A MODEL FOR A SUCCESFUL IMPLEMENTATION OF KNOWLEDGE MANAGEMENT IN ENGINEERING ORGANIZATIONS

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ABSTRACT

Knowledge management (KM) is an emerging discipline that promises to capitalize on organizations intellectual capital. KM refers to the process of managing the life-cycle of knowledge relevant to areas that are mission critical to the organization. This includes efforts to capture, store, and deploy knowledge using a combination of information technology and business processes. In recent years, KM has become a critical subject of discussion in the business literature. Both business and academic communities believe that by leveraging knowledge, an organization can sustain its long-term competitive advantage. Approaches to KM varied form emphasizing the capabilities of information and communication technologies to the focus on social systems such as employee training and motivation.

Engineering organizations led the way in KM initiatives realizing the potential of successful KM implementation in decreasing production time and cost, increasing quality, making better decisions as well as improve organizations' performance and provide a competitive advantage. Although some engineering organizations reported early KM success, other organizations have tried and failed to implement KM. These failures have been linked to the lack of a generally accepted framework and methodology to guide successful implementation of KM in organizations.

This primary aim of this research is to produce a model for a successful implementation of KM in engineering organizations which integrates the various

approaches and key factors to implementing KM. The study has produced a model which provides a framework that identifies the different types of knowledge available in engineering organizations, the KM life-cycle which is needed to manage this knowledge, and the key factors that facilitate this process. The model also provides management with guidance for implementing KM in their organizations.

In order to achieve the aims and objectives of this research, a triangulation non-experimental approach is adopted using qualitative in-depth case study with triangulation of data collection methods that uses observation, structured interviews, unstructured interviews, historical data collection, and document review. This is followed by a quantitative approach with the use of a questionnaire to further validate and generalize the proposed KM model. In building the KM model a thorough review of previous related literature from different disciplines was conducted. The literature reviewed included various issues relating to KM, such as KM approaches, perspectives, frameworks, and methodologies as well as strategic planning, human resources, instructional design theories, organizational learning, information technology, etc.

CHAPTER 1

INTRODUCTION

1.1 Introduction

As Alvin Toffler (1990) said, we are living in a "knowledge-based society", where knowledge is the source of the highest quality power. In a world where markets, products, technology, competitors, regulations and even societies change rapidly, continuous innovation and the knowledge that enables such innovation have become important sources of sustainable competitive advantage. The growing emphasis on "knowledge assets" (as opposed to labor or capital), "knowledge work", and "knowledge worker" as the primary source of productivity in contemporary society suggests that the need to manage knowledge will endure as a core business concern, even if the label may change (Drucker, 1993). Hence, management scholars today consider knowledge and the ability to create and utilize knowledge to be the most important source of a firm's sustainable competitive advantage (Cyert et al., 1993; Drucker, 1993; Grant, 1996; Henderson and Cockburn, 1994; Leonard-Barton, 1992 and 1995; Nelson, 1991; Nonaka, 1991 and 1994; Nonaka and Takeuchi, 1995; Quinn, 1992; Sveiby, 1997; Winter, 1987).

The importance of intellectual capital and the management of knowledge are strongly emerging themes in today's organizational world (Chase, 1997). Many authors and practitioners (Quinn et al., 1996; Martinez, 1998; Numri, 1998; Albert and Bradley, 1997) note that the emerging patterns are that intellectual capital will replace natural resources, commodities, finance, technology, and production processes as the key factor influencing competitive advantage. This is because, with the exception of intellectual capital, everything else (IT, materials, and technical information) is available to everyone on more or less the same terms. A KPMG research report on KM opens with the words "There is little doubt that we have entered the knowledge economy where what organizations know is becoming more important than the traditional sources of economic power (capital, land, plant, and labor) which they command" (KPMG, 1998).

Furthermore, in a 1989 survey, several Fortune 50 CEOs agreed that knowledge is a fundamental factor behind an enterprise's success and all its activities (Wiig, 1994). They opined that enterprise viability hinges directly upon the competitive quality of the knowledge assets and their successful exploitation. Leaders of progressive organizations and nations are pursuing ways to create and generate value from knowledge assets within organizations (Wiig, 1997a).

Knowledge Management (KM) is an emerging discipline that promises to capitalize on organizations' intellectual capital. KM refers to the process of managing the life-cycle of knowledge relevant to areas that are mission critical to the organization (Nonaka and Takeuchi, 1995; Skyrme, 1999; Price and Mynett, 2000). This includes efforts to capture, store, and deploy knowledge using a combination of information technology and business processes (Harvard Business Review on Knowledge Management, 1998; Liebowitz and Wilcox, 1997; Schreiber, 2000). KM provides a framework to improve organizational knowledge infrastructure aimed at getting the right knowledge to the right people in the right form at the right time. A report by Business Intelligence (quoted in Numri, 1998), claimed that successful knowledge management programs can produce returns of hundreds or even thousands of percent. Still, the same report emphasized that KM is a very young discipline.

Knowledge management is still a young field with almost as many definitions to the term than there are approaches or "schools" of authors contributing to the field. These definitions of KM are arising form differently focused studies (Shankar et al., 2003). However, most working definitions in the literature point to fundamentally the common idea that KM incorporates facilitating the process of identifying, capturing, developing, distributing, and effectively using both tacit and explicit knowledge within an organization to achieve its business objectives.

The KM concept emerged in the mid 1980's from the need to derive knowledge from the "deluge of information" and was mainly used as a "business word" term. In the 1990's, many industries adopted the term KM in connection with commercial computer technologies, facilitated by the development in areas such as the Internet, group support systems, search engines, portals, data and knowledge warehouses, and the application of statistical analysis and artificial intelligence techniques (Rus and Lindvall, 2002).

KM implementation and use has rapidly increased since the 1990's; 80 percent of the largest global organizations now have KM projects (Lawton, 2001). Over 40 percent of Fortune 100 companies now have a chief knowledge officer; a senior-level executive who creates an infrastructure and cultural environment for knowledge sharing (O'Leary, 1998). Moreover, from a survey of 100 leading companies in the UK, 43 percent considered their organizations to have a KM initiative in place (KPMG, 1998). Similarly, Ruggles (1998) writes, "To a growing number of companies, KM is more than just a buzzword or a sales pitch, it is an approach to adding or creating value by more actively leveraging the know-how, experience, and judgment resident within and, in many cases, outside of an organization".

Sheina and Wood (1999) reported that knowledge management market is growing rapidly and will continue to evolve and expand over the next five years as KM becomes a core element of corporate IT strategies. It is forecast that the worldwide market for KM software is set to increase from US$515 million in 1999 to US$3.5 billion in 2004. In the same period, KM services will grow from US$2.6 billion to reach US$8.8 billion (Sainter et al., 2000).

In a recent study (Maier, 2002), conducted in late 1999, the use of KM was studied in the 500 largest German companies. In 22 of the 73 responding organizations (30.1 percent) KM was well established in the sense that they had already started formal KM programs. According to the study, KM initiatives combine heterogeneous KM approaches and singular KM activities which are supposed to deliver business value by improving the way an organization handles knowledge.

There are a variety of disciplines that have influenced and informed the field of KM (Quintas et al., 1997; McAdam and McCreety, 1999; Kakabadse et al., 2003). These are: cognitive science (in understanding of knowledge workers); social science (understanding motivation, people, interactions, culture, and environment); management science (building knowledge-related capabilities); knowledge engineering (eliciting and codifying knowledge); artificial intelligence (automating routine and knowledge-intensive work) and economics (determining priorities). Many approaches have been developed to guide organizations to manage their knowledge more effectively and a number of key factors have been proposed. These include: strategic management, information and communication technologies (ICT), human resources as well as organizational culture and structure.

Alavi and Liedner (1999) indicate that many organizations are developing information systems designed specifically to facilitate the sharing and integration of knowledge. However, KM encompasses much more than technologies for facilitating knowledge sharing. In fact, practitioners are beginning to realize that people, and the culture within which they work, are the driving factors that ultimately determine the success or failure of KM initiatives (Bobbitt, 1999; Saint-Onge, 1999).

