the data that is not significantly worse than that of the measurement model, support  $M_{r2}$  as the research *final* model.

## Chapter 10

### Results From An Iteration Of The Action Research Cycle At Directorate

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*Some people do not become thinkers simply because their memories are too good.*

*Anonymous*

#### 10.1 Introduction

This chapter describes an iteration of the AR cycle [cf. 5.2.2] conducted at Directorate<sup>1</sup>, one of the human resources department of the public service in Botswana. Directorate had a staff complement of 435, and 8 functional divisions at the start of the iteration. These divisions are spread over four offices throughout the country. Communication between these offices is via traditional means: post, telephone, facsimile and also the application of groupware technology, namely email (Lotus Notes<sup>2</sup>, and a corporate intranet. The Government Data Network (GDN) supports the groupware application. All four offices were connected via the GDN. All senior officers had computers in their individual offices, which were networked in a campus network, and connected to the GDN. They all had access to the Lotus Notes mail server, and Domino Docs<sup>3</sup> database. Each officer had an email address assigned to him/her, and was able to communicate with each other without any difficulty.

The researcher will now discuss the experiences observed in implementing a KM system.

#### 10.2 Diagnosing

Directorate decentralised its portfolio responsibilities to the human resources (HR) divisions of client ministries in 1998. The new role of Directorate was now one of policy formulation, etc. Directorate is one of the leaders in facilitating the nation's Vision 2016, and it has a number

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<sup>1</sup>The Directorate is the short name for the Directorate of Public Service Management.(DPSM)

<sup>2</sup>Lotus Notes Corporation

<sup>3</sup>Data Base Management System of Lotus Corporation

of reform initiatives currently being implemented. However as the public sector has grown, problems have arisen in the effective management of the human resources management (HRM). The functional responsibilities of the Directorate is illustrated in Appendix F. Directorate gets its authority from the Public Service Act, (1998). The functions as set out by the Act are indicated in Appendix F, Table F1. Several unstructured interviews conducted at this stage revealed symptoms of the computerised personnel management system (CPMS), and a number of suggestions were provided as to how Directorate may alleviate them. The system had a number of problems at the onset. This was because the model of Directorate and the clients it serves were not properly specified. The Management of Directorate relied on the services of the commercial brokers to advise them on the choice of the HRM solution to purchase. All this was done before a proper system operations and user requirements documents was completed and proved by the senior management of Directorate. Additionally, systems personnel and developers for both the administrative and technical areas required for staffing the new infrastructure were not implemented. There was a major concern about the budgeting requirements for the different phases of the project.

The system was designed to support the integrated work carried out by the personnel administration and recruitment and placement divisions. Internal users of the system were intended to be able to store up-to-date information about public officers in ministries and keep track of policy development provided by Directorate through the online Policy Database. These processes are listed in paragraph 10.2.1 [cf. List of core processes].

### 10.2.1 List of Core Processes

After about two years of development, the system finally achieved an acceptable level of efficiency. It was decided by management to introduce new technologies which would provide greater understanding and knowledge on the core processes. An external consultant [IBM, 2000], was engaged to define these processes. Interviews were conducted to this end. The approach followed is discussed next. Before decentralisation, Directorate was nearly 100% responsible for keeping the CPMS system up-to-date. Since decentralisation the following is true:

- The Recruitment, Personnel Administration, and Training Divisions, which were the major players using the system, have now become occasional users;

- The Manpower Planning Division owns the responsibility to create and change positions in the Establishment Register; and
- The Industrial Class Division, which is already decentralized only needs the system for enquiries.

For the ministries, however, there was a big increase in usage and responsibility to keep the computer system up-to-date. The ministries now have complete ownership of the system except for the creation and changing of positions which still belongs to the Manpower Planning Division. The effect that decentralisation has had on the CPMS is three-fold:

- where the system had one owner responsible for the usage and ensuring that the information in the system was being kept up-to-date, there are now 18 ministries and independent departments that are responsible;
- no roles and responsibilities were formally clarified, which created confusion. This confusion forced the project to stop its planned work on the HRM Workflow Management System (WMS), as a WMS needs a very disciplined and focused environment, with everyone concerned knowing exactly what are their roles and areas of responsibility; and
- system training was not only required at the Directorate level anymore, but at ministries as well. This necessitated the change in scope and focus of the implementation of the CPMS project.

To enable the project to successfully implement the system at the ministries, it was imperative to ensure that the HR processes used by the ministries are integrated with the CPMS. In identifying this requirement, two other issues came to light, namely:

- whether the ministries had any formalised processes to build on, and
- ownership of the HR processes (personnel actions). The need that was jointly identified for the project, Directorate and the ministries, was a requirement for a process manual with each HR process defined where the following is clarified:
  - what must be done, and
  - who is responsible.

This manual could then be used to compile the operational manual by adding ‘how’ each step must be done. The key benefit from this manual is that it would enable Directorate, and the identified trainers to teach and train all the ministries in what must be done and how it should be done, using the computer system, in order to ensure that the system is kept up-to-date. For the CPMS to succeed in the Government, it requires that each ministry must keep their information in the system up-to-date. If the ministries fail to comply, the amount already spent on the implementation phase of the project would go to waste, and the data would become outdated and useless. The only way, it was felt, to ensure that the system is updated, and is available, is by ensuring that no personnel action can be executed without the use of the computer system in the process. For example, an officer should not be able to:

- hire without using the CPMS;
- promote someone without using the CPMS, and
- send someone for training without using the CPMS.

The following is the models used in developing the processes in the process manual. The core processes included in the manual, which show officers the process to follow, in terms of the identified personnel actions are also set out. The process manual when completed is expected to be used in conjunction with the system’s Procedure Manual, where the process shows an activity to be done by the CPMS.

### 10.2.2 The High-level Enterprise Model

HRM in the Botswana Government can be illustrated as set out in the policy-making framework, on people management, of Figure 10.1.

Furthermore, in theory, any successful organisation and department needs four different types of groups of processes to function effectively. These groups types are presented in Figure 10.2 [cf. Figure 10.2 Different groups of process in organisational management].

Based on the researcher’s knowledge of HRM, as well as the theory regarding processes and process groupings, the HR processes can now be broken down into these four groups. This is set out in Table 10.1 [cf. Table 10.1 List of processes]. Each process performed by the HRM

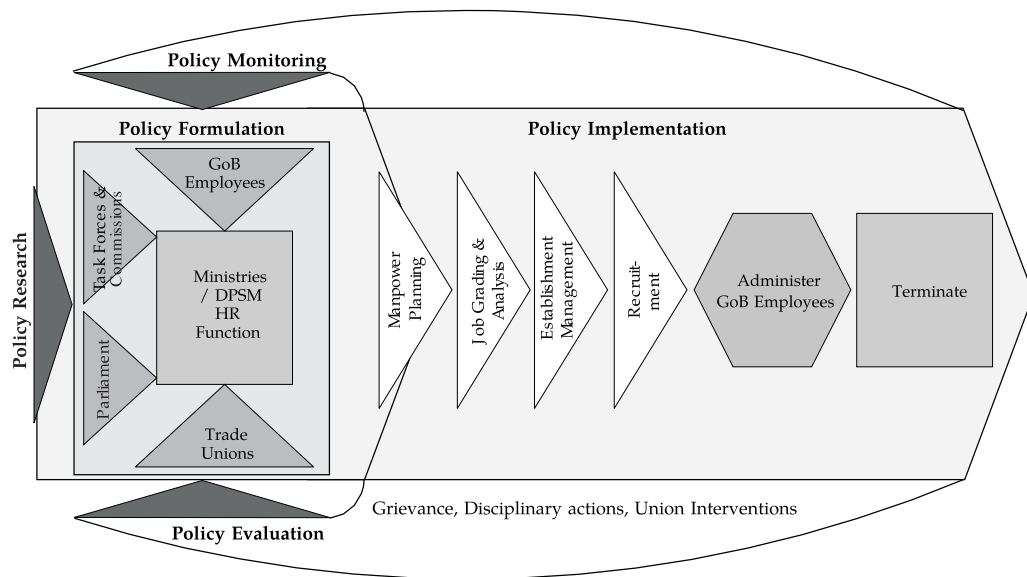


Figure 10.1: HRM policy-making framework

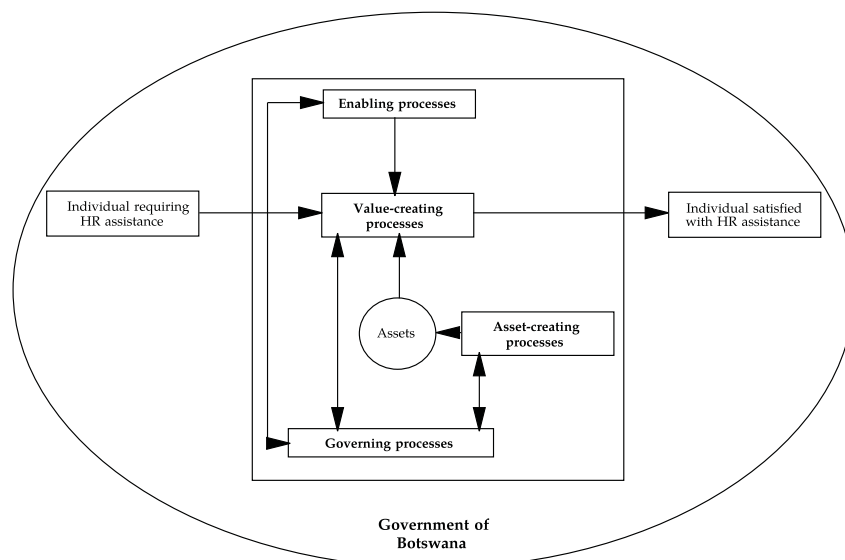


Figure 10.2: Different groups of process in organisational management

function should be able to fit into one of these four groupings. If there are, for example, no processes in the Governing Processes group, it means that there is currently no control function and policymaking in terms of HRM.

Table 10.1: List of processes

Governing processes	Value-creating processes	Asset-creating processes	Enabling processes
<ul style="list-style-type: none"> <li>• Align with Vision 2016</li> <li>• Align with National Development Plan</li> <li>• Determine Budgets</li> <li>• Formulate Policy</li> <li>• Monitor Policy</li> <li>• Evaluate Policy</li> </ul>	<ul style="list-style-type: none"> <li>• Analyse jobs</li> <li>• Plan manpower</li> <li>• Recruit</li> <li>• Administer</li> <li>• Terminate</li> </ul>	<ul style="list-style-type: none"> <li>• HR Research</li> <li>• HR System</li> <li>• Knowledge System</li> </ul>	<ul style="list-style-type: none"> <li>• Financial management</li> <li>• Records keeping</li> <li>• Advertising</li> <li>• Public Relations</li> <li>• Employee Relations (Law)</li> <li>• Operations (Ministries &amp; Parastatals)</li> <li>• IT Operations</li> </ul>

The study uses this information, to compile an enterprise model for the HRM function in the Botswana Government. An enterprise model is a holistic picture of the HRM function within the Botswana Government, which shows all the high level processes and the links between them.

The enterprise model has the same form as the physical building in which the ministries are situated:

- Roof: The customer interfacing processes (the part of one organisation that the customer can see);
- Walls: The enabling and governing processes (the barriers in between, in which one has to function);
- Floor: The processes, which assist one in delivering a first-class service,. For example, research and development, etc; and
- Living area: The main reason for having the house, that is, the value-adding processes of the HRM function.

There are a number of reasons, for having an enterprise model, in an organisation. The following reasons were used in Botswana, for building the enterprise model for this project:



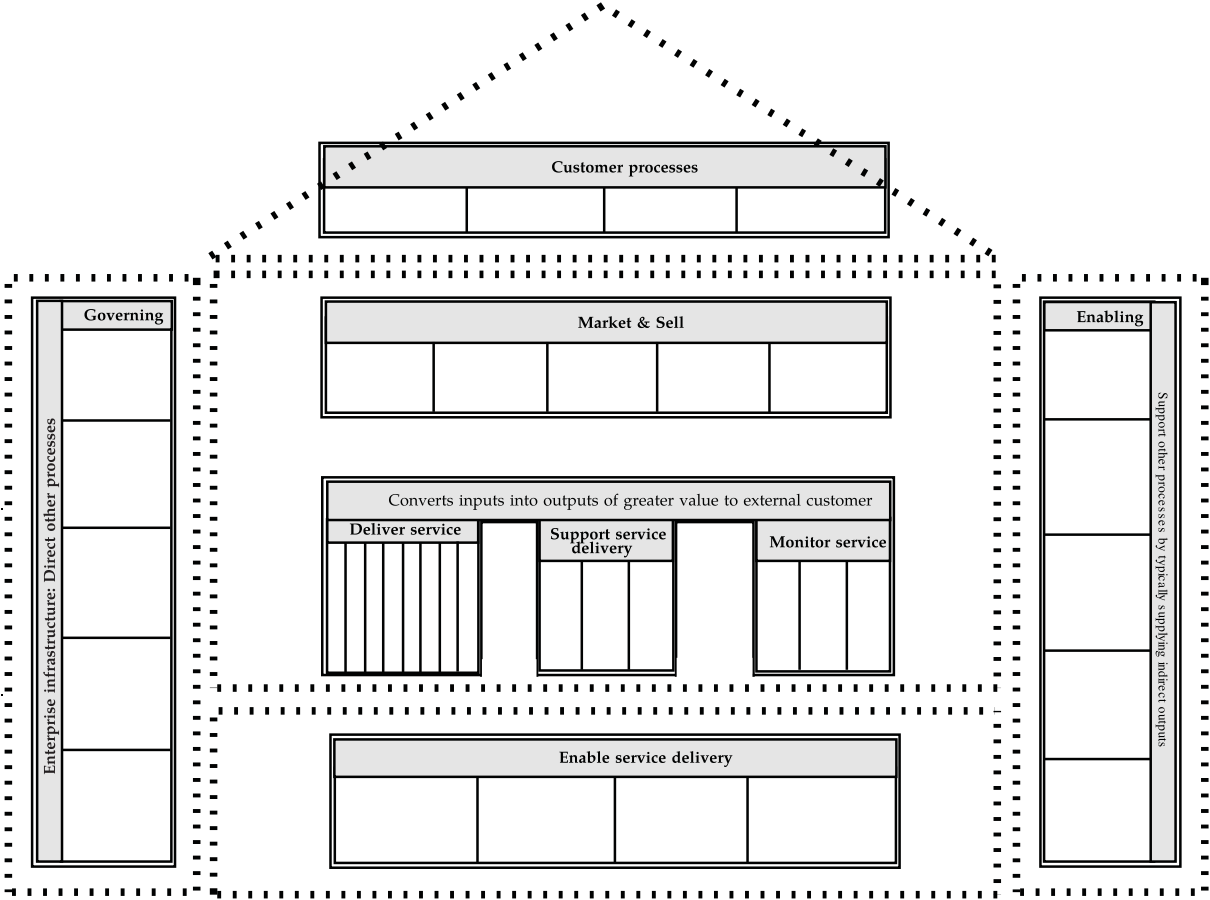


Figure 10.3: Conceptual model of the HR function Source: Government of Botswana, 2000

- It's an articulation of the personnel action's strategic intent;
- It tells the story of how HR faces its "customers";
- It provides a non-traditional perspective that stimulates other non-traditional ideas;
- It provides a context for integration;
- It's irrelevant whether it is the "As is" or the "To be"
- It tells us what we do, not how we do it;
- It's a description of what the business is all about, and
- It's how we pick our targets for re-engineering.

Characteristics of a good enterprise model:

- Shows the interfaces with the customer processes;
- Contains a logical flow;
- Has only a few clear processes;
- Has clearly definable and measurable results;
- Is action oriented;
- Not generic;
- Centres on value-adding processes;
- Describes everything that occurs in the organisation;
- Uses pictures, not words.

The High-level Enterprise Model, for the HRM function of the Government of Botswana, may then be modelled in the following process:

One then modelled the following processes:

- (i) Recruitment process;

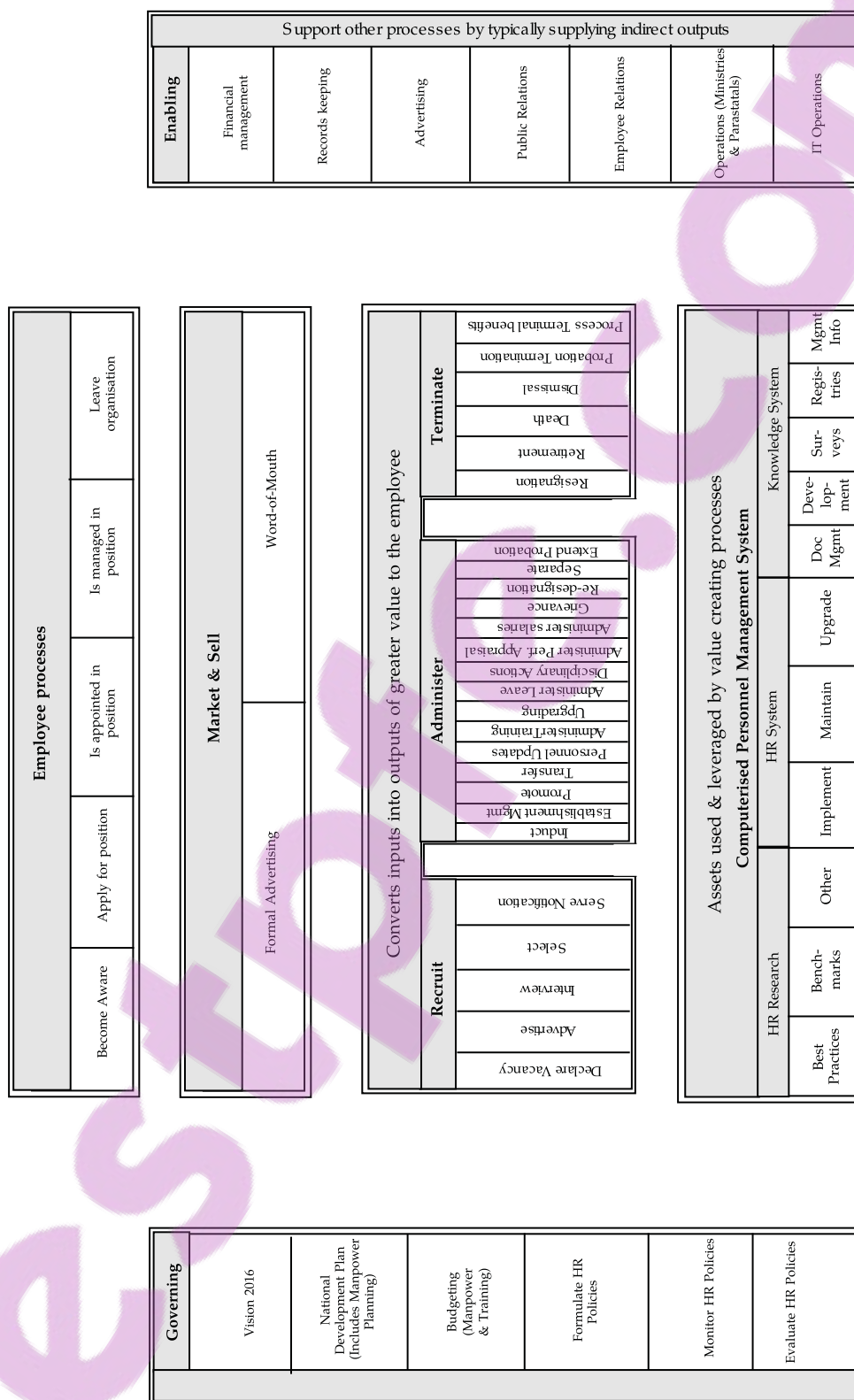


Figure 10.4: The high-level Enterprise Model for the HR function (Source: Government of Botswana, 2000)

- (ii) Promotion process;
- (iii) Upgrading process;
- (iv) Transfer process v. Personnel Updates – Where the Employee requests an update (e.g. Personal Information);
- (v) Personnel Updates – Where the Line Manager requests an update (e.g. Confirmation);
- (vi) Termination – Retirement;
- (vii) Termination – Resignation;
- (viii) Termination – Dismissal;
- (ix) Termination – Death;
- (x) Termination – Probation;
- (xi) Training – Planning;
- (xii) Training – Budgeting;
- (xiii) Training – Administration;
- (xiv) Manpower Planning; and
- (xv) Industrial Class.

Several unstructured interviews conducted at this stage revealed symptoms of an organisation in which the process of learning involved in adapting to a fast changing business environment was the sole responsibility of its top management. Permanent Secretaries of ministries were unhappy with the current system. Government expressed dissatisfaction with the lack of service delivery of the system. A major reengineering of the system was required. Employees were unmotivated, reporting as the most important reason for their lack of motivation was the excessive centralisation of decisions by the divisional managers. Employees showed no interest in either improving business processes, or learning new methods and techniques. It was noted by one manager that: “What keeps [the employees] working are their monthly pay cheques and the prospects of overseas per diems, travel, seminars and training at international colleges and universities”. The inability to motivate officers at the Directorate called for changes in the management approach. Some techniques for enhancing the level of employee participation in

decisions were tested; among these techniques were brainstorming sessions, suggestion boxes, and campaigns for new ideas to solve specific problems.

None of these techniques generated the expected gains, due to two reasons. Firstly, they were strictly based on the assumption that front-line workers should have an active role in management and solution of problems, which is one of the several facets of process improvement. For example, employees were called to participate in routine strategic decisions, following an approach suggested by Semler (1989; 1993). However, this proved to be a counterproductive strategy, supporting the assumption that group decisions may not be better than individual decisions (Senge, 1990). Strategic decisions to form new partnerships or sign a large government contract, for example, were found to be better made only by managers as usual. Directorate experience suggested that sharing the responsibility of taking some types of decisions with large groups of employees not directly involved with decision making on a daily basis simply delayed what could not be delayed, undermining both the employees and management's confidence in participatory management.

There were a number of problems experienced during this phase. These were exacerbated due to a lack of ownership on the part of management. They include such issues as budgeting and funding concerns, the rigid structure of the ministry management, massive staff turnover, poor project ownership, and the absence of a proper system protocol and data availability regime.

Secondly, the analysis and redesign of the human resource processes received a low priority status in the public sector's reform initiatives, and national development plans. For example, by the time this research iteration had begun, the whole set of interrelated activities involved in reviewing the pay structures and performance incentives, from consultants engaged to study the relationships between private sector and public sector remuneration, and the Presidential Commission on salary structures coupled with the implementation difficulties of the performance management system (PMS), had not been addressed by government in at least three years. The emphasis was on having employees participate in management decisions, rather than in the analysis of how activities were executed and improvements could be attained. Moreover, new ideas for improvement coming from employees covered an overly broad range of subjects, from new designs for promotional material to better wages, leading to a vast amount of contributions coming from staff that had little knowledge about the work of the areas likely to be affected by the ideas. This, and the repetition of ideas, progressively undermined the interest of managers, and consequently employees' motivation to generate new improvement ideas.

### 10.3 Action Planning

The researcher was a consultant with the Management Services' Division (MSD), of the Directorate. MSD is the internal management consultancy arm of government. The researcher was assigned the responsibility of re-engineering the remaining 6 processes, which were not done by the IBM consultants. The project team was expected to tackle a number of problems, both at the local level in the Directorate, and at the level of the human resource departments of client ministries. The researcher was also expected to help coordinate the use of information technology (IT) as an enabler in the implementation of the workflow proposals which came as a result of the human resource process re-engineering. The research iteration was expected to last approximately one year, for the duration of the Directorate's annual performance plan (APP). The researcher and the process owners (Heads of Divisions – Senior Assistant Directors of Directorate, participated in this training exercises and became project champions for the role-out of the CPMS to ministries.

The proposed structure<sup>4</sup> of the Directorate is set out in Figure 10.5.

Directorate is a super Department of the ministry of State President. The Directorate is headed by a permanent secretary level Director. The executive management team of the Directorate comprised the Director, two Deputy Directors, and eight Senior Assistant Directors, who are the functional heads of the Divisions of the Department.) They decided that the iteration would begin with a number of training sessions, involving line managers of client ministries, in which officers would receive formal hands-on training on HRM techniques based on a methodology developed by the researcher and the IBM Consulting team. This group has its roots in the total quality management movement, and used many of the tools of Deming (1986) and Juran (1989). The training sessions were planned so as to include practical HRM exercises, to be done in groups, comprising ten members each. Participating officers from ministries and independent departments were expected to replicate these exercises with real organisational processes after the sessions, using the infinium's (the Human Resources Management Information Systems (HRMIS), personnel actions along with the user manual, of the HRMIS.

The researcher suggested the use of the Lotus Notes (email) groupware system to support the work of the KM groups during the planning stage. This idea was received with much interest by the Deputy Director, Productivity and Development, and other project leaders. The main focus

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<sup>4</sup>This structure was eventually approved by Government, for adoption, on May 30, 2003.

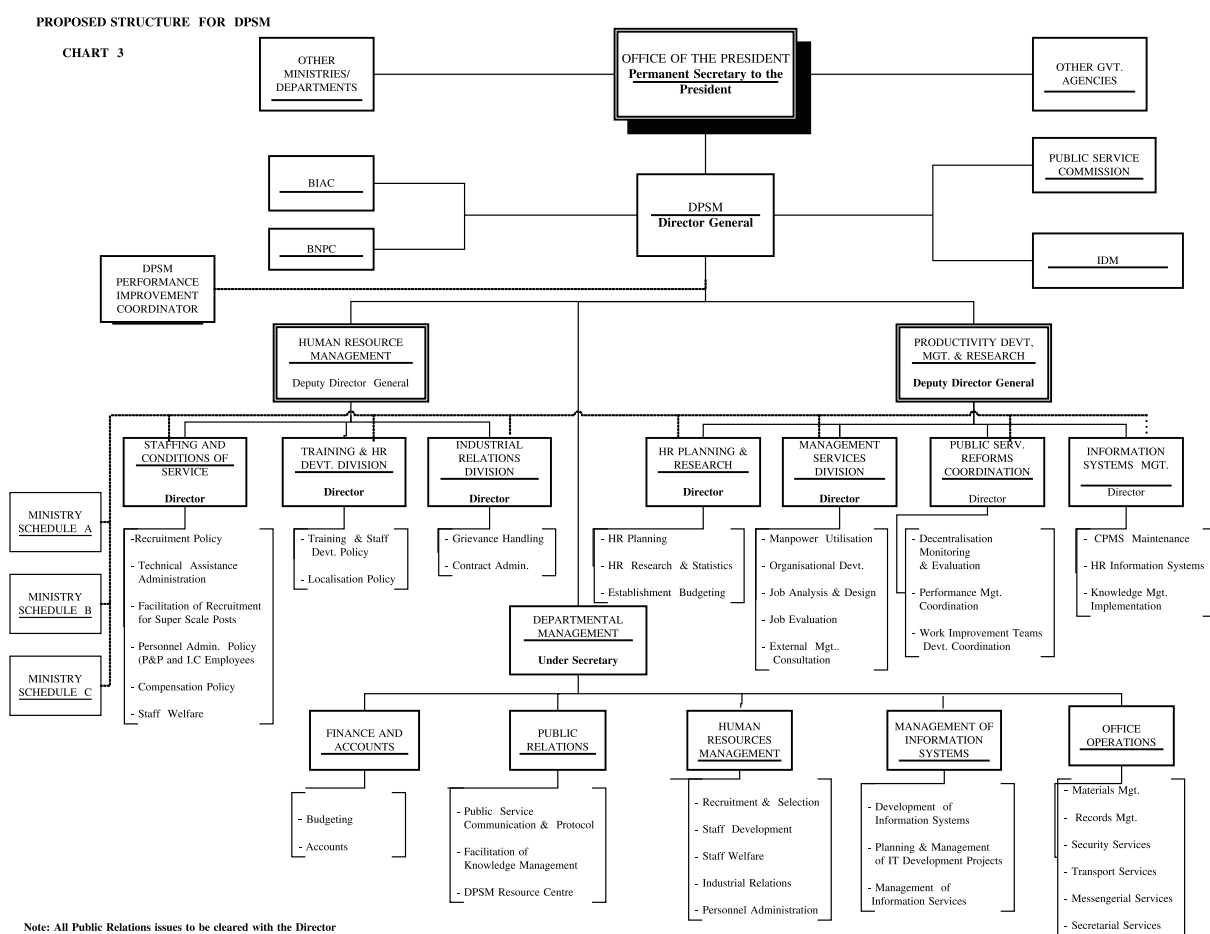


Figure 10.5: Functional structure of Directorate

of the expectations of these training sessions were on the outcome of the groups themselves, and not whether they interacted face-to-face or electronically. One apparent reason for this was the popular literature on TQM, particularly Walton's (1989; 1991) accounts of improvements brought about by business process improvement (BPI) groups, and work improvement teams (WITS) in a number of organisations, and particularly, in other departments in the Public Service. There was a culture of public service reform, and transformation in the Public Service. The Lotus Notes email system was installed on all officers' (Public Officers responsible for the HRM function or personnel actions) computers from early 1998, and officers had knowledge and "user" training on the use of this application. Given, this fact, it was decided by the project owners that much progress could be achieved if the techniques of the WITS (KM groups) could be used to assist with the process definitions. The researcher recommended that the Lotus Notes email system should be used to asynchronously conference, collaborate and meet between these process owners. The expectations were to have them submit their comments to the 'project team', participate in and collaborate with the project team on process re-engineering changes and or amendments.

It was agreed that KM groups should complete a process definition proposal within the first quarter of 2002. The procedure followed was that the researcher was appointed as the group facilitator, to ensure that members of the project follow the approved WITS methodology, and that the works of the groups are properly documented. A total of nine, (3 stages by 3 process owners), separate meetings were held with each Division process owner to explain how the email system should be used. The meetings were deemed necessary to discuss the stages of KM group methodology. This was without any groupware support, other than the initial email contacts, notifying participants of the meeting schedule, objectives, agenda and location. The stages which were discussed with each group were: process definition, analysis and redesign, as discussed in chapter 6 – Research Methodology. The objective of these meetings was also to ensure that delegates understand how the stages fit in the overall project for the re-engineering of the core HRM processes. Re-engineering, after the approach taken by Hammer and Champy (1993), was undertaken in this project. This was to streamline the processes of the CPMS.

The procedure followed is set out next for the "Recruitment Process". The group members who participated in this process are listed in Table 10.2.

One now presents a summary of the process information next.



Table 10.2: KM Group Members

Position / Role	DPSM / Ministry
Senior Assistant Director	Directorate
Under Secretary	MOH
Under Secretary	MOE
Under Secretary	MLH
Principal Personnel Officer	Directorate
Chief Personnel Officer	Directorate
Under Secretary	MFDP
Under Secretary	MMEWA
Principal System Analyst	Directorate
Consultant	Infinium
Principal Management Analyst	Directorate
Management Analyst	Directorate
Under Secretary	MOA
Consultant	IBM (Botswana)

### 10.3.1 Summarised process information

a) Process objective:

- to fill the vacant position,
- to employ qualified staff, and
- to employ someone to get the job done.

b) Summarised process:

- First activity: Declares the vacancy, and
- Last activity: Sends Casualty Return<sup>5</sup> to the appropriate departments.

c) Customer:

- Line manager is the responsible officer in ministries and departments.

d) Role-players:

Three role players were identified throughout this process. These were:

- Line Manager – Any officer who has staff responsibilities;
- HR – Ministries – The department of ministries responsible for the HRM function, of the ministry; and

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<sup>5</sup>Casualty Return – A form that is filled out by the Line Manager to notify other relevant departments that there is a change to the employee details.