Engineering organizations embrace vast amounts of knowledge in various areas that are critical to achieve business goals, such as knowledge related to product development and process integration (Rus and Lindvall, 2002; Shankar et al., 2003). Rus and Lindvall (2002) suggested that managing this knowledge effectively can help engineering organizations in deceasing production time and cost, increasing quality, and making better decisions. This is achieved by avoiding mistakes and reducing rework. Repeating successful processes increases productivity and the likelihood of further success. Additionally, Shankar et al. (2003) and Koch (2002, 2003) suggested that successful KM promises to improve engineering organizations' performance, and provide a competitive advantage. Other researchers emphasized the importance of managing project knowledge in engineering organizations as these firms are project oriented (Disterer, 2002; Lytras and Pouloudi, 2003; Szymczak and Walker, 2003). The focus is to reuse experience gained from one project in future projects and to link between KM and project management. Thus, engineering organizations need to successfully implement KM to capitalize on their knowledge and achieve those benefits.

Engineering organizations led the way in KM initiatives and efforts realizing the potential of KM to improve business performance and support organizations' strategies. The business press widely publicized early successes at consulting firms such as Booz Allen, applications engineering companies like Buckman Laboratories, and oil companies like BP (Lucier and Torsilieri, 2001). However, many organizations have tried and failed to implement KM (Scarbrough and Swan, 1999). The majority of such failures go unreported in the literature as organizations are much more likely to report their successes. These failures have been linked to the lack of a generally accepted framework and methodology to guide successful implementation of KM in organizations (Rubenstein et al., 2001a, 2001b; Beckman, 1998; Maier and Remus, 2003).

1.2 Research Problem

Research in the field of KM is still inconclusive, particularly in the area of implementing KM. A number of KM frameworks and methodologies have been suggested in the literature to provide organizations with guidance and direction of how KM should be done (Chase, 2000; Wiig, 1999b; Wiig et al., 1997; Junnakar, 1999; Dataware Technologies, 1998; Xerox cooperation, 1999; Liebowitz, 1999; Rubenstein et al., 2001b). However, many of these frameworks and methodologies have been criticized in the literature for suffering shortcomings; hence, there is neither a universally accepted KM framework nor methodology (Rubenstein et al., 2001a, 2001b; Beckman, 1998; Maier and Remus, 2003).

An analysis of KM failures revealed that many organizations who failed did not determine their goals and strategy before implementing KM systems (Rus and Lindvall, 2002). In fact, 50 to 60 percent of KM developments failed because organizations did not have a good KM development methodology or process, if any (Lawton, 2001). Some organizations ended up managing documents instead of meaningful knowledge. This is an easy mistake to make, because many tools advertised as KM tools address document management rather than knowledge management (Rus and Lindvall, 2002).

The importance of deploying a methodology that provides a systematic and specified process for acquiring, storing, organizing, and communicating engineering knowledge has been recognized by an increased number of engineering organizations (Price et al., 2000; Nonaka and Takeuchi 1995;

Schott et al., 2000; Koch, 2002; Sainter et al., 2000; Rus and Lindvall 2002). However, despite the growing interest in KM and the number of KM frameworks and methodologies proposed in the literature, which tend to emphasize different aspects of KM, there is a lack of commonly agreed procedures and methods to guide KM implementation. The lack of clear guidelines led to considerable confusion, especially among practitioners, regarding the question of what exactly they would have to do in order to implement KM (Maier and Remus, 2003). Thus, there is a need for a structured methodology and a framework that guide organizations in successfully implementing KM.

1.3 Research Proposition

KM is a young field for which neither a commonly agreed framework nor methodology has been established to guide organizations in successfully implementing KM. In order to contribute to the field, a clearer picture of the various KM approaches, frameworks, and methodologies needs to be presented along with the various key factors affecting KM implementation and their interrelationships. This study aims to fulfill this need by producing a novel model for the successful implementation of KM in engineering organizations which integrates the various approaches and key factors to implementing KM. The model provides a framework that identifies the different types of knowledge available in engineering organizations, the KM life-cycle which is needed to manage this knowledge, and the key factors that facilitate the KM life-cycle. The model also provides management with guidance for implementing KM in their organizations.

The proposed KM model provides management in organizations with a tool that highlights the various aspects affecting KM implementation. Such a tool would assist organizations in identifying their knowledge needs as well as the current status of the various key factors affecting the successful implementation of KM in their organization. These factors are: strategy, organizational culture, people, technology, and organizational structure. This provides management with effective guidance that contributes to meeting their business objectives by achieving the critical success factors (Rockart, 1979). Management would then be in a better position to develop plans for implementing KM focusing on the weak areas and according to the organization's knowledge needs; thus, increasing the likelihood of KM success.

1.4 Research Aims and Objectives

The successful implementation of KM has been the concern of researchers and practitioners, particularly in engineering organizations, in the last few years, where the research field of KM implementation is still inconclusive (Rubenstein et al., 2001a, 2001b; Beckman, 1998; Maier and Remus, 2003; Koch, 2002, 2003; Sainter et al., 2000; Rus and Lindvall, 2002; Bhatt, 2001; Shankar et al., 2003; Wiig et al., 1997). It still lacks a holistic framework that incorporates key KM factors and issues and provides organizations with guidelines to successfully implement KM (McAdam and McCreedy, 1999; Levett and Guenov, 2000; Rubenstein et al., 2001a, 2001b; Beckman, 1998; Maier and Remus, 2003; Chourides et al., 2003).

Despite the fact that a number of engineering organizations such as BP and Buckman Laboratories reported successful KM initiatives (Lucier and Torsilleri, 2001), others have tried and failed to implement KM (Scarbrough and Swan, 1999). Additionally, in spite of the recognition of the main factors which can affect the success of KM, no encompassing tool that addresses those factors in an integrated manner has been produced. The primary aim of this research is to improve the likelihood of successful implementation of KM in organizations through the development of a tool that assists engineering organizations to successfully identify the key elements and factors that affect KM implementation.

The specific objectives of this research are to:

1. Carry out an extensive literature review on KM and the factors that affect the implementation of KM in engineering organizations. This will lead to:
    a. The evaluation and classification of the different approaches to KM;
    b. Identifying the effectiveness of the different KM frameworks and methodologies suggested in the literature; and
    c. Identifying key factors and explore issues affecting the successful implementation of KM in engineering organizations.
2. Propose an alternative and systematic approach to implementing KM that resolves some of the shortcomings highlighted in the literature.
3. Identify the requirements to successfully manage knowledge in engineering organizations. These include categorization of the available knowledge, identifying the steps needed to manage this knowledge, and describing key factors that affect this process.

4. Establish, using the literature as a guide, a model for the successful implementation of KM in engineering organizations that highlights the different elements of KM and provides organizations with effective guidance to implement KM and meet their business objectives.
5. Explore, test, and validate the proposed KM model through detailed case studies and questionnaire.
6. Propose a methodology for implementing the KM model.

1.5 Research Contributions

This study intends to make the following contributions:

To knowledge and theory:

- This study proposes a novel model for the successful implementation of KM in engineering organizations that enables conceptualizing of KM implementation in a new perspective, and helps to overcome some of the shortcomings that exist in the research field.
- The study also introduces a methodology for implementing the proposed KM model.
- In addition, this study widens the understanding of the role and benefits of KM in engineering organizations, and the different factors that affect this role. It introduces the steps needed to manage the knowledge available in engineering organizations. These are: knowledge identification, knowledge acquisition and development, knowledge distribution, and knowledge measurement and review. It also describes the various key factors needed to facilitate KM, their roles in the implementation process, and their interrelationships. These are:

strategy, organizational culture, people (employees' skills and managers' role), technology, and organizational structure. This view advocates that the successful implementation of KM in engineering organizations requires the integration of all the key factors which affect KM implementation.

To management practice:

For managers and consultants, the study highlights the various factors affecting successful implementation of KM in engineering organizations. It also provides them with a tool/model that enables them to identify the current status of KM in their organizations. In addition, it provides them with guidelines to develop action plans, for implementing KM, focusing on the weak areas and according to their business needs. This new approach will create new opportunities for management/consultants to propose "better" and more focused strategies and plans for implementing KM.