- Directorate – the co-ordinating agency responsible for Public Service HRM, training and development, conditions of services and regulations, and public service reforms and productivity.

e) Process-owner:

- Directorate representative responsible for policy regarding Recruitment process: The Senior Assistant Director, Directorate.

f) Key Performance Indicators:

- Vacancy number created by the ministry and the position number in the Establishment Register has to be the same number,
- CPMS needs to accurately print out Letters of Regret to applicant, and
- CPMS needs to accurately print out Offer Letter to applicant.

g) Person accountable for process:

- DPSM representative responsible for policy regarding Recruitment process

h) Person responsible for process:

- Manager appointed as head in HR – Ministries

i) People to consult:

- Decentralisation is currently up to the level of D2.(Senior Management Grade) Therefore, the Permanent Secretary to the President (PSP) needs to approve an advertisement of any position for appointment higher than D2.

j) People to inform:

- Auditor general, and
- Accountant general.

k) Key outputs:

- Vacancy or position number,
- Advertisement,
- Short list details,

- offer letter,
- New employee details, and
- Casualty Return

1) Trainer for this process:

- The Senior Assistant Director.

### **10.3.2 Process models**

The six Recruitment process maps, which were developed for this iteration and presented in Table F2.1 of Appendix F. The process maps for the other processes are presented in Tables F2.2 to F2.4, respectively, of Appendix F.

### **10.3.3 Issues and comments from the recruitment session**

The group members raised a number of comments and issues. These are set out next.

- Appointing Boards are made up of representatives from Directorate, HRM in ministries, and Line Managers;
- When a new position has been created the Division of Manpower Planning, Budgeting and Research should notify the affected ministries for them to start the recruitment process;
- It is possible that vacancy numbers will be fully automated when the system is fully implemented. The vacancy number and the position number (as currently reflected in the system) should be the same;
- The vacancy declaration form may need to be changed so that the Line Manager does not have to indicate his/her candidate preference when he/she declares the vacancy in the vacancy report form;
- A policy decision must be made on the length of time the historical data (record) on employees that have left the Government service.
- There is need for a policy decision on how and who is going to screen candidates for short-listing since this will involve the Directorate, other ministries, other government agencies, such as the Police, the Teaching Services, etc.;

- An assumption was made that advertisements, and offer letters will have maximum periods for response;
- If officers in ministries apply for internal positions, it has to go through their Line Managers first. (employees fill out a UFS<sup>6</sup>, and send it to their Line Managers). The appointment letters should also go to the employee through the Line Manager. This should also trigger the Transfer process, and
- Recruitment costs for interviewing a potential candidate from different regions needs to be investigated. This is catered for in the CPMS system now.

### 10.3.4 Exceptions to the process

- “Serve Notification” process: When an applicant has been appointed, but he/she is unable to take up the employment;
- Decentralisation is currently up to the grade level of D2 (Senior Management), therefore any appointment higher than a D2 is regarded as an exception to the process;
- External recruitment (outside Botswana) and advertisements are processed through agencies. Although the process remains the same, Activity 14 to Activity 18 (see the General Orders), will be performed by that Agency, and
- Recruitment of expatriate has not been decentralised and so the process is still the responsibility of the Directorate.

### 10.3.5 Recommended workflow points

The group noted and recommended the following workflow points:

- When a vacancy is declared by the Line Manager, a template in Lotus Notes should be e-mailed, to the Directorate and the Ministry; advising them about the vacancy.
- The Ministry and the Directorate are required to acknowledge the existence of the vacancy to the Line Manager, which should ideally be a response template of Recommendation;

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<sup>6</sup>UFS – Under Flying Seal is defined as Letters that can not be passed on directly to the employee. UFS has to be passed on to the Line Manager first, and then the Line Manager passes it on to the employee

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- Directorate and the Line Manager should be notified via Lotus Notes when the vacancy has been actually created in the CPMS;
- If there are recommendations from within the system - all the applicable officers should be notified via Lotus Notes of the vacancy;
- All the job descriptions and advertisements should be kept in a Lotus Notes database and taken from there for electronic approval by the HR ministries;
- The Appointing Board should be notified via Lotus Notes from the system of interview times and dates;
- A database should be set up with rejection letters that are automatically generated from the system;
- The Appointment Board should notify and verify interview times via Lotus Notes;
- The same database in Lotus Notes, should generate the letters of invitation inviting an applicant to come to an interview;
- Notify the Appointment Board that an offer letter has been sent out to the applicant;
- Once the start date is confirmed a form is generated (Casualty Return) and send to the relevant Departments (Accountant General, Directorate, Auditor General, HRM ministries);
- Casualty Return should be triggered by the CPMS, and filled in, in a softcopy format. This should then trigger an e-mail (asynchronously), to be sent to the appropriate parties; and
- Once the employee has actually started his/her duties, the Ministry should be formally notified via e-mail (Lotus Notes).

The researcher and the project team, in diagnosing the problem and the service delivery requirements of the decentralised personnel system, decided to develop an interactive WMS using Lotus Workflow release 3.0. This application was selected because the Directorate was using 'Lotus Notes' and 'Domino Doc', already. Lotus Workflow 3 is one of the product group from the Lotus Corporation groupware solution suite. This KM group was expected to complete the analysis and redesign of each HRM business processes within four to six weeks. After that, a proposal should be generated and implemented, under the coordination of the group leader, who would then prepare a report for approval by Government.

## **10.4    Action taking**

Seven training sessions were held over a two-week period. These sessions involved all HR managers and officers, lasted one day each, and were conducted by the researcher.

### **10.4.1    Core KM groups**

The core KM groups were tasked to review the following processes:

1. Recruitment, and
2. Personnel Administration.

The evaluation had earlier on, set out how these processes fit within the overall structure of the Directorate. This analysis is set out in section 10.2.1: List of core processes, and present the six process maps for the Recruitment process, in section 10.3.2 [cf. 10.3.2]. These processes are also relevant to how these processes translate into the Directorate Policy Databases. Four of the main process maps/workflow process maps are illustrated in Appendix F. These being Table F2.1: Promotions, Table F2.2: Transfers, Table F2.3: Personnel Updates, and Table F2.4: Termination.

The remaining processes were completed within the specified time, and successfully implemented.

Three high-level KM groups were formed involving the Director and the two Deputy Directors. All three groups had 10 to 14 members, were led by the Deputy Director, or the Senior Assistant Director, and facilitated by the researcher (The members were of similar seniority in the three groups). These groups targeted three main core processes at Directorate: (a) Recruitment process; (b) Personnel Administration, and (c) Policy Database.

The KM group working on the recruitment process made a number of recommendations which were implemented by management within six months of those recommendations being made. The main recommendations are indicted in paragraph 10.3.5 for the recruitment process. The group also felt that the unit responsible for managing the technical infrastructure of the CPMS should be elevated to the status of a Division with the Directorate structure. This was done within the same time period, as is evidenced by the Functional Structure in Figure 10.5. The

Directorate and HRM ministries were encouraged to use the process maps as templates for carrying out any personnel action. They were also asked to use the CPMS network, and the Lotus Notes groupware system whenever they must carry out any personnel action.

Although a number of technical problems were reported by Line managers, during the implementation phase of the CPMS, in general, the system, (the computerised Policy database, and the Infinium HRM applications) were running on the Directorate – Ministry intranet seamlessly, and users of the system, in general, reported significant efficiency gains in their respective local processes (Line ministries) due to the resulting decentralisation of access to data relevant to their activities/personnel actions.

In line with this development, the Directorate implemented version 5, of the Lotus Notes, groupware system, in order to provide greater functionality to users. This email system was linked seamlessly in an integrated suite of tools with the Domino Docs, a database application, which is a sister product of Lotus Notes. This was the kernel on which the Policy Database was built.

The email system (ES) was used as a vehicle to conduct personnel actions. The ES was widely accepted by all the process owners. There were much concerns about issues of confidentiality and security in the use of officers personal information, and the protection of the personnel record and data of the Directorate. There were no observed or reported resistance or reluctance, in using the ES for the processing of personnel actions. The researcher surmised this to be due in part to the prior experience officers have in the usage of ES for interaction on a personal basis with family, friends and colleagues. The use of the ES for facilitating KM group work and BPI for the purposes of improving the workflow interactions were implemented for all the 14 processes which were proposed by the consultant.

#### **10.4.2 Local KM groups**

The researcher recommended the use of ministry specific KM groups, using the principles of WITS to target processes cutting across only a few departments within the Ministry. This was the reason for calling them “local” KM groups. One of the rationales for these groups was to improve the ownership of the changes, which were introduced in the processes. These groups had very short-term projects. Some of them lasted only for a few weeks to a month; while others only for a few days. The researcher found that this short-term group duration were particularly

linked to a narrow target process scope. Also, that the shortest groups being those targeting very localised processes at the departmental and divisional level. Local WITS groups were led by management as well as line staff.

In the case of Directorate, which was the agency responsible for implementing the PMS in the Public Service, local KM groups abound. There was a long tradition of WITS projects and usage within this agency. So, there was no resistance to the setting up of local KM groups – teams. About seven months after the research iteration had begun four KM groups had completed their work. These groups met exclusively face-to-face, as the ES was unavailable at that stage. As the Directorate had 50 management level staff working in a campus environment, and considering that, a group would last on average of 4 weeks, the Directorate's maximum WITS group capacity was approximately of 4 five-member groups at a time. Some of the groups recommend very impressive alternatives to some of the Directorate processes, while others concentrate on short-term problems. This apparent tendency of some groups to focus on problems rather than on underlying processes has also been pointed out by previous research on both gradual and radical KM groups/community of practice interaction [Deming, 1986; (Dennis et al., 1993) and (Storck and Hill, in Lesser et al (ed), 2000)], and occurred in spite of the one-day training sessions previously mentioned.

Some of the Directorate's employees who did not take part in any of the KM groups, reported as one of the reasons for non-participation as being the inability to attend KM group meetings because they were engaged in external activities (e.g. meeting with a client) during scheduled group meetings. Since all the Directorate staff had access to the intranet – the GDN, this problem called for the introduction of the ES prototype developed by the researcher as a tool to allow KM group members to interact from their own computers at different times. This prototype was built on the Lotus Notes infrastructure. Each KM group was assigned a group mailbox upon its creation. KM group mailbox topics were suggestive of the business process under consideration, and held postings from group members' related to different stages of the KM methodology (i.e. process definition, analysis, and redesign). Some KM group mailboxes allowed public access within the organisation to group postings so other public officers could participate in the ongoing discussions. However, some of the KM group mailboxes had restricted access to group members, whenever the discussion was perceived as addressing confidential issues (e.g. possible dismissals as a result of process changes, terminal benefits, termination, etc.).

In addition, a number of public mailboxes were created and gradually populated with information



regarding the core business processes of the HRM policies and regulations. This information was previously held in the conventional paper-based “General Orders,” and other policy document, such as “savingsgram”<sup>7</sup>. These mailboxes also contained some regularly updated postings with information about efficiency, PMS outcomes, and service delivery, and ministries and clients complaints for each business process. Employees were instructed about how to use the Lotus Notes system (ES) to support KM group communication and retrieval of previously posted information, and were encouraged to use the ES as much as possible. None of the local WITS was directly facilitated by the researcher, as was the case of the core KM groups. The reason for this was that the researcher’s support was restricted to troubleshooting and orientation meetings with other group facilitators. This means that the researcher’s facilitation of local KM groups was indirect.

## 10.5 Evaluating

In this stage of the AR iteration, one observed a number of patterns evolving into practical learning opportunities. This was against the basic action research routine advocated by Stringer (1999:19). This ‘road map’, is set out below, in Figure 10.6, and Table 10.3.

These were related to both face-to face and the ES supported KM groups. The patterns observe in face-to-face discussions related only to the core KM groups, and are summarised in the next three sub-sections [cf. 10.5].

The pattern observed in the ES-supported KM groups relate to apparent ES-support challenges, and effects on the groups’ effectiveness and relevance of the process emerging as a result of these collaborative efforts. These are discussed in the remaining subsection. Although the model, Figure 10.6, depicts a linear format, it should be viewed as a continuous recycling set of activities [Stinger, 1999:19]. The main routine of Action Research are represented in Table 10.3.

### 10.5.1 Technical committee meetings

The researcher participation in the three core KM groups, which were conducted through asynchronous groupware mediating meetings, was motivated because of the difficulties officers faced

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<sup>7</sup>SAVINGRAM – A circular/memorandum document, which provides information on policy/regulation issues that subsequently, becomes part of the “General Order”.

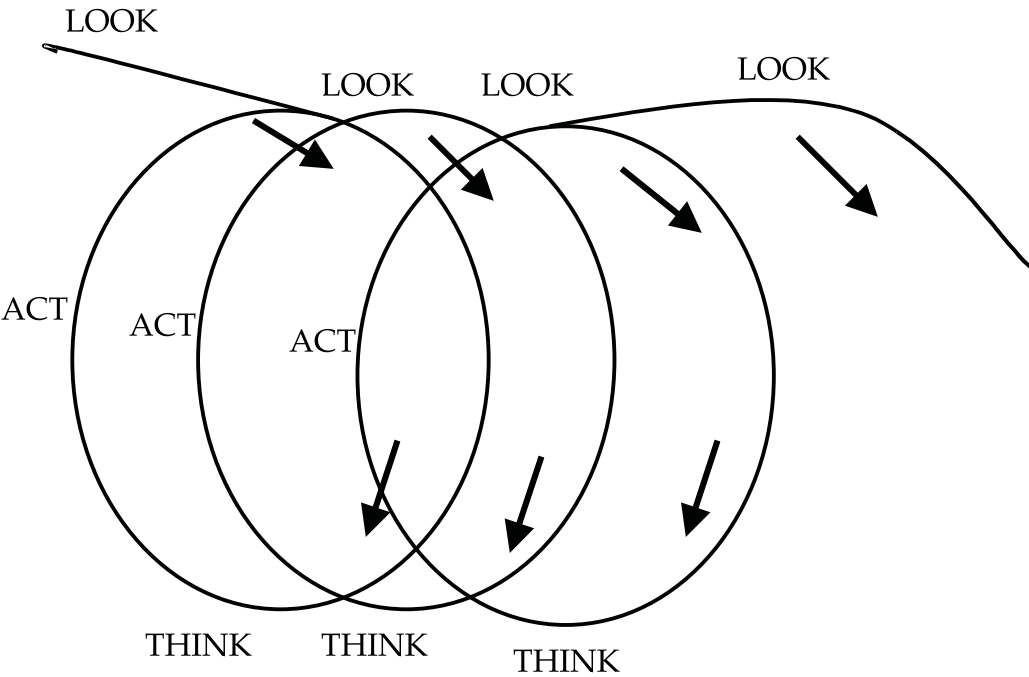


Figure 10.6: Action Research Interacting Spiral Source: [Adapted from Stringer, 1999:19]

Table 10.3: A basic Action Research Routine

Look	Gather relevant information (Gather Data) Build a picture: Describe the situation (Define and describe)
Think	Explore and analyse: What is happening here? (Analyse) Interpret and explain: How/Why are things as they are? (Theorize)
Act	Plan (Report) Implement Evaluate

Source: [adapted from Stringer 1999:18]

which led to the observation of three main group behaviour patterns. This represents the “LOOK” routine of Table 10.3.

### 10.5.2 Face-to-Face discussion

The Main patterns are:

#### a) First pattern

The technical committee meetings were postponed on several occasion. There was much difficulty in to arranging meetings with group members. Much time was loss and project delays were caused because of these difficulties. Scheduled meetings were often cancelled by certain group members who made other appointments or had appointments scheduled in the designated time slots for the group meetings.

#### b) Second pattern

There was also a high incidence of illness of some group members for 1 to 3 days. In these cases of illness the meeting would be cancelled until the members were well enough to continue with the groups proceedings. The reasons being were that any progress made in the absence of those members would have to be revisited for the benefits of the member who were absent. This was because the consultants wanted the full ownership of the completed project.

#### c) Third pattern

The third pattern of observation was the air time usage and dominance by certain group members. This is consistent with the findings from McQueen (1991) in a study of 10 business meetings.

### E S Supported KM Group

The formalisation and implementation of the ES was the major phase of the implementation of the CPMS project. The speed of interactions and the resolutions of personnel actions were handled more effectively and expeditiously. There were some incidences of resistance in the use of the ES. Some officers in client ministries were affected by paradigm paralysis, and felt uncertain about the implementation of the workflow points as identified in the process document.

Although process maps were provided to provide a visual and graphic representation of the conceptual model of the process action points, the workflow language was encapsulated in the object instances of the process, so as to mask the technical treatment of the workflow interacting model. Four of the completed maps are illustrated in Appendix F2 Table F2.1: Promotion, Table F2.2: Transfers, Table F2.3: Personnel Updates(x 2), and Table F2.4: Termination (x 5), were well enough to continue with the group's proceedings.

Occasionally, some group leaders felt compelled to call "face-to-face" meetings to discuss certain pertinent issues which they did not feel could be adequately dealt with via the ES. This was found to be a cultural bias, and although they confess to the effectiveness of some of these face-to-face meeting, they felt that they were necessary to meet in this traditional manner.

The perceived impact of AG on group efficiency were also observed and reported from the various unstructured face-to-face interviewed which were held with all of the HR department heads of the client ministries.

## 10.6 Summary

In this chapter the first iteration of the AR cycle, are described, which were carried out over a period of approximately one year at DPSM, a Public Administration department, in the Republic of Botswana. At most thirty six public officers were directly involved in this exploratory study. They were all trained based on a methodology developed by the researcher on how to conduct, and participate in, KM groups.

## **Part IV**

# **Discussion of Results and Conclusion**

## Chapter 11

### Conclusion

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*... and more anon.*

*Anonymous*

#### 11.1 Introduction

This chapter provides an overview of the study, restating the primary research question and the three secondary research questions, and justifying the interpretive methodology used to explore them [cf. 11.2]. It summarises the main findings [cf. 11.3] before discussing the significant issues raised in the exploratory research [cf. 11.3.1], as an evaluation of the findings in Chapters 7, and 8, respectively; and which is then followed by a discussion of the confirmatory factor analysis, as applied to structural equation modelling, as presented in Chapter 9. This is distilled here as an evaluation of the measurement model [cf. 11.3.2], and an evaluation of the structural model [cf. 11.3.3, respectively].

The main contributions emanating from this study is then presented in Section 11.4 from a general perspective, while the salient KM practices and strategies, regarding the application of the KM-BI model [cf. 11.4.1] is considered. The possible implications and recommendations emerging from the study are discussed in Section 11.5. Much of this has already been done in detail in chapters 7, 8, 9, and 10, concurrently with the findings in those chapters. Finally, limitations [cf. 11.6], and directions for future research [11.7] are presented.

#### 11.2 The research motivation

According to Rastogi [2002:229],

Any enterprise can potentially grow profitably through its management of knowledge for intellectual capital. For this purpose, it however, needs to craft an innovative

and viable design of its business system. A business system design (BSD) comprises a dynamic architecture which is isomorphic across firms in space and time. A dense dynamic nexus of social capital, human capital and knowledge management – the KMN – forms the core of BSD. KMN continually rationalises and revitalises the BSD.

Indeed, he further advocates the need for an inclusive concept of the knowledge spectrum as the quintessential resource for value creation in the modern competitive organisation, in terms of its dynamic configuration. In his view, a firm's intellectual capital (IC) is seen as the resultant of its KMN. IC represents a firm's meta-capability aimed toward overcoming challenges and exploiting opportunities in its continual pursuit of value creation. This is in line with the literature, particularly, Bontis (1998:63), who lamented that there is a need for much more research in the field of KM, by asserting that,

Knowledge creation by business organisations has been virtually neglected in management studies even though Nonaka and Takeuchi (1995) are convinced that this process has been the most important source of international competitiveness for some time. Drucker (1993) heralds the arrival of a new economy, referred to as the knowledge society. He claims that in this society, knowledge is not just another resource alongside the traditional factors of production – labour, capital, and land – but the only meaningful resource today. Because knowledge is shared among organizational members, it is connected to the firm's history and experiences [Von Krogh et al., 1994] and soon becomes the ultimate replacement of other resources [Toffler, 1990]. This notion underpins a more general idea that economies of the future will be education-led [Young, 1995]. *What does this mean for managers?* It means that the capacity to manage knowledge-based intellect is the critical skill of this era [Quinn, 1992]. It is up to symbolic analysts (Reich, 1991) who are equipped to identify and solve intellectual capital issues, that will sustain the knowledge advantage for their own organizations. If there is one distinguishing feature of the new economy that has developed as a result of powerful forces such as global competition, it is the ascendancy of intellectual capital. A shift is clearly perceptible from a manufacturing to a service-oriented economy: firms that are thriving in the new strategic environment see themselves as learning organizations pursuing the objective of continuous improvement in their knowledge assets [Senge, 1990]. Recently, there has been exponential growth in researching this area [Crossan and Guatto, 1996]. Competitive,

technological, and market pressures have made continuous organizational learning a critical imperative in global strategy effectiveness [Osland and Yaprak, 1995]. Organizations that have been unable to enhance their knowledge assets have failed to survive [Antal et al., 1994] and are left wondering what the fuss is all about [Roos and von Krogh, 1996].

In this study, the research motivation, in large measure, is taken from Salomon and Almog (1998), who attest that one lives in an age of *constructivist, socially shared, situative, technology - intensive learning environments* (p. 233). Indeed, a review of the management literature informed by constructivism indicates that good learning is a process of socially based, active co-construction of contextualised knowledge. There has been a demand for appropriate investigations of these types of environments. For example, Kozma (2000) called for more research on the impact of technology environments on the cognitive processes and social practices of learning. Indeed, Harper and Hedberg (1997) challenged researchers to *demonstrate for developers<sup>1</sup> how to capture these opportunities and support the intrinsic motivation of learners to explore their own world and the variety of viewpoints within it* (p. 15). They also identified a need to further investigate the facilitative strategies that support learners in sociocultural processes. The present study attempts to add to the knowledge base of these types of technology-mediated organisational learning environments by investigating the collaborative use of AG tasks for the purpose of generating BI, and harvesting IC through the harnessing of the SC, and the ubiquitous tacit HK conceptions of the organisation, and promoting discussion and reflection on these views. Although organisational KM-BI strategy is well explored in the literature, the particular use of a portal to deploy the KM-BI strategy has not been reported.

Consequently, the goal of this research has been to develop practical techniques for KM, so as to whet the interest of other researchers to collect empirical evidence. This is with a view to improve our knowledge and enquiry of information on KM, BI, and AG systems, processes, and projects. This is firstly done from an historical perspective. Where the researcher tries to frame some of the key questions and challenges about the myths and facts of KM, and position KM as a value-enabling strategy as it seeks legitimacy as a the traditions on which it rests (Chapter 3). The study explores some of the successful projects, which have been implemented by organisations (see Chapter 3). This is done by examining how they map their KM efforts - their knowledge strategies - to some key aspects of their business strategies. The researcher

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<sup>1</sup>The term "Developers", is interpreted to mean practitioners by this researcher.



takes a holistic approach in our investigation by addressing the three main aspects of any KM project, namely technology, process, and people, and how these components contribute to the formulation of a robust knowledge plan (see Section 3.4). The investigation points out that such a KM plan rests on four facets. These being (a) knowledge of the business environment, (b) knowledge of strategic thinking, (c) knowledge of business design, and (d) implementation of KM (see Sections 3.4.1 - 3.4.4). This holistic approach is normally used to encourage virtual teams - working in active knowledge sharing [Currie, 1998]. For most organisations, that means focussing on one or more of the following four areas: (a) *Innovation*, (b) *Responsiveness*, (c) *Productivity*, and *Competency*, as discussed in Section 1.1.2.

The discussions in Chapter 3, Section 3.6, focuses on how technologies can be used in the context of KM projects. The researcher cautioned in that chapter that the technologies in question are not necessarily characteristic of earlier developments. In addition, one laid no claims to the completeness of the use of the technologies mentioned in that section [cf. Section 3.6]. The researcher commended the efforts being made here and the contributions in terms of the technical challenges being faced in the context of KM implementation. In this study one explores two technology-oriented interfaces. These being groupware (see Section 3.6.1) and document management (see Section 3.6.2). Other interest is, however, on AG, as it applies to KM. This is the subject of Chapter 4.

In this thesis, a model (see Figure 2.1) is constructed through a comprehensive literature survey (see Chapters 2, 3, and 4). The body of information gathered is then filtered and concentrated in a technological and investigative framework (see Figure 9.2). This frameworks are then used to study links between the: (1) SC, HK and AG constructs; (2) BI and AG constructs, and their covariances with those factors of SC and HK; (3) Structural efforts of task-related outcomes and those of group-related outcomes, in the use of AG technology, in assessing the productivity and performance-oriented initiatives of organisations, and (4) Efforts of the individual in task-related outcomes and those of individuals in team-related outcomes, in the use of AG technology, in assessing the productivity and performance-oriented initiatives of organisations.

Having established the possible relationships for the links between the KM strategies and those of the AG processes, and their impact on the organisation through the use of intellectual capital, customer relations, and the enabling role of technologies (see Section 3.6.3, and Figure 5.4), the research objectives were discussed. These objectives were framed to answer the following fundamental questions in terms of how an organisation maps its KM efforts - (its knowledge

strategy) - to the key performance aspects of its business strategy, through the support and use of AG systems. This then led to the primary research question, which was the seminal interest of this research. Three subsidiary research questions were also raised, and informed the metrics of the research. The research results have been discussed in chapters 7, 8, 9 and 10, respectively.

The primary research question was:

*How KM strategies are enabled by the support of asynchronous groupware systems?*

The subsidiary research questions are set in Section 1.2.2. The results associated with subsidiary questions 1, 2, and 3 are presented in Tables 7.29 - 7.32; Tables 7.33 - 7.34, and Table 8.22; and Tables 7.35 - 7.38, and Tables 8.23 - 8.24, respectively. Arising of these, the central research problem of this study, as framed from the research question, is noted on page 421.

The observed findings of this study, that AG (F2) has a significant direct casual effect ( $F2 \rightarrow F1 : .2708$ , [cf. Figure 9.13]) on BI (F1) is in line with Campbell and Pellissier (2001), and Sproull and Kiesler (1991) view that people connected to wide-area networks tend to respond more readily to knowledge and information sharing, and thus enhances the overall electronic community and leads to a richer knowledge and information environment. Additionally, the literature supports the point that this casual relationship leads to many advantages in the use of AG to support KM strategies, particularly as it relates to savings in economy of time and expense, as against the use of paper mail [Toffler, 1991, McQueen, 1993].

There were four research hypotheses which were assessed with reference to the final model presented in Figure 9.13, in Chapter 9. These hypothesis are discussed in Chapters 1 and 5; Sections 1.2.4, and 5.3.2, respectively.

The four hypotheses helped us to analyse the hypothesized KM-BI model (see Figure 2.1), and to develop a KM-BI framework (see Figure 9.2). To assess the research, one performs an exploratory factor analysis (see Chapter 7) on the 95 items of the instruments to explore the data. This was with the aim to determine the number or nature of the factors that account for the covariation between the variables used to test these hypotheses. Hence, the use of the EFA is due to the lack of, a prior, sufficient evidence to form any hypothesis about the number of factors underlying the data. The use of EFA may therefore be seen as a theory-generating procedure, in this research, rather than as a theory-testing procedure [Stevens, 1996].

This was initially achieved by using the seven hypothesized (see Table 7.3) constructs, in the exploratory phase of the research. In addition to these constructs, one also draws direction from Figure 5.4: the research model, in order to test the four hypotheses.

The multilevel process used in the EFA is discussed in Chapter 6, under the section statistic model. For *hypotheses 1 and 2*, the objective was to relate the rank order correlation between AG and KM practices (HK and SC), and AG technology and BI, in the case of *hypothesis 2*.

The analysis also sought to test these hypotheses using the bivariate correlation procedure of SPSS. For the case of *hypotheses 3 and 4*, one uses the bivariate correlation procedure of Kendall's tau b as the test statistics. The result of these hypotheses were validated by Spearman's rho, at the same level of significance,  $p < 0.01$  (see Tables 7.33 - 7.39) in Chapters 7, see Tables 8.22 - 8.24 in Chapter 8, respectively.

Given the sampling frame, [cf. Section 6.2], Figure 5.5: *Research Framework*, was used for *hypotheses 1 and 2*, with four latent variables to test *hypotheses 1 and 2*. Here, the principal component analytical procedure of factor analysis was used to extract the underlying factors hypothesized in Figure 5.5. The procedure was discussed in Sections 6.3 and 6.4. Additionally the factor score of each of the rotated rank order correlation between AG and HC<sup>2</sup>. While in the case of *hypotheses 2*, the rank correlation of AG and BI were tested. This also allowed for the computation of the factor scores of these two latent variables from the principal component analysis, as set out in Sections 6.3 and 6.4 respectively. The factor score of BI takes cognisance of the relevance of KM strategies in the design of a business system.

The view was also taken conceptually, that a knowledge-based business model or system must have KM playing a central role. The design of such a business system may be viewed, in the main, as consisting of a set of dynamically interrelated components or modules as set out on page ??.

The study concludes that the features built into the KM-BI model combine to make KM strategies more realistic as it applies to the deployment of BI and thus allowing organisations to leverage greater competitive advantages.

Modern management theories still focus on Porter's competitive strategies [Porter, 1985]. These are built around customers, market and products, regulatory principles, methods and process.

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<sup>2</sup>HK - is used interchangeable

This was followed by Senge's (1990) work on the learning organization that shows organizational learning as a continuous growth process with core principles personal mastery, mental modeling, shared envisioning and team work, and systems thinking. While this work draws support from Senge and Porter, it also relied on the work of Bontis et al. (2002) in their perspective on the 4I's of organisational learning. However, it is postulated in this work, that the growth into knowledge and IC, cannot be seen in isolation, but are all part of a BI-KM model (cf Figure 2.1) where AG becomes the facilitative vehicle for BI actualization. None of these can exist in isolation. They all become part of a bigger model to sustain organizations in a growing BI environment. The principles in the model was discussed in the context of the theoretical motivation, in Chapters 2, 3 and 4, respectively, but moreso in line with the hypothesized theoretical casual model (see Figure 9.2), in Chapter 9, and page 308.

There are three covariant inputs, which are the exogenous latent variables, and an intermediary variables - AG. These are:

1. *Inputs:*

- (a) *Structural knowledge:* Business strategy and competitive advantage, as enablers for driving the KM process [Porter, 1995];
- (b) *Organisational learning:* The learning organization as championed by Senge (1990) seeks to measure the role corporate learning in creating competitive advantage. This has mushroomed in the literature, in recent times to such a degree so as to engender an increasing interest in a firm's intellectual capital and collective knowledge, and the means by which to increase it (organizational learning), store it (organizational memory), and manage it (KM). Although often discussed separately, these three concepts are tightly interwoven [Hall, Paradice,& Courtney, 2003].
- (c) *Human knowledge:* This involves the tacit and tangible aspects of KM [Nonaka & Takeuchi,1995]. This component deals with the harnessing and retention of knowledge within the organisation. This requires a certain level of leadership. For this component to be successful, then there is a need to recognize the knowledge worker as a construct of the knowledge-based enterprise (KBE). Bundled in our model is the concept that the practices for motivation and retention have more in common than those found to be effective for attracting knowledge workers. Consistent with Butler and Waldrop (2001), Hackman and Oldham (1980), Kinnear and Sutherland (2000)

and Thompson and Heron (2002), common practices for motivation and attraction relate to work design and reorganisation, work challenge and personal control, and the need for top management support. In other works the concept of reengineering and radical change cannot be successful if it remains top down.