1.6 Research Approach and Methodology

In order to achieve the aims and objectives of this research, a triangulation non-experimental approach is adopted using qualitative in-depth case study with triangulation of data collection methods that uses observation, structured interviews, unstructured interviews, historical data collection, and document review. This is followed by a quantitative approach with the use of a questionnaire to further validate and generalize the proposed KM model. In building the KM model a thorough review of previous related literature from different disciplines was conducted. The literature reviewed included various issues relating to KM, such as KM approaches, perspectives, frameworks, and methodologies as well as strategic planning, human resources, instructional design theories, organizational learning, information technology, etc.

The use of case studies in this research aims to test and validate the model produced in the research in as close to "real life" situations as possible. While the elements and issues addressed by the model are "logical" and supported by the literature, it was important to experience the actual implementation of the model in a real organizational setting as much as possible, and to solicit the opinions of people involved with KM in engineering organizations regarding the usefulness and practicality of the model in real situations.

1.7 Limitation of the Study

This study, as is usually the case with other research, has some limitations. These limitations are mainly related to generalisability, time, accessibility, and resources constraints.

The three cases did not cover all the steps involved in the implementation of KM. This is because KM is a new field and the practice of KM in engineering organizations has only emerged in the last few years. It was not possible to determine the sequence of KM implementation or the exact status of the various KM key factors prior to conducting the case studies.

Also, it is important to note that the evaluation of the various KM initiatives in the organization under study was performed entirely on the respondents' perceptions and/or accounts. Because of accessibility, resources, and time limitations, it was beyond the researcher ability to conduct this evaluation directly. When it is possible, the actual status of the various initiatives should be directly studied by the evaluator.

1.8 Organization of Thesis

This thesis comprises eight chapters. After this introduction chapter, Chapter 2, is the first of two literature review chapters. It presents definitions, levels, and the two states of knowledge as well as the interaction between the two states of knowledge. It also presents a discussion on organizational knowledge as a strategic asset and the link between knowledge management and intellectual capital. The Chapter then introduces definitions and benefits of knowledge management followed by a discussion on KM in engineering organizations. In addition, the Chapter introduces the various KM perspectives and approaches, life-cycle models, frameworks and methodologies suggested in the literature.

Chapter 3 is the second literature review chapter. It introduces various KM tools and enablers. These are: corporate and strategic management, information technology, human resources, culture, organization structure, and office design. The Chapter then presents key issues relating to KM. These are: performance measurement, organizational learning, and e-learning. The discussion on KM and e-learning includes a description of four instructional design theories, namely: conditions of learning, component display theory, elaboration theory, and instructional transaction theory. The Chapter also presents three published case studies describing the implementation of KM in engineering organizations.

Chapter 4 introduces the methodology and the design of this research. It also presents the exploratory work conducted following the initial literature review. This exploratory work verifies and expands on issues affecting the implementation of KM in engineering organizations which are introduced in the literature. Chapter 5 presents the proposed model for the successful implementation of KM in engineering organizations. This includes a description of the various elements introduced in the model. Chapter 6 presents the three conducted case studies and their analysis. The case studies test and validate the proposed KM model. Chapter 7 presents the questionnaire used in this research and its findings. Chapter 8 concludes the study, presents a proposed methodology of implementation, and recommends directions for future research. Figure 1.1 shows an overview of the structure of the thesis.

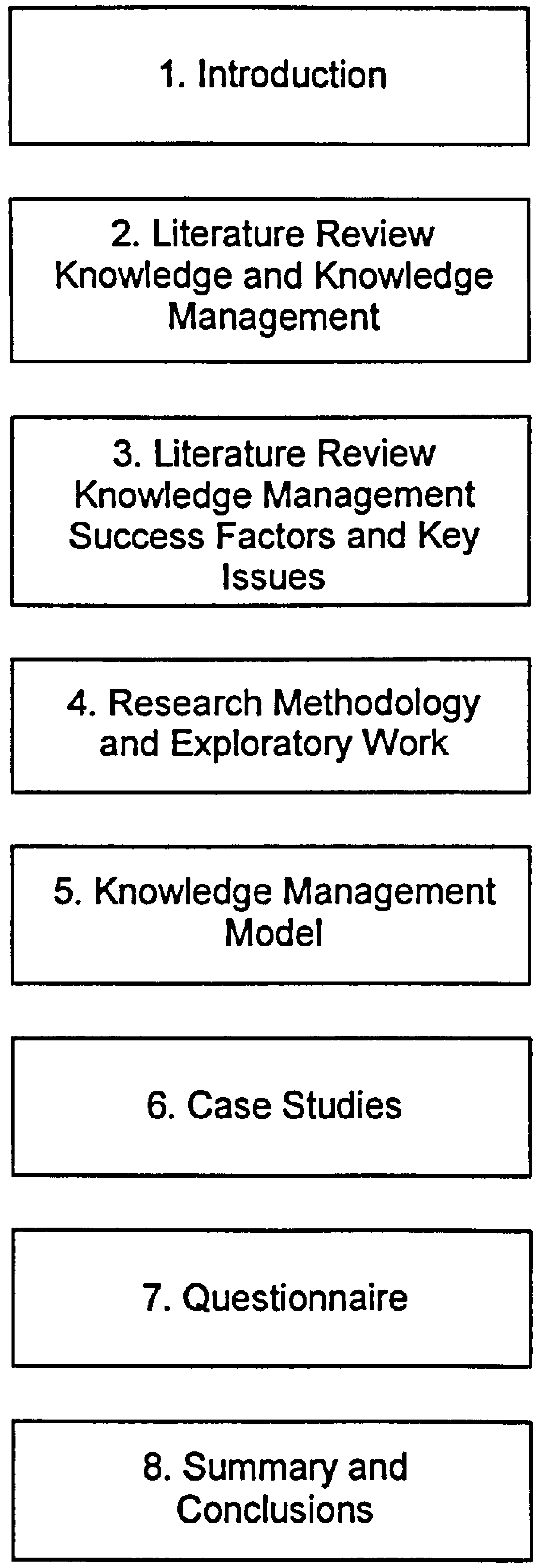


Figure 1.1: Organization of Thesis

1.9 Ethical Considerations

The confidentiality of the respondents, both the individuals and their organizations, have been promised and respected, since managers, engineers, and other respondents have given confidential information about the internal operation of their respective organizations during the exploratory work, case studies, and questionnaire.

1.10 Summary

The Chapter has introduced the nature and intent of this research. It began with an introduction on knowledge management and its role-in and benefits-to engineering organizations. The Chapter than presented the research problem and the research proposition. It then explained the aim and objectives of this study, and its significance for both research and practitioners. The Chapter then presented the methodology used in this research followed by the limitations of the study. This chapter then concluded by presenting the organization of the thesis.

CHAPTER 2

KNOWLEDGE AND KNOWLEDGE MANAGEMENT

2.1 Introduction

The last century has seen the re-discovery of the knowledge debate, starting with scholars from economics (Hayek, 1945; Arrow, 1962; Marshall, 1965), organizational theory (March and Simon, 1958) and philosophy (Polanyi, 1966). These perspectives concerned with the characteristics of knowledge and its role within the organization has led to invigorating debate among scholars and practitioners from other disciplines in the last decade. Knowledge received explicit acknowledgement in economic analysis by the neo-classical economist, Alfred Marshall (1965) who argued that capital consists, in the greater part, of knowledge and organization and that knowledge is the most powerful engine of production organizations increasingly focused on management. In 1959, Drucker (1993) coined the term "knowledge worker" and later argued that, in the "knowledge society" the basic economic resource is no longer capital, natural resources or labor but is, and will be, knowledge. The ability to use intellectual capability and create new solutions for human needs now takes central place in the global info-economy. Human knowledge and capabilities have always been at the core of value creation, but this truism has become more visible in the info-age where the "intellective" component of work is increasingly important (Zuboff, 1988). For years, organizations paid lip service to the management of knowledge, being concerned with more tangible and physical assets. The knowledge component of the value-chain had been obscured by the tendency to think of work as fundamentally a physical activity (Zuboff, 1988).