2. *Asynchronous groupware*: This construct is viewed as a catalyst for knowledge transfer. Just as strategy and people are the principle drivers for KM then it can be argued that IT–*Our Technology component* is a fundamental enabler. In a modern organization an essential part of the KM infrastructure will be an IT system that will not only collect, organize and disseminate data but will aid and facilitate exchange, creativity and innovation. This for us is the groupware component of the IT infrastructure. Ruggles (1997) and Leug (2001) argue that knowledge building is dependent upon IT. This position supports Huffman et al. (1990) who state that organizations must develop the capabilities this presents. In fact the survey evidence from KPMG (2000), which is supported by our own research, suggests that in practice many KM programs are being led from an IT perspective. One can understand why this should be so as clearly much specialist and technical knowledge will be needed to create the systems and infrastructure. However, one sees some dangers in allowing this to go unchecked, as Gao et al. (2002) have found. There exists, for example, the possibility that projects are narrow, not strategically aligned, and does not deliver on the promise for which the IT infrastructure was put in, in the first place.
3. *Output*: BI: New force driving competitive advantage from when Porter (1985) identified the five forces : this is a framework that models an industry as being influenced by five forces. The BI component of this research, draws on Porter’s model, by advocating that a strategic decision maker seeking to develop an edge over rival firms can use this model to better understand the industry context in which his firm operates. In his in his book, *Competitive Advantage: Creating and Sustaining Superior Performance.*, the five forces are noted as: (1) *Rivalry*, (2) *Threat of substitutes*, (3) *Buyer Power*, (4) *Supplier Power*, and (5) *Barriers to Entry / Threat of Entry*. The harvesting of BI requires a KM specific strategy, which should draw on an understanding of these five forces, as they impact on a firm’s competitive advantage.

The study found that there are many themes relating to strategy, competitiveness, and planning, in the KM literature. Curren et al. (1992), propose that KM is a key factor which can inform strategy and benefit the overall strategy formulation process. Carneiro

(2000) argues that KM is essentially a strategic tool, because it can be a key resource for decision making, mainly for the formulation and evaluation of alternative strategies. McAdam (2000) emphasizes innovation, and competitive advantage, as important factors. The study is in support of these expressed views, and our KM-BI model [cf. Figure 2.1] seeks to offer an approach as to how these views may be encapsulated in the creation of BI. The summarised views as they relate to this study are: (a) competitive advantage; (b) customer focus; (c) improve employee relations and development; (c) innovation; and (d) lower costs.

Consequently, the KM-BI model as developed and the hypotheses tested are intended to form a basis for future discussion. They are not meant to be the final word or arbiter on the subject under discussion here. KM strategies, although not universally recognised as such, have been considered one of the underlying change dynamics of management movements that have been widely regarded as the causes of economic revolutions and fundamental paradigm shifts [Champy, 1995, Prusak & Davenport, 2001, Nonaka, 1995], such as the total quality management and business process re-engineering movements [Hammer and Champy, 1993; Davenport, 1993; Tapscott and Caston, 1993; Walton, 1991].

The results are shown in Tables 7.35 - 7.38, and Tables 8.23 - 8.24, respectively.

### 11.3 General summary of the research

The findings are concerned with:

1. the relationship between the SC, HK and AG constructs [*Hypothesis 1*].
2. the relationship between the BI and AG constructs, and their covariances with SC and HK. [*Hypothesis 2*].
3. the relationship between the efforts of task-related outcomes and those of group-related outcomes, in the use of AG technology, in assessing the productivity and performance-oriented initiatives of organisations [*Hypothesis 3*].
4. the relationship between the efforts of the individual in task-related outcomes and those of individuals in team-related outcomes, in the use of AG technology, in assessing the productivity and performance-oriented initiatives of organisations [*Hypothesis 4*].

Arising from these, a set of metrics was developed to help their analyze knowledge bases, and to assess the research, a framework, [cf. Figure 3.5] for mapping and building a knowledge system as a metaphor of undertaking a knowledge journey was considered. This framework was conceptualised in a model of *knowledge-creating principle*., which firms' may used in undertaking the KM deployment process. The five stages of the model are discussed in Chapter 3 (see Sections 3.7.1 - 3.7.5).

In Chapter 4, the study reviewed the impact of AG systems on KM strategies and projects. The analyses are drawn from one of the acceptable definitions of groupware systems (see section 4.1). The research, and discussions in this chapter focus on the two taxonomies of groupware, namely, the application-level taxonomy, and the time-space taxonomy (see Section 4.2).

The researcher discussed and drew support from the literature that the two taxonomies are clearly related (see Section 4.2.1). This relationship is illustrated in Figure 4.2, on page 111.

The study then took a critical view of AG support effects on groups, and explored how these can be shaped in comparison with other modes of interactions (see Section 4.3). These pros and cons of AG are further discussed in terms of the advantages a firm faces when compared to non-groupware supported interactions, in that AG supported interactions presented positive aspects from different points of view (see Section 4.3.1).

The researcher then discussed the advantages firms may realize with the adoption of synchronous groupware. The researcher analysed the advantages over synchronous groupware support (see Section 4.3.3). Sections 4.3.3 and 4.3.4 drew some balance in highlighting some of the disadvantages over no groupware support at all, and disadvantages over synchronous groupware support.

### 11.3.1 Evaluation of the exploratory research

This section of the study focussed on the factor analytical, and descriptive statistics associated with the survey. The study explored the general findings on the status of the five extracted factors. This is from the exploratory factor analysis of the data set using principal components. The present study found that there is a simple structure from the seven hypothesized factor solution of our data set. The five extracted factors are: (1) BI, (2) AG, (3) HK, (4) OL, and (5) SC. These five factors were found to be not significantly different from the seven original hypothesized

constructs used in the survey.

The summaries results arising from the principal component analysis of the rotation to a final solution [cf. page 205], are presented next:

1. **Business Intelligence (BI):** The variables of the first factor are most highly correlated with each other. The researcher called this construct, [cf. Table 7.9], BI, because it represented almost 70% of the variables of the Business Intelligence construct. The underling theme of the construct are explained by nine [9 of 13 variables] variables. The study found that the overall correlation of this factor BI was significant at the 0.01 level (2-tailed).
2. **Asynchronous Groupware (AG):** Similarly, the second factor was most highly correlated with its associated variables, [cf. Table 7.10], around the general concept of AG Infrastructure. These variables were found to load uniquely on this component. As such, the researcher was able to safely assign the name AG Infrastructure, to the factor. This choice, represented almost 90% [9 of 10 variables] of the variables of the constructs on IT Infrastructure which are used to measure innovation to fit within our hypothesized model for KM-BI, [see Figure 2.1]. The remaining variable: *Value knowledge about competitors' market (SK01D)*, reflects the characteristics of SC, as it relates to IT infrastructures and KM networks.
3. **Human Knowledge (HK):** In terms of the third factor, the coefficients of all 16 variables of the factor were positively inter-related with each other, [cf. Table 7.11], and significantly correlated, with an overall correlation of the factor HK at a significance level of  $p < 0.01$  (2-tailed). The results suggested that the factor focused on HC which deals with the knowledge sharing strategy of the organisation, in terms of its human capital. The factor was correctly named, HM. Ten of the sixteen variables have very significant loading, varying between a high of .915 to .651. These are illustrated in Table 11.1.Chapter 7  
  
The remaining six variables were also contextually relevant, with loadings in excess of .500.
4. **Organisational Learning (OL):** The fourth component is illustrated in Table 7.12. The researcher found that all 10 variables were highly correlated with each other, and seems to define the characteristics of the organizational learning processes. Consequently, the factor was named, as OL.
5. **Structural Capital (SC):** The final component is most highly correlated with its seven



Table 11.1: HK Factor Loadings

Variables	Loads
(a) Loss of significant income	.915
(b) Damage to key client/supplier relationship	.897
(c) Lost of best practice in a specific area	.885
(d) Lost of vital information	.836
(e) Employees provided with resources	.818
(f) Value knowledge about own market	.810
(g) Awareness of KM	.809
(h) Value knowledge about own customers	.786
(i) Value knowledge on employees skills	.705
(j) Transforms organisation's business	.651

hypothesized variables, one however, choses to retain only six, (see Table 7.13) to represent the factor. The underlying theme of the construct was adequately explained by the six retained variables, so naming the factor as SC, was deemed reasonable.

The evidence of simple structure allowed the confirmation of the construct's validity, and uni-dimensional reliability of the five extracted factors which were used in the hypothesised casual model in Figure 9.2, and validated in the research final model, through structural equation modelling in Figure 9.13. Thus causing one to conclude that the research proposed KM-BI model [cf. Figure 2.1] was plausible for use in practice and to aid further research in the various parameters proposed.

The present study used descriptive statistics associated with the survey in the form of frequency distribution, cross-tabulations, and interactive graphs and charts, to explore the general findings on the status and attitudes of KM practices in the respondents organizations, within the 26 countries from the Commonwealth of Nations (formerly British colonies) that were sampled. This analysis was also performed on the seven original hypothesized constructs, in order to cross validate the results from the principal component analysis. These findings are important from a number of perspectives, particularly as it relates to the proposed KM-BI model [cf. Figure 2.1]. Those which are considered to be specific are presented next:

**1. Current State of KM :** Two measures are of some concern here:

- (a) *Awareness of KM* : Of particular interest is the the changing attitudes [cf. Table 7.14: Attitudes towards KM] of organisations to the practice of KM. Although this study was conducted four years ago, the literature (Rodgers, 2003), supports the results

that respondents held that KM is growing rapidly in importance and has gained great impetus in importance to the competitive strategy of organisations. Rodgers advocates, however, that there is a ground swell of interest by practitioners in: *The understanding of how to evaluate intangible assets or knowledge-based assets (KBA)* (p. 2). He is in concert with Edvinsson, 2000; Stewart, 1997, 2001; and Sveiby, 1997, 2001). At most 100% of respondents said KM was clearly transforming the way their organisation did business. This is a high proportion given the significance of any organisational transformation.

- (b) *KM initiative in place* : In line with this growing acceptance of KM in organisations, the study also found that at most 97% of respondents considered their organisation to have a KM initiative in place [cf. Figure 7.2: Existence of a KM initiative]. The result is supported by the literature (Wah, 1999), where in that particular study at most 53% of the organisations studied either has a KM initiative in place or expects to implement one in the short-run. Interestingly, at most nine out of ten (89%) of the largest organisations had a KM initiative in place against just over 11% of the rest [cf. Figure 7.4].

Although the results are encouraging, this research also found that only a few organisations were fully reaping the benefits of KM in terms of: (a) providing employees with the necessary resources to contribute to the organisation's knowledge, (b) establishing a strategy for KM, (c) identifying the expected benefits and managing their realization, and (d) making the most of existing technology to store and disseminate information which is most critical to an organisation's success.

These findings add to the body of knowledge about the levels of understanding in the implementation of KM strategies in the organisation. The research proposed a framework which is depicted in Figure 5.4. The KM strategies component of that figure, along with the findings suggest that knowledge-based enterprise needs to have a good change management programme in place to engender support from employees.

2. **Human Knowledge** : The results from the factor analysis procedure (as shown in the previous section) shows that the leveraging of HK is an important strategy for achieving sustainable competitive advantage. This perceived view is also echoed by the literature [Baker, Marc & Barker, Mike and Thorne, Jon & Dutnell, 1997]. The final casual model [cf. Figure 9.13], suggests that firms consider HK to be an important construct. The

researcher found in support of the literature [Bontis, 1998; Rahman, 2004], that both human capital and intellectual capital are requisite strategic initiatives that firms need to manage. There were four major issues reported here. These were:

- (a) *Cost of ignoring human knowledge* : This research is of the view that much of the knowledge in an organisation is personal. This is the tacit concept of knowledge of which most organisations are ill-prepared to capture, share and disseminate. The evidence suggest that organisations have difficulty in converting this, tacit knowledge, into explicit knowledge. The resulting effect is that when individuals leave these firms their knowledge is usually lost, to the organisation. The findings showed that the value of this human knowledge is important to many organisations, and although many had suffered in various ways when key individuals left, particularly from loss of knowledge of best practice, and severe damage to their key client and supplier relationships, which ultimately translate into significant financial loss, many have done nothing to alleviate this problem.
- (b) *Loss of knowledge of best practice* : At most 90% of all respondents said that they had lost corporate knowledge of best practice in a specific area of operations because of a key employee's departure.
- (c) *Damage to a key client or supplier relationship* : All the surveyed respondents (100%) indicated that a relationship with a key client or supplier had been damaged by the departure of a key individual. This fact was also observed in the largest organisations [cf. Figure 7.5].
- (d) *Loss of significant income* : The findings in response to this variable, indicated that at most 100% of the respondents from organisations whose turnover was over five hundred million dollars, and who agree with this view, said that their organisation had lost significant income because of a key employee's departure. Figure 7.7 illustrates this profile. On the converse, 52% of the smaller firms experienced the same phenomenon, while only 44% of the other categories were so affected.

**3. Structural Capital** : This construct was hypothesized to be one of the main drivers enabling knowledge creation. It informs both the value creating conception and the storage of requisites of knowledge. The research model [cf. Figure 7.8], informs the overarching role of a firm's strategies in building a robust and relevant structural capital interface. Four concerns of note from the respondents are presented next:

- (a) *Failure to store critical knowledge effectively* : This research tested whether organisations were able to identify which types of knowledge are important to their business. The present study found that organisations are very good at identifying which types of knowledge are important to their business [cf. Figure 7.9]. But, on the other hand, many of the sampled firms were less effective at using appropriate formats to store and share it, even if they already have such facilities and the infrastructure in place [cf. 7.10].
- (b) *Types of knowledge important to an organisation* :The study also found that organisations valued most highly their knowledge about their customers [cf. Figure 7.9], their own markets [cf. Figure 7.10], their competitors' market [cf. Figure 7.11], and their own products and services [cf. Figure 7.12]. The largest organisations regarded knowledge of customers and their markets as more important (somewhat) than other organisations did (100%) respectively. This is represented in Figure 7.8 – 7.14.
- (c) *Methods of storing important knowledge*: One also found that organisations valued most highly their knowledge about their customers [cf. Figure 7.9], their own markets [cf. Figure 7.10], an understanding of their competitors' market [cf. Figure 7.11], and their own products and services [cf. Figure 7.12]. The largest organisations regarded knowledge of customers and their markets as more important (somewhat) than other organisations did (100%) respectively. This is represented in Figures 7.8 – 7.14.
- However, the findings show that while organisations are using various technologies, they are not necessarily doing so with KM in mind [cf. Table 7.17].

4. **Technological Infrastructure** : This construct deals with the technological infrastructure that a firm needs to implement so as to reap the full benefits of the KM-BI model proposed in this research. In the final model this construct was bundled with the SC construct. There is, however, one area of some concern. This is the:

- (a) *Failure to exploit technological infrastructure* : Despite the implementing of a wide varieties of technologies and applications that can be used, for the purposes of creating KM oriented solutions, the investigation found that firms were not to fully utilising them to derive the expected benefits. In attempting to ascertain the reasons , the researcher asked about some of the key types of technology in use and why they were implemented. The IT infrastructure needed for KM has often been put in place for other reasons.The present analysis found that at most 90% of respondents had

implemented Internet Access, while only half of those firms, had done so with KM as the primary focus. Continuing on the same trend at most two-thirds of respondents used Document Management Systems on a regular basis, but only 48% had KM as the primary focus. In the same vain the investigation found that two-thirds of these firms had implemented Intranets infrastructure in their organisation, but an alarming 41% had KM as the primary focus. As discussed under Structural Capital, these findings suggest that organisations are not exploiting the full potential of the technology they have.

5. **Business Intelligence :** This construct is the capstone component of this research, where our motivation was to test the degree to which some organisations make use of KM initiatives to drive their strategy, its current status, and level of implementation. The indicative responses were scaled to measure three states of BI strategy and implementation. These being:

- (a) *Strategic infrastructure of the KM initiatives:* This research sought to measure the various strategies organisations were using to implement KM and intellectual capital initiatives.
- (b) *Benefits from implementation of KM initiatives:* This research sought to measure the perceived benefits organisations were harvesting from the implementation of the KM initiatives, and
- (c) *Difficulties in implementing KM initiatives:* This research sought to measure the difficulties organisations were experiencing in implementing their KM strategies.

Although the reliability coefficient, Cronbach's alpha, was computed at 0.91, and viewed as being highly significant, nevertheless, the investigation found four areas which can have direct effect on the development of a facilitative BI milieu, to be of some concerns. These were:

- (a) *Need for vision and strategy :* Organisations need a clear and unambiguous organisation-wide strategy to drive the strategic impetus of BI. The present evaluation showed in Figure 7.15, the level of difficulties organisations reported in their efforts to implement the technological support needed to drive the sharing and storage of KM. The results are discouraging, given the importance organisations placed on the collaborative benefits to be gained from knowledge sharing. The researcher tested the extent to which organisations have a clear vision or strategy of KM and are actually implementing it.

- (b) *Importance of a strategy* :The researcher found that a number of organisations in recognising the importance of a KM, were at various stages of implementing an initiative (See Table 7.20). These include the following:
- those with an existing KM initiative, were establishing informal KM networks;
  - many of those initiatives were bottom-up driven activities. The inference seems to be encouraging and shows that people have a genuine interest and enthusiasm in participating in the KM strategy deployment.
  - the need for top-down planning and careful location of resources is essential if the observed early enthusiasm is to be nurtured and rewarded with organisation-wide results.
- (c) *Need to allocate responsibility* : It is the view of this Researcher that in allocating responsibility for an activity is a litmus test that the organisation, in question, is taking that activity seriously. The study showed that this was not the case in over 40% of the organisations, which had an existing KM initiative in place. The results showed that there was no one at board level responsible for the initiative.
- (d) *Importance of a dedicated budget* : As highlighted earlier, a dedicated budget is an indicator of the commitment of the organisation to any project. The results showed that nearly a third of the sampled organisations did not have any budget had been allocated for their KM project.

## 6. Performance Analysis :

- (a) *Investing in knowledge* : The conventional wisdom, confirmed as recently as four years ago by the survey conducted by the Information Systems Research Centre of Cranfield School of Management, is that the barriers to knowledge sharing are personal and cultural, revolving around individuals' unwillingness to share knowledge or put themselves out for others. Our findings suggest that individuals are willing to share knowledge but do not have the time to participate actively. This and other barriers to the implementation of KM are illustrated in Table 7.23.
- (b) *Obstacles to knowledge sharing* : As shown earlier, organisations are mainly at the planning stage. The researcher asked what barriers they are facing. The results show the main ones are lack of time to share knowledge (33%), lack of skill in KM (18%) and lack of understanding (26%).

It is an investment in KM that organisations need to make. Knowledge work requires organisations to give people/employees time and space to progress with other work. The issue that arises comes in quantifying the benefit, which can be hard to do directly as is explained in Paragraph 7.3.6.5. The data in Table 7.24 is relevant.

- (c) *Impetus from outside* : Respondents indicated that sharing knowledge with outside organisations was more likely to be treated as a useful investment by their organisations – over a third of respondents said that knowledge was effectively shared with relevant outside organisations such as suppliers and customers. This is presumably because organisations identify external organisations as either a source of income (customers) or cost reduction (suppliers) whose financial impact on the company will be improved through the sharing of knowledge. Collaborative working with suppliers and customers will increase. It creates win-win relationships and enables organisations to complement each other's strengths and is the direction in which a number of disciplines – from supply chain management through to marketing – are developing. However, the ability to share knowledge effectively requires organisations to have their internal KM systems in place.
- (d) *Changes needed to reward structures* : Respondents identified that if organisations are serious about KM, they will have to consider reflecting this in their reward and incentive structures. At most 45% of respondents said their organisation did not reward knowledge sharing, and this was considered to be the third biggest drawback to storing and sharing knowledge after lack of time and wasting effort through re-inventing the wheel (i.e. re-doing work already done elsewhere). Recasting reward structures would relieve the emphasis of conventional reward on dealing with existing deadlines and would also provide immediate reward for efforts which, in KM terms, may take longer to show through. This means focusing on allowing employees to gain personal development in return for sharing their own knowledge; which allows work to become more fulfilling, and makes the organisation more attractive to work in, with better retention of staff [cf. Table 7.25: *Important issues driving KM*].

The study also found that organisations that had adopted KM strategies at the onset of the the KM renaissance were actually reaping more benefits than those firms which started later. The summarised results are discussed next.

- (a) *The benefits are there to be realized* : The researcher asked respondents whose organ-

isations had a KM initiative to assess the reasons for embarking upon the initiative and whether their expectations had been fulfilled. Better decision-making was the single, overwhelming reason. At most 86% cited it as a reason and the 66% said their organisation had achieved it as a result. At most 86% also cited faster response time to key issues and two-thirds said they had achieved it. These and the findings for improved productivity and reduced costs are high levels of attainment, which confirmed that those organisations pursuing a KM initiative believe they are gaining benefits from it.

- (b) *The impact on the bottom-line will come through* : Financial goals such as increasing profit and increasing the organization's share price were mentioned by respondents but were less widely achieved. In the researcher's view, there were two motives at work. The first was conventional – respondents cited these as possible benefits for budget-justification purposes (relevant, given the number of organisations still at the planning stage). The second was genuinely aspirational – respondents believe that these bottom-line benefits can be delivered by their KM initiative – and was borne out by the survey that shows clearly that some organisations are achieving these benefits. Three-quarters of respondents with a KM initiative said they had gained a reduction in costs, up to two-thirds said they had achieved improved productivity and over half had increased profit, showing that financial benefits can be realised. Those organisations in the vanguard of KM are gaining hard-edged financial benefits, which are measurable. But many of the benefits are not financial; it needs a balanced conventional approach.
- (c) *The full range of benefits has still to be realized* : Benefits were also realised in other areas such as creating new business opportunities (57%), sharing best practice (77%) and better staff retention (57%). Of those with a KM initiative 60% had achieved an increased revenue growth. These results indicate the potential is there for the full range of benefits promised by early proponents of KM. The study also asked what the key business issues driving organisations towards KM and BI, and found them to be primarily financial and business performance oriented. Financial measures are, ultimately, the conventional measure by which the success of any management initiative is judged. But respondents were also concerned with their market position and, in particular, defending their market share against competitors. Organisations need to find a way of creating a competitive edge that will allow them to maintain



their market position for sustainable growth, and KM with its broad range of benefits appears to offer that opportunity. At the technological level, organisations were also concerned about the issues of component interaction between technologies (83%) and also about how to formalise the knowledge development cycle (77%). The data in Table 7.25 is relevant.

## 7. Asynchronous Groupware :

This construct, AG, provides the catalyst for aiding organisations to fully exploit the benefits of BI. The collaboration efforts of individuals are eased with the presence of technological support, such as those discussed in Chapter 4. The study proposed a classification of three domains, which present different challenges for organisations. These are the organisation, group and individual domains. These are presented next.

- a) *Organisation Domain:* The overall initiative of organisations, in recent times, is to integrate asynchronous groupware technology and group-based KM efforts. It also involves the expectations of organisations to assess the effects of their ability as a whole to self-improve their quality, productivity and overall competitiveness.

The results indicate that the role that AG plays in facilitating the use of KM practices and strategies in organisations is found to be approximately 97% in reducing inter-level and interdepartmental barriers to communication in KM groups involving members of different departments and levels.

Additionally the results showed that the use of AGT in group-based efforts lead to an increase in the openness in the discussion of weaknesses and opportunities of improvement related to individuals, teams, processes, organisational strategies, and other related factors at nearly 96%.

Approximately 97% of respondents reported that the use of AGT in group-based KM efforts increases the awareness about mission-based organisation's goals and how those goals might be achieved. Furthermore, 93% of respondents reported that the use of AGT in group-based KM efforts lead to a decentralisation in their organisation's improvement initiatives. The same number of respondents (93%) also reported that the use of AGT in group-based KM efforts lead to an increase in knowledge and information sharing in their organisations. In congruence with these results is the support from senior management. Just about 95% of respondents reported that the use of AGT, as a publicly available information repository about the work of KM groups, lead to

an increase in the support from management to decentralised improvement and as an acceptance of it as an appropriate behaviour in their organisations.

These results are presented in Table 7.26.

- b) *Group Domain:* The assessment of the productivity and performance-oriented initiatives attributed to the efforts of work improvement teams (WITS), communities of practices, and focus groups have been the main strategy of some organisation in differentiating the outcomes of these groups into two categories, task-related and group-related outcomes.

The results endorses the work of Kock and McQueen (1995a), in reporting that the use of AGT for the group domain is generally facilitated by the inclusion and participation of members from different departments in the KM groups. This was reported at just about 95% in occurrence.

Additionally, the use of AGT makes it faster and easier to access information relevant to the three main phases of a KM group-business process definition, analysis, and redesign was found to be at 100%. This, consequently, leads to a reduction in the costs involved in running KM groups, along with assisting KM groups to complete their tasks faster were found to be a large extent for most firms at 91% and 93%, respectively, in both cases.

This coincides with the reported effectiveness of process design in the use of AGT leading to an increase in the effectiveness of process redesigns proposals by KM groups at 98%. From the present evidence it was also found that there is a strong association between the degrees of openness in discussion, in the organisation domain at 96% with that of the suppression of hierarchy barriers in the group domain at 93%.

The relationship is significant at the  $p < .0001$  for the Mantel-Haenszel Chi-Square. These findings are presented in Appendix D.8. The summary statistics in the table informs that respondents are firmly of the opinion that AGT may be used to suppress hierarchy barriers to the contribution of ideas among members from different hierarchical levels in KM groups, openly within their organisation.

Additionally, the present analysis found that 99.1% of the firms reported that the application of synchronous groupware technology with the predicative response of, “a very large extent”, leads to an increase in the effectiveness of process redesigns proposals generated by KM groups.

- c) *Individual Domain:* The assessment of the productivity and performance-oriented ini-

tatives attributed to the efforts of the individual have been the main strategy of some organisation in differentiating the outcomes of these individuals into two categories, task-related and team-related outcomes.

In this domain, domain, the three variables (satisfaction from group interaction, commitments to group proposals, and individual learning) of this sub-construct were reported at 100%. These results suggest that individuals were willing to share the benefits they derived from the use of AGT while interacting in KM groups. Table 6.27 presents the results of these findings.

### 11.3.2 Evaluation of the measurement model

Jöreskog's (1993:294-314) recommendation that constructs should be separately subjected to CFA before a full measurement model is assessed, proved to be accurate, by demonstrating satisfactory results. These results are presented in Chapter 9, Sections 9.2.2, 9.2.3, 9.2.4, 9.2.5, and 9.2.6, respectively.

Another area of concern is the widely used Maximum Likelihood (ML) estimation method in combination with ordinal data as a result of using Likert-type measurement scales. While some literature suggest using polychoric correlations as input to, for example, the Weighted Least Squares (WLS), or Asymptotically Distribution Free (ADF) estimation methods (for example, Jöreskog, 1993:305; Hox and Bechger, 1998), it appears that empirical research that use Structural Equation Modelling (SEM) generally ignored the ordinality problem. This might well be attributed to the more stringent requirement of using a very large sample size for ADF estimation even for relatively simple models. Additionally, using ordinal data with ML method provides satisfactory results when certain conditions are met (Kline, 1998:145; Babakus, Ferguson and Jöreskog, 1987). These are, among others, using a minimum of five response options with Likert-type scales, low univariate skewness and multivariate normal distribution of the data. Since this research satisfied these requirements and used a moderately sized sample,  $N = 1225$ , polychoric correlations and WLS, or for that matter, ADF, were not viewed as feasible by the researcher.

The literature recommends that in SEM research at least three indicator variables should be used to measure a latent variable (F variable), this study concurs with the recommendation. In this study the researcher ascribes to the concept, postulated by the literature that a measurement model describe the relationship between its latent factors and the manifest indicator variables

that measure those latent factors.

The KM-BI model [cf. Figure 9.1 on page 308] of this study consisted of five constructs, a reduction from seven constructs in Chapter 7. The factors of these seven hypothesized factors are: (1) KM strategy created for promoting IC, (2) Groupware technologies used to support structural capital; (3) Formal networks for KM strategy; (4) Value of human capital; (5) Learning from KM initiatives; (6) Effectiveness, and (7) Benefits from setting up KM initiatives.

These constructs demonstrated alphas of: .942, .940, .940, .937, .903, .317, and -.876, respectively. The consolidated, raw alpha was .973, and with standardised alpha of .975, for all seven constructs of 78 items. Thus indicating that the data reliably measure these seven constructs. Notwithstanding this, the researcher uses the selection criteria in both Chapters 7 and 8 to reduce these factors to five. The factor loading of the variables are included in Chapters 7 and 8. Tables 7.9 - 7.13, respectively, demonstrate the constructs' validity of the associated variables.

The study used these five constructs to perform a confirmatory factor analysis in Chapter 9. The study also reported that each of the factors were reliably measured by the data. The assessment of the fit between the data and the model is set out in Section 9.2.1. The present analysis use the internal consistency to perform the measure of reliability. Hatcher (1994:132) asserts that *Internal consistency is the extent to which the individual items that constitute a test correlate with one another or with the test total*. The formula, Equation 9.1 for Cronbach's coefficient alpha is used for this purpose. Cronbach (1951:331) states that *an estimates, is a lower bound to, the proportion of test variance attributable to common factors among the items*.

The final retained factors are presented in Table 9.1, and are distilled in Tables 9.2, 9.3, 9.4, 9.5, and 9.6, respectively.

The study found the indices from the Cronbach coefficient to be very reliable, and consistent with the measures of the hypothesized factors. They are set out next.

$$Raw = 0.959283 \qquad Standardized = 0.959966$$

Although there were a number of concerns mentioned in that Chapter 9, the final measurement model demonstrated satisfactory fit, reliability and validity. Section 9.4.5 and Table 9.10, and Section 9.4.6 are relevant. This seems to suggest that the hypothesized theoretical causal model,

Figure 9.2 adequately predicts the relationship between the five constructs of BI, AG, SC, OL and HK. Consequently, one accepts Figure 9.9 as the final measurement model.

Given the significance of the findings in Table 9.12, where one presents the results of the composite reliability indices and the variance extracted estimates for the final revised measurement model. The present investigation were able to next proceed to the evaluation of the structural model. This is discussed next in Section 11.3.3.

### 11.3.3 Evaluation of the structural model

The values for the final theoretical casual model (Revised model 2) that is shown in Table 9.17 (model  $M_{r2}$ ) and Figure 9.13 demonstrated acceptable levels of parsimony. The satisfactory fit to the sample data was evidenced by a non-significant difference with the final measurement model,  $M_m$  (cf. Section 9.5.6). Consequently, the model was used for hypotheses testing as discussed in Section 11.1. A concern however, is the magnitude of the path coefficient of the disturbance terms  $D_1$  and  $D_2$ , at .5628, and .7972, respectively. They may seem to indicate that this study's hypothesized model is oversimplified because there seems to be a considerable effect of committed unknown latent effects on the endogenous latent variables BI (F1) and AG (F2), respectively.

While the hypothesized causality was drawn from the literature review presented in Chapters 2, 3, and 4, it cannot be claimed by measurement due to the cross-sectional nature of this study. Kelloway (1995:216) points out that causality can be only be supported when the exogenous latent variables precedes the endogenous latent variable in time, and that all relevant causes of the endogenous variables are included in the model. On the other hand, in the absence of these conditions, the literature review provided at least some support for the suggested causality [Kline, 1998: 96-99].

Furthermore, other models may equally well account for the variances and covariances in the sample data. For example, an organisation can only learn and adapt if feedback loops exist [Bontis, Crossan & Hulland, 2002]. These views are explored much further in Section 11.4.1.

Likewise, the correlation between SC, OL and HK might be reciprocal. Although the usual assumption with exogenous variables in SEM is that they covary. This is the case in this study. For example, it seems reasonable to assume that the synergy of skills, structure and corporate

culture determines what structural capital must be employed in the delivery of organisational learning, and harvesting of HK, that is the IC of a firm's employees. Similarly, new technology provides opportunities for learning and thus may have a positive effect on skills, structure and corporate culture, that is Structural capital affects both HK and OL.

To support this point, the model was modified so that SC affects both OL and HK, which in turn casually affects both AG and BI. This model is presented in Figure 9.13. Without going into the same detail as presented in Section 9.5 [see Chapter 9], it was shown that also this model acceptably accounts for the sample data indicated by significant path coefficients of .2708, .5012 and .2039 for the constructs BI (F1) to AG (F2), SC (F3) and HK (F5), respectively; and .0540, .4964 and .0923 for the constructs AG (F2) and SC (F3), OL (F4) and HK (F5), respectively, at a significant level of  $p < .001$ . These values are illustrated in Table 9.19.