Knowledge is seen at the center of global economic transformation (Bell, 1978), competitive advantage of an organization (Mayo and Lank, 1994) and a shift from "info-war" to "k-warfare" (knowledge warfare) (Baurnard, 1996). Increasingly, knowledge is seen as outstripping traditional resources such as land, labor, and financial capital and is considered the key source of comparative or competitive advantage (Grant, 1996; Swan and Newell, 2000). For some, knowledge is "economic ideas" (Wiig, 1997b) or "intellectual capital" (Stewart, 2000; Van Buren, 1999). Practitioners see knowledge as having distinctive characteristics of a marketable commodity, as defined by economists. It is non-monopolistic- once produced it can be reused by others; non-excludable- it is difficult to protect once in the public domain; and indivisible- it can be aggregated to a certain minimum scale to form a coherent picture before it can be applied (Johnston and Blumentritt, 1998). For others, knowledge is a commodity that "shares attributes with money in that it seems of value only when it is moved and used" (Murray, 2000). There are many definitions and models of KM, each adding new insights to a crucial, but nebulously defined, field.

This chapter presents part of the literature reviewed during the course of this study. It first addresses different meanings and definitions of knowledge as well as the levels and states of knowledge and the interaction between them. It then addresses different definitions of knowledge management and introduces the benefits of KM as well as KM in engineering organizations. The Chapter then presents the various KM perspectives and approaches, KM life-cycle models, and KM frameworks and methodologies described in the literature.

2.2 Definition of Knowledge

The search for the definition of knowledge has occupied philosophers' minds since the ancient Greek period. Western philosophers have generally agreed that knowledge is "justified true belief", a concept that was first introduced by Plato (1953) in his *Meno, Phaedo, and Theaetetus.* Nonaka and Takeuchi (1995) adopted the definition; however, focusing on the "justified" rather than the "true" aspect of the belief and suggesting that it is important to consider the dynamic, humanistic, and relative dimensions of knowledge.

Knowledge is dynamic as it is created in social interactions among individuals and organizations. Knowledge is context-specific, because it depends on a particular time and space (Hayek, 1945). Without a context, it is just information, not knowledge. Knowledge is also humanistic, because it is essentially related to human action. Knowledge has the active and subjective nature represented by such terms as "commitment" and "belief" that are deeply rooted to individuals' value systems. Information becomes knowledge when it is interpreted by individuals (Schoenhoff, 1993) and given a context and anchored in the beliefs and commitments of individuals. Hence, knowledge is relational; such things as "truth", "goodness", and "beauty" are in the eye of the beholder. As Alfred North Whitehead (1954) stated, "there are no whole truths; all truths are half truths".

It is well agreed that knowledge is an organized combination of ideas, rules, procedures, and information. In a sense, knowledge is a "meaning" made by the mind (Marakas, 1999). Without meaning, knowledge is inert and static.

According to the Oxford Dictionary (2002) knowledge is defined as "understanding gained through experience, observation or study". Bollinger and Smith (2001) define knowledge as the understanding, awareness, or familiarity acquired through study, investigation, observation, or experience over the course of time. It is an individual's interpretation of information based on personal experiences, skills, and competencies.

To an organization, knowledge is defined as what people know about customers, products, processes, mistakes, and successes (Grayson and O'Dell, 1998). It resides in databases or through sharing of experiences and best practices, or through other sources both internal and external to the organization. Organizational knowledge accumulates over time, and enables firms to attain deeper levels of understanding and perception that lead to business astuteness and acumen, all characteristics of wisdom. Wisdom is acquired as organizations gain new knowledge through the transformation of collective experiences and expertise (Bollinger and Smith, 2001).

2.3 Levels of Knowledge

The terms "knowledge" and "information" are often used inter-changeably in the literature but a distinction is helpful. The three levels of refinement to knowledge items are data-information-knowledge. Data consists of discrete, objective facts or observations out of context that are, therefore, not directly meaningful (Zack, 1999); it is raw material for creating information. Information results from placing data within some meaningful content to make it useful for end users who perform tasks and make decisions. Information can reside in computers and is increasingly available to everyone because of the far reaching effect of globalization (Harari, 1997).

Knowledge is broader than data and information and requires understanding of information. It is not only contained in information, but also in the relationships among information items, their classification, and metadata, information about information, such as who created the information (Rus and Lindvall, 2002). Knowledge is that which people believe and value on the basis of the meaningful and organized accumulation of information through experiences, communication or inference (Dretske, 1981; Lave, 1988; Blacker, 1995). Humans inherently possess knowledge (Malhotra, 1998).

A hierarchy can be perceived from data to information to knowledge with each stage possessing different values of context, usefulness, and interpretability (Alavi and Leidner, 1999). Fleming (1996) traces the knowledge form data processed into information (Figure 2.1) and concludes that:

- Information relates to description, definition, or perspective *(what, who, when, where).*
- Knowledge comprises strategy, practice, method, or approach *(how).*
- Wisdom embodies principle, insight, moral, or archetype *(why).*

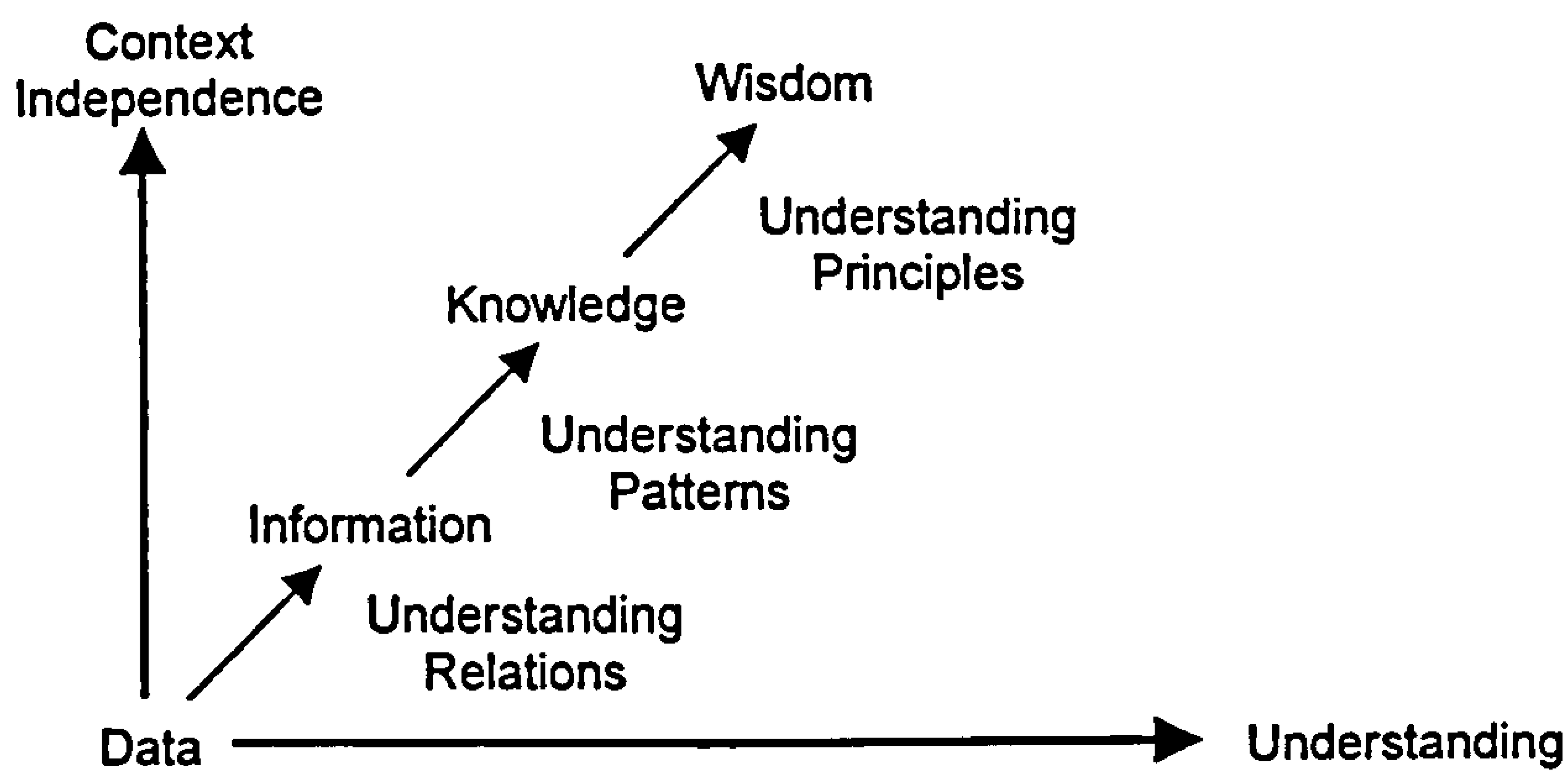


Figure 2.1: Knowledge hierarchy (context independence Vs understanding)

Source: Fleming (1996)

Godbout (1999) further explains the hierarchy meanings attached to the data-information-knowledge-wisdom cycle in Figure 2.2.

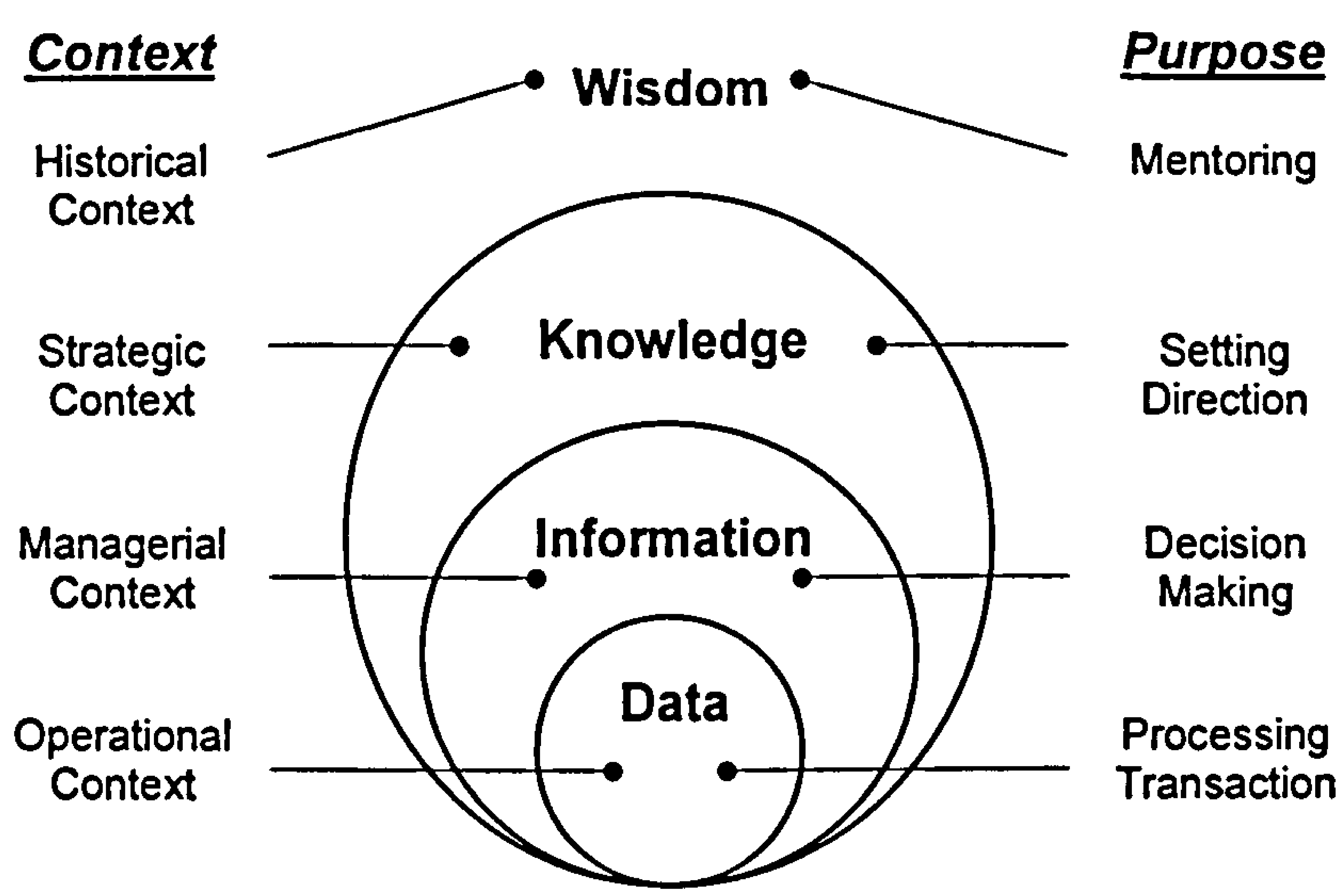


Figure 2.2: Knowledge hierarchy (context and purpose)

Source: Godbout (1999)

In fact the three levels of knowledge can be perceived to form a value chain, known as the "knowledge value chain" (Figure 2.3).

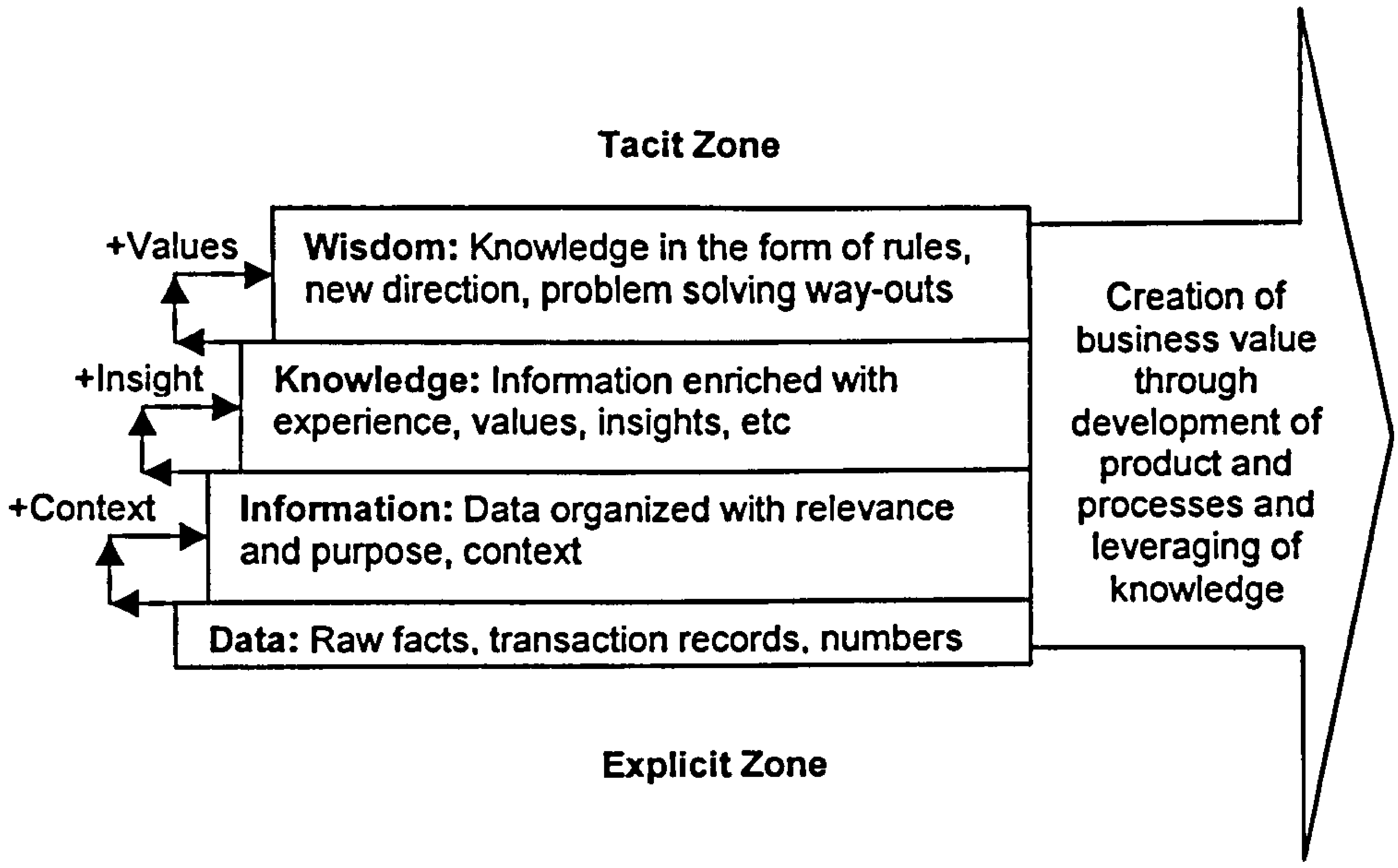


Figure 2.3: Knowledge value chain

Source: Shankar et al. (2003)