There are two points of concerns to us here, on the positive side, the  $R^2$  values for Ag, SC and HK accounted for 68.3% of the variance in BI, and with a moderately high disturbance term,  $D_1$ , of .5628. However, on the negative side, SC, OL and HK accounted for only 36.4% of the variance in AG, concurrently with a high path coefficient of the disturbance term,  $D_2$  at .7992.

Nonetheless, the SEM methodology provided an acceptable final theoretical casual model ?? - at least for this sample - to assess the research problem [cf. 1.2.2], the research objectives [cf. 1.2.1], the research question [cf. 1.2.2], and the research hypotheses [cf. 1.2.4], respectively.

Table 9.17 also presents indices that reflect the parsimony of the models that were tested. The parsimony ratio, or PR (James et al., 1982) indicates the parsimony of the overall model, with higher values reflecting greater parsimony. The parsimonious normed-fit index (PNFI) [James et al., 1982], is obtained by multiplying the parsimony ratio by the normed-fit index, resulting in a single index that reflects both the parsimony and the fit of the overall model.

These indices show that revised model 2 displayed a parsimony ratio of .10, which was somewhat lower than that of revised model 1, which displayed a  $PR$  of .15. However, this was more than offset by the superior fit achieved by (  $M_{r2}$  ), as is demonstrated by the fact that the parsimonious normed-fit index for (  $M_{r2}$  ) was .619, while the PNFI for  $M_{r1}$  was only .636.

Table 9.17 also provides indices that represent the fit and parsimony in just the structural portion of a model; that is, the part of a model that describes just the relations between the latent variables (the F variables). For example, the relative normed-fit index, or RNFI [Mulaik

et al., 1989] reveals the fit achieved in just the structural portion of the model, independent of the fit of the measurement model. In the same way, the relative parsimony ratio (RPR) reveals the parsimony of the structural portion of the model, regardless of the parsimony of the measurement model. Finally, the relative parsimonious fit index (RPFI) is obtained by multiplying the RNFI by the RPR. The RPFI indicates how well the model explains all possible relations among the F variables, from outside the data [Mulaik et al., 1989].

The RNFI indices in Table 9.17 show that revised model 2 demonstrated a fit to the data that was superior to that of revised model 1, due to the deletion of VARE21 from variable, V21.

On the other hand, the deletion of this path, VARE21, did hurt the parsimony of revised model 2, as  $M_{r2}$  displayed values on both the RPR and RPFI that were slightly lower than those exhibited by the simpler (although poorer-fitting)  $M_{r1}$ .

As a final test, a chi-square difference test was used to compare the fit of  $M_{r2}$  with that of  $M_m$ . This comparison resulted in a difference value of  $633.26 - 617.24 = 16.02$ , which, with 3 df was nonsignificant ( $p > .001$ ). The nonsignificant chi-square indicated that  $M_{r2}$  provided a fit that was not significantly worse than that provided by a measurement model in which all F variables were free to covary. In other words, this finding showed that the causal relationships described in revised model 2 were successful in accounting for the observed relationships between the latent constructs.

Combined, these findings generally provide support for revised model 2 over the other models tested.  $M_{r2}$  was therefore retained as this study's *final* model, and is displayed in Figure 9.13. Standardized path coefficients appear on the causal paths.

## 11.4 Contribution of this research

This section lists those ideas developed in this research which are believed to contribute to a general understanding of how organisations may develop strategies for KM, so as to create a practical KM system which will allow them to harness the full benefits of the tacit knowledge (IC) within their firms. It also attempts to position KM as a value-enabling strategy as it seeks legitimacy as a management process. The present investigation also sought to highlight some of the new opportunities within KM, as well as cover some of the traditions on which it rests. The analysis to follow explore some of the successful projects, which have been implemented by

organisations. From the evidence at hand this was done by examining how they map their KM efforts - their knowledge strategies - to some key aspects of their business strategies. Most of the contributions can be thought of as techniques for better organizing knowledge, both in the knowledge representation as well as in how the knowledge is presented to convert IC to BI. The degree to which the contributions are practical relates to how the three main aspects of any KM project, namely technology, process, and people, and how these components contribute to the formulation of a robust knowledge plan. The analyses point out that such a KM plan rests on four facets, which are the:

(1) knowledge of the business environment, (2) knowledge of strategic thinking, (3) knowledge of business design, and (4) implementation of KM.

This section also suggests approaches that organisations may use to encourage virtual teams - working in active knowledge sharing environments. Some ideas are novel while others represent improvements of existing ideas or else new applications of old ideas. The most significant contribution is the synthesis of a large number of these ideas in one system, the KM-BI model.

#### 11.4.1 Contributions to KM practices and strategies

The following are some ways in which the use of KM practices and strategies may be replicated by organisations to contribute to the development of similar strategies for KM, so as to create practical KM systems, for harnessing the full benefits of their IC.

Following from the discussion in Section 11.3.3, it is evident that an integrated approach (*syn-trategy*) is needed. The study therefore proposed a model for creating and sustaining BI through KM (see Figure 9.1), using the important concept of corporate portals to act as a medium for the tangible and intangible data/information to obtain the BI Portal. The portal in this model becomes the engine that provides the heuristic - the business logic that creates intelligence or corporate memory.

The portal consists of the strategies, cultures, infrastructures, structures, values and beliefs, as well as the appropriate application software to harness knowledge, at all levels both inside and outside the organisation. Within the portal are the enablers for creating, sustaining and applying knowledge. Specifically, culture could act as a barrier or an enabler for the knowledge creation and use. In addition, there must be a sharing of values. Shared values, must be established and



communicated by the organisation. This is of paramount importance, given the cross-cultural dimensions of knowledge sharing and transfer in terms of its diversity of language, cultural and ethnic background, gender and professional affiliation [Glisby & Holden, 2003]. Thus, the portal becomes the engine that transfers knowledge throughout the organisation.

There is a very close relationship between knowledge processes, and outcomes. Outcomes depend largely on the grand strategies adopted by the organisation - in other words, the organisation's value proposition. These are generally tangible and include components such as products and services, offerings, marketing campaigns, throughput, cost-reduction initiatives and contract outsourcing, as well as project cycle-time. Investments in KM, such as groupware and intranets, content management and integration of the various information workbenches (such as document and records management and workflow management), allow managers to automate their business processes with collaborative 'e-business' teams, in which people are linked together in a seamless manner. This strategic perspective empowers organisations to put e-business to work for them in rapidly accessing their business-critical information. On an organisational scale, the relationships between suppliers and customers are circumscribed by the degree to which these processes streamline the collaborative mechanisms of groupware for (example, e-mails) in cohesively managing their corporate epistemology. The epistemological issue of managing knowledge and IC can only be successful if the nature of knowledge creation and its use are viewed with the following expectations: innovation, responsiveness, productivity, and competency. These are performance criteria, which organisations may use to gauge how well their KM and IC projects are being managed in the new age of the BI economy.

The hypothesized model in Figure 9.1, is supported by this research, as is demonstrated by the findings in Chapter 9, and the validation by the final casual model in Figure 9.13. These findings are revisited in Sections 11.3.1, 11.3.2, and 11.3.3, respectively.

From these findings one is able to conclude that a value chain for KM (Figure 9.1), may be implemented by organisations, based on the posited definition of KM, by Campbell and Pellissier, [2000:29]

*a transformation process that takes the inputs (tangible and people data) and change these into a physical or virtual DB, involving the harvesting of innovation, and BI.*

From the final casual model, Figure 9.13 one is able to see some similarity with the model

in Section 8.3.3, Figure 8.2. Our final model seems to point to the same three areas of KM practices. These are:

(1) normative knowledge (2) strategic knowledge practices, and (3) operative knowledge practices.

On the *operational level*, the model consists of the six core processes, discussed in Section 8.3.3.

Referring to the model, Figure 9.13, one is able to relate the SC and AG constructs as the normative component discussed in Section 8.3.3, since it deals with the structural make-up of the organisation. The OL and HK constructs of the model, relate to the strategic knowledge practices of the organisation, while the BI construct relates to the operative knowledge practices component. These are in terms of the operational level of Figure 8.2.

## 11.5 Implications and recommendations

A number of implications both for practitioners, particularly those involved in or planning organisation-wide KM projects, and researchers, are noted next.

The results of this study shows that as firms invest in developing intellectual assets a parallel investment must follow by individuals for mutual benefit. The literature also take a similar position, where Meso et al. (2002) say that this relationship between firm and individual is crucial and may be reflected in the measurement of individual inputs into the firms corporate wide decisions; and Stahle and Hong (2002) present similar arguments and conclude that KM is about creating the right kind of dynamics that promote individual response to strategy formulation.

These arguments are strong and compelling, and is supported by the literature [Chourides, Longbottom, & Murphy, 2003]. These findings would seem to suggest that for firms to be successful in the implementation of KM projects, they need to have a well honed KM you must corporate-wide strategy, and individuals must be persuaded to contribute to both its formulation and implementation. Arising from our research question, is the challenge as to the approach firms should employ, in initiating and implementing an organisation-wide KM programme. This research points to the confusion surrounding the process that should be followed, in terms of whether it should be one that is similar to the current strategic planning models that the researcher knows, or one with a knowledge focus rather than business focus angle, and whether it

should be a part of the overall strategic plan or separate. In the same vain many firms question the type of tools and techniques which should be used, in terms of the IT infrastructure, and its place in the KM milieu. Running throughout this study is the underlying question, of how can how can organisation create sustainable BI. This of course, points to the research question [cf. see chapter 1]. The inference seems to be that this can be done through a number of initiatives and strategic approaches which should involve the commitment of the organisation's leadership cadre, and commitment of appropriate investment, for the right organisational structures and It infrastructure.

Investment in building knowledge may prove a challenge to the often argued notion that people are the most important organization asset. This study found, and is supported by the literature, that there are very strong arguments to suggest that successful KM will revolve around strong leadership commitment [Prusak, 1999], and creating the right culture and environment [Hibbard and Carrilo, 1998], creating the right organization conditions [Bhatt, 2000]. Scarborough et al. (1999) state that organizations will need to examine social and cultural values, motivations are thought of as a shared space, or common place (virtual, physical, mental) for developing relationships. Several authors are in agreement to the need for emphasis on organisational learning, by both practitioners and researchers. This study suggests that effective knowledge transfer is dependent on a formal and supportive organisational learning culture. This view is also supported by Goh (2002). These arguments for providing leadership, investing in people, and developing supporting organizational conditions, are clearly crucial to any success in a KM programme which aims to have value-added BI.

The normative knowledge practices deals with the enterprise structure.

The first core process of *knowledge identification*, is supported by the findings, in Chapter 8, Section 8.3.3, on page 287, in reference to the level of awareness, differing degrees of attitudes and state of initiates, organisations have on their KM project implementation. The contribution at this level, that this work seeks to make, is that practitioners should:

1. craft a KM strategy and set policies which allow them to effectively conceptualise the store of knowledge in the organisation, through a principle of SWOT analysis.
2. co-opt all their stakeholders and agents in restructuring, and articulating the KM plan/project through a series of reflective fora (workshops, seminars, virtual net-meeting, among others)

with the aim of making improvements in the KM process.

3. drawing from the model in Figure 10.6, the organisation's senior management should then develop a measurable implementation action plan (the *Act* component of Figure 10.6), which deals with the execution of the strategic directions crafted by the organisation.
4. finally, the *end state* of this process is evaluated, with the intended objectives.

The next process is *knowledge acquisition*. It is the strong belief of this researcher that a primary requirement of any KM system is that it should have a robust knowledge repository or some platform for knowledge acquisition. Figure 8.2 identified four different types of knowledge acquisition. The BI construct of Figure 9.13, and its relationship with the AG construct, and the SC and HK constructs offered such a platform. This is also reflected in the portal of the hypothesized KM-BI model of Figure 9.1.

*Knowledge development* plays two important roles in the organisation. These roles have been previously discussed in Section 8.3.3. Aligned with this is a mechanism, backed by organisation-wide policies for knowledge transfer. In this process lies the AG, and other flexible IT infrastructure and communication technologies can make invaluable contribution, to the organisation collaborative strategies and practices, thus building visible communities of practice.

In terms of the *knowledge use* component, the literature supports the view that for KM to be practical, an organisation should be sensitive to the culture in which the KM programme is being deployed [Nonaka, 1995, Glisby & Holden, 2003].

The final process that of *knowledge evaluation*, provides the reflective and feedback mechanism of the model. It allows a review of the normative, strategic and operational knowledge practices, which were previously discussed.

In terms of this study, if the level of operational performance is low, an investigation might reveal that individual skills, that is, organisational learning, and human knowledge, are not appropriate. This may motivate a firm to conduct training courses for increasing the skills and expertise of their staff. The effect is, hopefully, that firms will install an appropriate structural knowledge infrastructure which includes the collaborative mechanism of the AG. This relationship shows, from the final casual model, Figure 9.13, that operational performance will increase, that is, competitive advantage for a firm if there is a coordinated effects of the observed factors of AG driving the delivery of BI through SC, Ol, and HK, respectively. This example further shows that

it is possible that a reciprocal relationship may exist between AG and BI. This was investigated in the hypotheses [cf. Sections 1.2.4 and 5.3.2].

This viewpoint is supported by the findings of the hypotheses (1, 2, 3 and 4) [cf. page 147], which conclude that there is a direct relationship between:

1. KM practices (SC and HK) and AG systems, in the sampled organisations [cf. page 244];
2. strategies of Asynchronous Groupware technology and those of BI used by organisations to self-improve [cf. page 249];
3. those productivity and performance initiatives attributed to the efforts of task-related outcomes and those of group-related outcomes in the use of AGT in the sampled organisations [cf. page 255], and
4. those productivity and performance initiatives attributed to the efforts of the individual in task-related outcomes, and those of individuals in team-related outcomes in the use of AGT, in the sampled organisations [cf. page 268].

as it would make the model non-recursive and complex, which is beyond the scope of the research problem.

Arising from the validation of hypotheses, some ways in which firms may position the use of KM as a value-enabling strategy, in their management process, were identified and discussed. The researcher previously summarised some of these approaches. As a consequence, one is confident that the research adequately answer the research question [cf. page 421], by suggesting strategies firms may adopt to enable the effective use of KM strategies by the support of AG systems.

**1. Leadership:** The research findings and results support the general assumptions that a viable KM programme must have an integrated strategy, and individuals must be persuaded to contribute to both its formulation and implementation. The research suggests that the process of initiating and implementing a KM programme should be led from the Executive office with a dedicated knowledge officer or a KM unit responsible for providing leadership. The concerns of many practitioners were whether the KM strategy of the firm is similar to the current business strategy planning models that are commonplace in practice, or should it take on a more knowledge focus, rather than a business focus. The results suggest that there is

compelling reasons for firms to develop policies and strategic road maps for managing their IC, in terms of:

- (1) there should be a dedicated responsible role or unit for the KM program in the organisation, preferable a the senior management level;
- (2) the findings suggest that in most firms, KM practices were the responsibility of everyone, from the KM unit, to the non-management workers, and to managers and executives.
- (3) the findings also showed that firms should explicitly assessed worker participation in KM as part of their performance reviews.
- (4) the use of both monetary and non-monetary incentives as rewards for knowledge sharing - was a common practice used by a number of firms.

These findings are supported by the literature as strategies firms may use to sustain their KM programmes.

**2. Knowledge capture and acquisition** The study's findings add to the body of literature endorsing the requisites of knowledge capture and acquisition.

Firms also show their inclination towards capturing and using knowledge by the participation of their employees in project teams with external experts. There is also a strong inclination to use knowledge from formal knowledge repositories, such as public institutions, universities and government sources. These findings show that every firm sampled was using at least one KM practice and actively captured and used knowledge obtained from other industry sources such as industrial associations, competitors, clients and suppliers.

A number of firm reported that they were not effective at KM capture from Public Institutions.

There was however, an increased in the ability to capture knowledge from other business enterprises, industrial associations, technical literature, etcetera (See table 8.15).

Sharing knowledge and information generated from work within the firm is one method that firms use to manage their knowledge. Another important aspect of managing knowledge is acquiring it from outside of the firm (See Figure 8.3).