2.4 Two States of Knowledge

Despite the fact that the literature includes numerous typologies for organizational knowledge; scientific and practical (Hayek, 1945), objective and based on experiences (Penrose, 1959), procedural (Winter, 1987), incorporated (Zuboff, 1988), migratory and embedded (Badaracco, 1991), and codified (Blacker, 1993); the most frequently used is the one that distinguishes between tacit and explicit knowledge, proposed by Polanyi (1966) and later utilized by other authors.

According to Nonaka (1991), two types of knowledge reside in any organization; tacit and explicit knowledge. Explicit knowledge is knowledge that can be codified. It can be expressed in formal and systematic language and shared in the forms of data, scientific formulas, specifications, manuals and such (Nonaka and Teece, 2001). It can be processed, transmitted and stored relatively easily. Therefore, it is easier for organizations to capture this knowledge in repositories, systems, or operating technologies and make it available to all the members of the organization.

Meso and Smith (2000) identified three types of explicit knowledge resident in any organization as; cognitive knowledge, advanced system skills, and systems understanding. Cognitive knowledge, also termed "know-what", is the "basic mastery of a discipline that professionals achieve through extensive training and certification" (Quinn et al., 1996). Advanced skills or "know-how" refers to the "ability to apply rules of a discipline to complex real world problems" (Quinn et al., 1996). Systems understanding, also termed "know-why" is the deep understanding of the web cause-and-effect relationships underlying a discipline (Quinn et al., 1996; Nonaka, 1991).

Tacit knowledge, on the other hand, is highly personal and hard to formalize. Subjective insights, intuitions, and hunches fall into this category of knowledge. Tacit knowledge is deeply rooted in action, procedures, routines, commitment, ideals, values, and emotions (Cohen and Bacdayan, 1994; Schon, 1983; and Winter, 1987). It "indwells" in a comprehensive cognizance of human mind and body (Polanyi, 1966). It resides within the individual and is difficult to express in words. Every employee has a wealth of tacit knowledge deeply rooted in his/her actions, and his/her commitment to "a particular craft or profession, a particular technology, a product market, or the activities of a work group or team" (Nonaka, 1991). In most organizations, tacit knowledge is rarely shared or communicated. Therefore, it is often lost when the individual possessing it leaves the organization.

Tacit knowledge can also be seen as that knowledge which resides in the culture of the organization. An example is self-motivated creativity, which refers to the will, motivation, and adaptability for success exhibited by employees working within certain corporate cultures. It is difficult to identify the precise cause for self-motivated creativity. But literature on KM acknowledges that high levels of this creativity significantly enhance the overall performance of the firm (Davenport et al., 1998). Other examples include organizational tacit knowledge, which comprises such knowledge as casual ambiguity; the inexplicable chemistry of resources that provides sustainable competitive advantage to a firm (Michalisn et al., 1997), and cultural tacit, which is the inexplicable knowledge resident in the corporate culture (Michalisn et al., 1997).

Essentially, tacit knowledge should not be considered independently from explicit knowledge, as there is a tacit dimension to all forms of knowledge (Polanyi, 1966). Table 2.1 shows the main differences between the two types of knowledge.

Tacit Knowledge (**Subjective**)	***Explicit*** (**Objective**)
Knowledge of experience (body)	Knowledge of rationality (mind)
Simultaneous knowledge (here and now)	Sequential knowledge (there and then)
Analog knowledge (practice)	Digital knowledge (theory)

Table 2.1: Two types of knowledge

Source: Nonaka and Takeuchi (1995)

2.4.1 Interaction between Tacit and Explicit Knowledge (Nonaka and Takeuchi Knowledge Conversion Model):

Nonaka and Takeuchi (1995) knowledge conversion model is based on the assumption that knowledge is created through the interaction between tacit and explicit knowledge. The model suggests four different modes of knowledge conversion (Figure 2.4). They are as follows: (1) *Socialization* (from tacit knowledge to tacit knowledge); (2) *Externalization* (from tacit knowledge to explicit knowledge); (3) *Combination* (form explicit knowledge to explicit knowledge; and (4) *Internalization* (from explicit knowledge to tacit knowledge). Following is a brief description of each of the four modes based on Nonaka and Takeuchi (1995).

From / To	Tacit knowledge	Explicit knowledge
Tacit knowledge	**Socialization**	**Externalization**
Explicit knowledge	**Internalization**	**Combination**

Figure 2.4: Four modes of knowledge conversion

Source: Nonaka and Takeuchi (1995)

(1) *Socialization* (From Tacit To Tacit): Socialization is a process of sharing experiences and thereby creating tacit knowledge such as shared mental models and technical skills. An individual can acquire tacit knowledge directly from others without using language. Apprentices work with their masters and learn craftsmanship not through language but through observation, imitation, and practice. The key to acquiring tacit knowledge is experience.

(2) *Externalization* (From Tacit To Explicit): Externalization is a process of articulating tacit knowledge into explicit concepts. It is a quintessential knowledge-creation process in that tacit knowledge becomes explicit, taking the shape of metaphors, analogies, concepts, hypotheses, or models.

(3) *Combination* (From Explicit To Explicit): Combination is a process of systemizing concepts into a knowledge system. This mode of knowledge conversion involves combining different bodies of explicit knowledge. Individuals exchange and combine knowledge through such media as

documents, meetings, telephone conservations, or computerized communication networks. Reconfiguration of existing information through sorting, adding, combining, and categorizing of explicit knowledge (as conducted in computer databases) can lead to new knowledge.

(4) *Internalization* (From Explicit To Tacit): Internalization is a process of embodying explicit knowledge into tacit knowledge. It is closely related to "learning by doing". When experiences through socialization, externalization, and combination are internalized into individuals' tacit knowledge bases in the form of shared mental models or technical know-how, they become valuable assets.

2.5 Organizational Knowledge as a Strategic Asset

Leading management and organizational theorists have popularized the concept of knowledge as a valuable strategic asset by suggesting that for an organization to remain competitive it must effectively create, locate, capture, and share knowledge and expertise in order to apply the knowledge to solve problems and exploit opportunities (Winter, 1987; Drucker, 1991; Kougot and Zander, 1992).

In the literature, employee know-how and organizational culture are said to possess the characteristics of strategic assets (Michalisin et al., 1997). Employee know-how is one component of organizational knowledge and a crucial strategic resource (de Hoog and Van der Spek, 1997). If the process of knowledge management is a function of the organizational culture and employees' collective knowledge, then it follows that organizational knowledge is almost certainly a strategic asset.

To be a strategic asset, the resource must possess four characteristics (Michalisin et al., 1997). It must be:

(1) valuable;

(2) rare;

(3) inimitable; and

(4) nonsubstitutable.

Bollinger and Smith (2001) argue that organizational knowledge meets the characteristics of a strategic asset in the following ways. It is:

- *Inimitable*: each individual in the organization contributes knowledge based on personal interpretation of information. Group interpretations and assimilation of knowledge are dependant on the synergy of the total membership of the group. In addition, organizational knowledge is built on the unique past history of the organization's own experiences and accumulated expertise. Therefore, no two groups or organizations will think or function in identical ways.
- *Rare*: organizational knowledge is the sum of employee know-how, know-what, and know-why. Since it is dependant on the knowledge and experiences of current and past employees, and is built on specific organizational prior knowledge, it is rare.

- *Valuable*: new organizational knowledge results in improved products, processes, technologies, or services, and enables organizations to remain competitive and viable. Being the first to acquire new knowledge can help the organization attain a valuable strategic advantage.
- *Nonsubstitutable*: the synergy of specific groups cannot be replicated. Thus the group represents distinctive competence that is nonsubstitutable.

This suggests that organizations that wish to remain competitive should develop mechanisms for capturing relevant knowledge, and disseminating it accurately, consistently, concisely, and in a timely manner to all who need it.

2.6 Knowledge Management and Intellectual Capital

In the literature there is a lot of confusion between the terms knowledge management (KM) and intellectual capital (IC); for example, EFQM (1997) and others use the terms interchangeably (McAdam and McCreedy, 1999). However, it is contended that KM and IC are different but related issues. It was Drucker (1995) who stated "we are entering the knowledge society in which the basic economic resource is no longer capital...but is and well be knowledge". This viewpoint effectively labels knowledge as a resource like land and oil which has independent existence outside human and social systems. Ultimately Drucker is considering knowledge as being capitalized hence the term intellectual capital. This type of capital is seen as consisting of intangible assets not frequently recorded on the balance sheet and can include employee skills, information, patents, copyright, brands, R&D, licensing opportunities, innovative use of assets such as data bases.

Brooking (1997) suggest that KM is actively concerned with the strategy and tactics to manage IC or human-centered assets. KM from this standpoint is seen as leveraging IC (Peters, 1992), or as recognizing or rediscovering assets that the organization is not using to full potential, ultimately employees. This approach is similar to that of Handy (1990) who spoke of creating value from intangible assets. Thus these approaches imply that the key areas within KM are IC and management of IC.

However the concept of knowledge as simply relating to IC or a managerial asset is a highly mechanistic view and is much criticized by those who see knowledge as socially constructed (Gergen, 1991; Alvesson and Willmott, 1996). This more socially oriented view focuses on knowledge construction as being a key area of KM.

2.7 Definition of Knowledge Management

There are a variety of disciplines that have influenced and informed the field of KM thinking and praxis (Quintas et al. 1997; McAdam and McCreety, 1999; Kakabadse et al., 2003). These are: cognitive science (in understanding of knowledge workers); social science (understanding motivation, people, interactions, culture, and environment); management science (building knowledge-related capabilities); knowledge engineering (eliciting and codifying knowledge); artificial intelligence (automating routine and knowledge-intensive work) and economics (determining priorities). Thus KM is multidisciplinary and as a result, there are a host of working definitions of KM and embryonic philosophies circulating in the literature and around corporations of the world. Scarbrough (1996) comments," The sprawling and electric literature and the ambiguity and definitional problems....allow different groups to project their interests and concern onto it". Table 2.2 provides a classification of KM definitions, arising from differently focused studies (Shankar et al., 2003).

SN	Reference	Definition of KM
Focus: Need of KM		
1	CPA Journal, 1998	Knowledge management is concerned with organizing and analyzing information in a company's computer database so this knowledge can be shared throughout a company, instead of languishing in the department where it was created, inaccessible to other employees
2	Bair, 1997	Knowledge management aims to capture the knowledge that employees really need in a central repository and filter out the surplus. Use of technology to capture the knowledge residing in the minds of the employees so it can be easily shared across the enterprise
3	O'Leary, 1998	Enterprise knowledge management entails formally managing knowledge resources in order to facilitate access and reuse of knowledge, typically by using advanced information technology. KM is formal and that knowledge is classified and categorized according to a pre-specified – but evolving – ontology into structured and semi-structured data and knowledge bases
Focus: What KM demands		
4	Thomas et al., 2001	Knowledge management is seen primarily as a domain of capturing, organizing, an retrieving information, evoking notions of databases, documents, query languages, and data mining

"Continue"

SN	Reference	Definition of KM
5	Hannabuss, 1987	Finding out how and why information users think, what they know about the things they know, the knowledge and attitude they possess, and the decisions they make when interacting with others
6	Hibbard, 1997	Combining indexing, searching, and push technology to help companies organize data stored in multiple sources and deliver only relevant information to users
7	Anthes, 1991	Polices, procedures, and technologies employed for operating a continuously updated linked pair of network databases
8	Gopal and Gagnon, 1995	Identification of categories of knowledge needed to support the overall business strategy, assessment of the current state of the firm's knowledge and transformation of the current knowledge-base into a new and more powerful knowledge base by filling knowledge gaps
9	Chorafas, 1987	Ensuring a complete development and implementation environment designed for use in specific function requiring expert system support
Focus: KM practices		
10	Mack et al., 2001	Capturing knowledge and expertise created by knowledge workers as they go about their work and making it available to a large community of colleagues. Technology can support these goals, and knowledge portals serve as a key tool for supporting knowledge work
11	Birkett, 1995	Bringing tacit knowledge to the surface, consolidating it in usable forms by which it is more widely accessible, and promoting its continuing creation
Focus: KM and IT		
12	Strapko, 1990	Understanding the relationships of data; identifying and documenting rules for managing data; and assuring that data are accurate and integrity is maintained
13	Zeleny, 1987	Facilitation of autonomous coordinability of decentralized subsystems that can state and adapt their own objectives

"Continue"

SN	Reference	Definition of KM
14	Maglitta, 1995	Mapping knowledge and information resources both on-line and off-line; training, guiding, and equipping users with knowledge access tools; monitoring outside news and information
Focus: KM processes		
15	Davenport, 1994	Processes of capturing, distributing, and effectively using knowledge
16	Garvin, 1994	Creation, acquisition, and transfer of knowledge and modification of organizational behavior to reflect new knowledge and insights
17	Albert, 1998	The process of collecting, organizing, classifying, and disseminating information through out an organization, so as to make it purposeful to those who need it
Focus: Holistic nature of KM		
18	Alavi and Leinder, 1999	Knowledge management refers to a systematic and organizationally specified process for acquiring, organizing, and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work
19	Magiltta, 1996	Knowledge management in general tries to organize and make available important know-how, wherever and whenever it is needed. This includes processes, procedures, patents, reference works, formulas, "best practices", forecasts, and fixes. Technologically, intranets, groupware, data warehouses, networks, bulletin boards and videoconferencing are key tools for storing and distributing this intelligence
20	Zuckerman and Buell, 1998	Knowledge management is the strategic application of collective company knowledge and know-how to build profits and market share. Knowledge assets, both ideas or concepts and know-how, are created through the computerized collection, storage, sharing and linking of corporate knowledge pools. Advanced technologies make it possible to mine the corporate mind

Table 2.2: Classification of KM definitions

Source: Shankar et al. (2003)

For some, KM is a "conscious strategy for 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 organizational performance" (O'Dell and Jackson, 1998). For others, it is "formalization of, and access to, experience, knowledge and expertise that create new capabilities, enable superior performance, encourage innovation and enhance customer value" (Beckman, 1997). A total of 73% of 260 UK and European corporations voted for the business definition of KM as the "collection of processes that govern the creation, dissemination, and utilization of knowledge to fulfill organizational objectives" (Murray and Myers, 1997).

However most working definitions in the literature point to fundamentally the common idea that KM can incorporate any or all of the following four components: business processes, information technology, knowledge repositories, and individual behavior (Eschenfelder et al., 1998). A consistent theme in all proposed definitions of KM is that it provides a framework that builds on past experiences and creates new mechanisms for exchanging and creating knowledge.

The business community has articulated the following core KM objectives, through an analysis described in KPMG (1999), as:

- supporting innovation, the generation of new ideas and the exploitation of the organization's thinking power;
- capturing insight and experience to make them available and usable when, where, and by whom required;

- making it easy to find and reuse sources of know-how and expertise, whether they are recorded in a physical form or held in someone's mind;
- fostering collaboration, knowledge sharing, continual learning, and improvement;
- improving the quality of decision making and other intelligent tasks; and
- understanding the value and contribution of intellectual assets and increasing their worth, effectiveness, and exploitation.