This can be done through hiring of new employees, an aspect of KM that was not covered by

this Survey, but was addressed in the Exploratory Survey, as well as by capturing knowledge generated elsewhere.

This point was discussed in the previous section, under knowledge acquisition. Obtaining knowledge from public research institutions, dedicating resources to obtaining external knowledge and encouraging workers to participate in project teams with external experts were the most frequently used methods of knowledge acquisition.

These results are consistent with the model proposed by Mauer (1999) as they relate to knowledge transfer. The model follows next in Figure 8.3. The Figure illustrates the different processes, from Maurer (1999). The total knowledge of an organization is managed through these tools and knowledge stocks. They include such knowledge and organizational aids as telephone directories and appointment calendars, internal and external digital libraries, web based training, synchronous and asynchronous groupware communication, such as email and workflows and quality management processes.

**3. Training and mentoring:** The two next most popular KM practices in use fell under training and mentoring. This form of practices indicates how firms develop, transfer and retain the knowledge of their workers. Training and mentoring practices included formal and informal training that encouraged the development of new knowledge or skills in workers as well as the transfer of work experiences between new and experienced workers [Dixon, 2000; Cross and Israelit, 2000; Baird, Deacon and Holland, 2000]. While some of these practices, such as apprenticeships, have been used for hundreds of years, their continued use emphasises the importance of transferring and sharing knowledge in the workplace. Not all workplace skills can be put down in writing (codified) and distributed through documentation [Denning, 2001]. Some skills and knowledge are shared and transferred through practical application or “doing”. The study found that many firms in the sampled firms (say 61%) encouraged experienced workers to transfer their knowledge to new or less experienced workers. This is a policy that is on the increase, particularly for those firms which adopted KM practices since 1999. The provision of informal training on KM practices was also widespread for those firms reported using it. The high proportion of recent adopters of this practice indicates a rising awareness of KM practices by those firms.

**4. Policies and strategies:** The present study found that there are three broad categories where KM practices were not predominately used. These are the policies and strategies oriented categories, incentives for using and promoting the use of KM practices, as previously discussed and the presence of infrastructure for documenting, transferring and communicating KM practices throughout the organisation, and between different levels and types of artefacts.

The findings showed that firms believe that their corporate cultures or value systems encouraged knowledge sharing and at most 63% (both practices) had policies or programmes in place that were intended to improve worker retention, this was reported a 73% for this practice.

The findings also suggest that worker retention policies could in part reflect the costs to firms associated with new hires ranging from providing basic orientation programs to the time and productivity lost while employees learn how to do their new tasks efficiently.

The study further found that using partnerships or strategic alliances specifically to acquire knowledge was a common KM practice for firms with almost 61% participating. Of interest, this high rate may reflect the importance that this strategy played in small to medium size firms.

**5. Incentives:** The researcher then examine those KM practices which were least used by the sampled firms. Alarming, the least popular KM practices being used by firms in this survey were collaborative work on project teams that were physically separated (virtual teams), and the preparation of written documentation such as lessons learned, training manuals, good work practices, articles for publication, etc (organisational memory). These practices, however, seemed to be changing as over 8% and 7% respectively of early adopters have started to use these practices since 1999.

**6. Communication:** The findings of this study overwhelmingly show that firms are turning to communications practices. This is supported by the literature in terms of having and requiring good documentation and making these materials available is recognised as being vital to maintaining high quality work standards [Field, 2001], and that accessing the lessons learned by others as well as good work practices helps to prevent firms from repeating errors while allowing new project teams to build on the work of their predecessors [Dixon, 2000]; and [Baird, Deacon and Holland, 2000]. As the results indicate, a number of workers were involved in preparing written documentation such as lessons learned, training manuals, and good work practices, in



the archiving of the knowledge bases. These activities taken together assist firms in developing their organisational memory.

This also involved formal methods of developing their organisational memories through documentation (or codification of knowledge) this however, was a new practice.

**7. Worker retention:** Worker retention was reported as important for many firms, at most 62% of all firms reported that improving worker retention was critically important to them. This is understandable, given that IC seems to be the new asset around which firms in the global economy of the twenty-first century differentiate in achieving their competitive advantage [Stewart, 2001; Bontis, 2001] (See Table 8.14).

**9. Competitive advantage:** It was followed closely by training workers to meet strategic objectives of the firm 36%. and ease collaborative work of projects or teams that are physically separated was reported at 35%; integrating knowledge within the firm 14% These findings suggest that firms are employing KM practices strategically to improve their competitive performance and productivity.

While more than 56% reported that identifying and protecting the strategic knowledge that was present in the firm was critically important to their business. At most 50% of them also asserted that improving the competitive advantage of the firm to be a critical reason to use KM practices; only about 20% of the firms found this reason of little importance. Promoting sharing or transferring of knowledge with clients or customers was reported at 46%, and increasing efficiency by using knowledge to improve production processes was found to be a critical reason to use knowledge management practices at 40%.

**10. Knowledge sharing:** The second least popular practice for knowledge sharing and transfer was off-site training to workers in order to keep skills current (29%). The adoption rate of 10% is also very low. This may be due to the practice where firms encouraged their employees to continue their training and skills development by reimbursing them (86%), and with an adoption rate of 26%.

KM practices were considered most effective for two human resources-oriented results. These results suggest that knowledge sharing, creation, generation, and maintenance are perceived as

important to a firm productivity; its excellent capital and development BI (see Table 8.13). The most effective result of using KM practices was improving corporate or organisational memory at 65%. The second most effective result was preventing duplicate research and development at 46% and increasing the adaptation of products or services to client requirements at 46%.

These results suggest that corporate memory, knowledge sharing, creation, generation and maintenance are perceived as important to firm productivity. KM practices were also very effective or effective at creating a client-oriented firm. Approximately 46% of firms indicated that the KM practices they used were very effective or effective at increasing the adaptation of products or services to client requirements as well as improving client relations.

### 11.5.1 Implications on the role of AG for the support of KM groups in the organisation domain

In the organisation domain of the use of AG infrastructure, the study found that the role that AG play in facilitating the use of KM practices and strategies in organisations is integral in reducing inter-level and interdepartmental barriers to communication in KM groups involving members of different departments and levels. The results also that the use of AGT in group-based efforts lead to an increase in the openness in the discussion of weaknesses and opportunities of improvement related to individuals, teams, processes, organisational strategies, and other related factors. The same reported level for the use of AGT in group-based KM efforts increase the awareness about mission-based organisation's goals and how those goals might be achieved, were found. These are summarised next.

**1. Decentralisation:** The use of AGT in group-based KM efforts lead to a decentralisation in improvement initiatives.

**2. Knowledge information sharing:** The use of AGT in group-based KM efforts lead to an increase in knowledge and information sharing in the organisation.

**3. Openness in discussion:** The use of AGT in group-based KM efforts lead to an increase in the openness in the discussion of weaknesses and opportunities of improvement related to individuals, teams, processes, organisational strategies, and other related factors.

**4. Inter-level and interdepartmental barriers:** The use of AGT reduce inter-level and interdepartmental barriers to communication in KM groups involving members of different departments and levels.

**5. management support:** The use of AGT, as a publicly available information repository about the work of KM groups, lead to an increase in the support from management to decentralised improvement and as an acceptance of it as an appropriate behaviour in the organisation.

**6. Awareness of organisational goals:** The use of AGT in group-based KM efforts increase the awareness about mission-based organisation's goals and how those goals might be achieved.

All of the results noted above are illustrated in Table 8.16.

### 11.5.2 Implications on the role of AG for the support of KM groups in the group domain

The study found that there was a moderate use of AGT for the group domain in facilitating the inclusion and participation of members from different departments in their KM groups. The findings also reported that AG technology makes it faster and easier to access information relevant to the three main phases of a KM group's project. These being the business process definition, analysis, and redesign, as reported in Chapter 10. As such the results led to a reduction in the costs involved in running these KM groups, and further aid with assisting KM groups to complete their tasks faster. These findings were predominant among over 38% of the firms sampled. One summarises some of the more general results in Table 8.17.

**1. Facilitation of information:** The use of AGT facilitate the use of information generated by former KM groups in a way that improves the efficiency and effectiveness of future groups.

**2. Adoption of groupware processes:** The use of AGT aid KM groups in adopting a pre-defined group process.

**3. Suppress barriers:** The use of AGT suppress hierarchy barriers to even contribution of ideas among members from different hierarchical levels in KM groups

**4. Participation of departments:** The use of AGT facilitate the inclusion and participation of members from different departments in the KM groups.

**5. Reduce imposition of ideas:** The use of AGT reduce the likelihood of authoritarian leaders, facilitators or group members, being able to impose their ideas on the KM group.

**6. Ease of access to information:** The use of AGT makes it faster and easier to access information relevant to the three main phases of a KM group- business process definition, analysis, and redesign.

**7. Assist KM groups in tasks:** The use of AGT assists a KM group to complete its task faster.

**8. Reduction in costs:** The use of AGT lead to reduction in the costs involved in running KM groups.

**9. Effectiveness of process:** Design The use of AGT lead to an increase in the effectiveness of process redesigns proposals generated by KM groups (See Table 8.17).

Additionally, the results reported that the application of SGT, to a very large extent, lead to an increase in the effectiveness of process redesigns proposals generated by KM groups, in a number of the sampled firms [cf. Chapter 8].

### 11.5.3 Implications on the role of AG for the support of KM groups in the individual domain

In the individual domain it was reported that the use of asynchronous groupware technology increase the commitment of KM group members to group proposals; and increasing individual learning about the organisation and its business processes from the participation in KM groups

were reported to be use at a very large extent. The indicative responses were that group members experience:

1. Satisfaction from participation in KM groups.
2. Increase the commitment to group, and proposals.
3. Increase individual learning about the organisation and its business processes.

These results are further summarised in Table 8.18.

## 11.6 Limitations

The research findings drawn from Chapter 8 should have also involve the testing of hypotheses 1 and 2, so as to better compare the results from the two samples in terms of the use of AG systems in their organisations to self-improve their quality, productivity, and competitiveness.

In Chapter 9, a decision-tree framework for modifying the theoretical model could have been muse, by following a structural approach to model modification, as described by Anderson and Gerbing (1988), this would, may be, an easier approach. This framework uses a series of  $\chi^2$  tests between the pairs of : (1)  $M_t$  – the initial theoretical model; (2)  $M_m$  – the measurement model; (3)  $M_c$  – a constrained model, and (4)  $M_u$  – an unconstrained model. This procedure results in the acceptance of a model that does not significantly differ from the measurement model, while at the same time is as parsimonious as possible. The iterative approach leads to an acceptable model. This sometimes, however, may shift from a confirmatory approach to one of exploratory, as the number of iterations increase.

The research findings drawn from Chapter 10, where an iteration of the AR cycle at Directorate was conducted, might have been biased by the nature of the researcher's active intervention in the organisation. This intervention might have biased the research findings by leading KM group members to behave in an artificial way, exactly what the researcher wanted to avoid by using action research. For example, the nature of the researcher's relationship with the Director, who championed the project, might have led staff to conduct more KM groups and use the ES system more intensely than they would have done otherwise, as staff were asked both to participate in as many groups as possible and to try and use the ES system to support most of

their group interactions. However, although it is understood that the researcher's intervention might have biased the research findings, the researcher believes that the context created by the researcher's intervention has been documented in enough detail to allow for its replication in similar circumstances.

Also in Chapter 9, the use of composite scales may have compromised the initial goodness of fit indices, particularly the  $\chi^2$  value and  $\chi^2/df$  ratio of the final measurement, and theoretical models.

## 11.7 Future Research

This section summarizes ideas for potential future work, as it relates to the design of a KM system, for the deployment of BI. This list does not include minor improvements or cosmetic changes that are in the implications of implementation of the KM-BI framework.

### 11.7.1 Future work on a learning-oriented KM system

Walls et al. (1992) called for the information systems (IS) field to begin to develop theory based on endogenous paradigms rather than based on other disciplines. The researcher followed the work of Churchill (1971), with regard to the development of the learning-oriented component (OL) of one's model [cf. Figure ??], for KM strategy. Churchill (1971) work deals with IS, and as such impacts on the use of the IT infrastructure, as it relates to groupware technologies to aid OL.

There is a need, however, to use a systematic approach to the implementation of this IT infrastructure. That is, where the work of Walls et al. (1992) illustrated the use of their design theory to conceptualize a robust IS based on expert systems theory and suggested that other systems may be designed using their process.

This research has suggested how a KM system may be specified by proposing a high-level casual model of latent factors which impact the implementation KM practices in an organisational milieu. The portal in Figure 9.1, requires the development of the conceptual heuristics so as to operationalise the model. This therefore, requires the testing of individual component [BI, AG, SC, Ol, and HK] validation is appropriate when applying management theories at the

implementation process level.

This work involves the use of systems theory, at a design level, to conceptualize both a learning-oriented, and strategy-oriented KM system.

Walls et al. (1992) talk about both the design product and the design process. This research presents the design product in our KM-BI model (the conceptualized learning-oriented and the portal components, of the KM-BI system) and portions of the design process (the components). The method of design for the other potential components identified as a result of this research is the conceptualization of methods to achieve other meta-requirements, such as the use of the IT infrastructure. Such work would be analogous to the suggestion made by Walls et al. (1992) that the normalization procedure is a design method that achieves the goal of reducing certain anomalies in a database. Each of the components identified in this research has the ability to achieve the meta-design for our hypothesized KM-BI system.

## 11.8 Conclusion

The findings in this research offer a number of approaches firms may use to implement their KM projects. The study previously summarised these, but found that the underlying dialogue is that managers need a corporate-wide strategy to implement their KM practices. The researcher discussed throughout this work, and intimated that any successful BI oriented strategy should have the following components:

1. Definition of the system to be assessed;
2. Identification of relevant stakeholders and their expectations;
3. Definition of the knowledge vision;
4. Deduction of factors of influence and use-and-effect patterns;
5. Identification of the most important drivers;
6. Prioritisation of the impact of the drivers on the expectations of the stakeholders, and
7. Development of an action plan.

These components are distilled from the results of the study. However, the approaches firms may use in implementing KM strategies, by the supported of AG systems [cf. page 421] have been fully explored. Some of these are summarised next.

- Use information flow and knowledge transfer to improve the competitive advantage and enhanced BI, of the firm through the use of innovative applications of tangible and intangible resources.
- Use new and emerging technologies to improve CA and enhanced BI, of the firm through the use of innovative applications of tangible and intangible technological resources.
- The technological effects of the organizational and environmental evolution needs to be validated with further research on contextualising effects on KM effectiveness. This would include such dimensions as trust and management (leadership) support. The related metrics need to be developed so as to validate the groupware-supported social facilitation factors, which were found in the group domain of the study.
- Understand the impact of organizational learning on information flow, knowledge transfer and new and emerging technologies, through the development of a systematic design model, which our KM-BI framework sought to initiate.

They are therefore constraining their firms from leveraging the BI which could be achieved through the proper use of the technological infrastructure which is a requisite of KM deployment. The observed failure to harness the full potential of the technological infrastructure goes to the heart of the difficult firms have in selling KM as a management technique to their employees. Technology has changed the way many firms do business globally. In most cases, it has improved their business, though there remain some areas where much improvements may arguably be made. The study found, and ascribe to the belief that the management of technology, has not added value to many organisations' BI.

Our proposed KM-BI model [cf. Figure 2.1], One believe should afford firms the opportunity to have immediate access to vast stores of processed, timely and relevant knowledge with which they can make decisions. In fact the study found that much of the technology, although new and has been implemented as organizations have begun to experiment with new ways of using it. If a sound business strategy is crafted, then all organisations need to do, when they implement the necessary technology, is to populate it with data so as to make it worth using and to add real



benefit to their *bottom-line*. This in turn means that organisations must focus on keeping the information up-to-date on an on-going basis, and develop a programme of removing out-of-date information and committing resources to this task. The researcher recommend that, in order to obtain the full benefits, organisations need to take a fresh look at the available technology from a KM perspective to realize the potential.

Part V

References

## References

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Part VI

Appendices