2.8 Benefits of KM

Organizations are interested in managing knowledge for several reasons. Core competencies are based on the skills and experiences of the people who do the work, and may not exist in physical form (Manville and Foote, 1996). Therefore, it is important that organizations find a way to tap into this knowledge base in order to preserve and expand their core competencies. Some believe that knowledge is the driving force in today's economy. If this is the case, then it becomes critical for an organization to find ways to accessing existing knowledge and creating new knowledge.

When knowledge within the organization is shared, it becomes cumulative. It becomes embedded within the organization's processes, products, and services (Demarest, 1997). Grant (1997) asserts that tacit knowledge is demonstrated only in its application. The goal should not be to capture what everyone knows so that everyone has the same knowledge, but to combine the various levels of expertise present to create new organizational knowledge.

There are several benefits of knowledge management that can be anticipated (Lank, 1997). Employees will spend less time looking for information and expertise. This will enable highly paid professionals to concentrate on their area of expertise. A knowledge management process will help employees to improve their performance and employability, by expanding resources immediately available to them and enabling them to make more intelligent decisions. An effective knowledge management process will also generate less stress for employees trying to do more with fewer resources. Knowledge management will help organizations become more competitive by using new knowledge to reduce costs, increase speed, and meet customer needs (Grayson and O'Dell, 1998).

Jarrar (2002) outlined the following benefits of KM perceived from the analysis of a study reviewing the experiences of 40 organizations in KM:

- contributes to increased competitiveness;
- Improved decision making and avoidance of wasted time "reinventing the wheel";
- increased responsiveness to customers;
- encourages employees who are not natural net-workers to engage in knowledge sharing and discourages information hoarding;
- improves support among colleagues because they value the knowledge and help they receive;
- improved efficiency of people and operations and better products and services;
- greater innovation.

2.9 KM in Engineering

Koch (2003) defines KM as management activities that frame and guide knowledge production in an organization. Knowledge production being defined as a combination of retrieval, combination, creation, and erasing of knowledge. Koch (2003) suggests that KM in engineering companies has two main dimensions. First, knowledge production practices in this setting are carried out within a frame of management, information systems, organizational and human resource policies and practices. The knowledge production resides in several organizational cultures and takes the form of political processes of negotiating knowledge claims. Second, knowledge production relies not only on information systems, but several systems supporting finance and accounting, document handling, engineering, internal communication (Intranet) and Web-based projects which all need to be integrated together to support the knowledge production.

Although engineers might assert that they have been managing knowledge, this has traditionally been on a personal rather than a company basis. The knowledge has normally been managed in an incomplete manner allowing knowledge loss (e.g. key members of the design team leave and people remaining in the company do not know why a certain aspect of the design has been designed in a particular way) (Sainter et al., 2000).

As an example (Sainter et al., 2000), a design team from an automotive company was asked to reduce costs on one of the company's models. It was discovered that the rear windows were designed to withstand speeds of 90 miles per hour. The design team saw no reason why this has happened, since most cars cannot reverse at that speed. It was decided that this was an ideal item to make a large saving on the production cost of the car; accordingly the requirements for the rear window were reduced to around 30 miles per hour. However, after the start of production of the new model, the design team started receiving complaints about broken or cracked rear windows. It then became clear that the reason why there was a 90 miles per hour speed requirement on the rear window, was the fact that transport trains from the car plant quite often reach high speeds and since the cars were loaded with the rear window facing forward on the train, the rear windows needed to withstand these high speeds. This is just a simple example of where a decision was taken and over the years the reason for it was lost.

Engineering organizations embrace vast amounts of knowledge in various areas, such as knowledge that is critical to achieve business goals (Rus and Lindvall, 2002). Some of these knowledge areas are:

- *Acquiring knowledge about new technologies.* The development of new technologies makes product development more efficient only if engineers (users) are proficient with the new technology and managers understand its impact. When managers use a technology that engineers are unfamiliar with, engineers often resort to the "learning by doing" approach, which can result in serious delays. So, organizations must quickly acquire knowledge about new technologies and master them.
- *Sharing knowledge about local policies and practices.* Every organization has its own policies, practices, and culture, which are not only technical but

also managerial and administrative. This knowledge is usually transferred to new employees informally from experienced employees. Passing knowledge informally is an important aspect of a knowledge sharing culture that should be encouraged. Nonetheless, formal knowledge capturing and sharing ensures that all employees access it. So, organizations must formalize knowledge sharing while continuing informal knowledge sharing.

- *Capturing knowledge and knowing who knows what.* Engineering organizations depend heavily on knowledgeable employees (Peery, Staudenmayer, and Votta 1994). Knowing what employees know is necessary for organizations to create a strategy for preventing valuable knowledge from disappearing. Knowing who knows what knowledge is also a requirement for efficiently staffing projects, identifying training needs, and matching employees with training offers.
- *Collaborating and sharing knowledge.* Group members are often geographically scattered and work in different time zones. Nonetheless, they must communicate, collaborate, and coordinate. Communication in engineering is often related to knowledge transfer. Collaboration is related to mutual sharing of knowledge. Group members can coordinate independently of time and space if they can easily access their work artifacts.

Shankar et al. (2003) categorized organizational knowledge engrossed across the various value propositions, measurable objectives to achieve business goals, for an engineering firm into:

- knowledge related to product development leading to product and service leadership;
- knowledge related to process integration leading to operational excellence;
- knowledge sharing with suppliers leading to strategic alliances with those suppliers;
- customer demand and transactional knowledge leading to customer intimacy;
- tacit knowledge of employees leading to employee capability; and
- knowledge related to the development of environmentally friendly products leading to environmental concern.

Other researchers emphasized the importance of managing project knowledge in engineering organizations as these firms are project oriented (Disterer, 2002; Lytras and Pouloudi, 2003; Szymczak and Walker, 2003). The focus is to reuse experience gained from one project in future projects and to link between KM and project management.

Rus and Lindvall (2002) suggested that organizations can view KM as a risk prevention strategy, because it explicitly addresses risks that are too often ignored, such as

- Loss of knowledge due to attrition
- Lack of knowledge and an overly long time to acquire it due to steep learning curves

- People repeating mistakes and performing rework because they forgot what they learned from previous projects
- Individuals who own key knowledge becoming unavailable

Rus and Lindvall (2002) also suggested that KM can help engineering organizations in deceasing production time and cost and increasing quality. This is achieved by avoiding mistakes and reducing rework. Repeating successful processes increases productivity and the likelihood of further success. So, organizations need to apply process knowledge gained in previous projects to future projects. Unfortunately, the reality is that the development teams do not benefit from existing experience and they repeat mistakes even though some individuals in the organization have the necessary know-how to avoid them. Project team members acquire valuable individual experience with each project. The organization and individuals could gain much more if they could share this knowledge.

Furthermore, Rus and Lindvall (2002) argued that KM can also help organizations in making better decisions. In engineering organizations, technical and managerial decisions are taken constantly. Most of the time, individuals make decisions based on personal knowledge and experience or knowledge gained using informal contacts. This could be feasible in small organizations but as organizations grow and handle a larger volume of information, this process becomes inefficient. Large organizations cannot rely on informal sharing of employees' personal knowledge. Individual knowledge must be shared and managed at organization levels. Organizations need to define formal methodology for sharing knowledge so that employees throughout the organization can improve their decision making process.

Engineering organizations led the way in KM initiatives and efforts realizing the potential of KM to improve business performance and support organization's strategies. The business press widely publicized early successes at consulting firms such as Booz Allen, applications engineering companies like Buckman Labs, and oil companies like BP and Schlumberger (Lucier and Torsilieri, 2001). However, many organizations have tried and failed to implement KM (Scarbrough and Swan, 1999). The majority of such failures go unreported in the literature as organizations are much more likely to report their successes. These failures have been linked to the lack of a generally accepted framework and methodology to guide successful implementation of KM in organizations (Rubenstein et al., 2001a, 2001b; Beckman, 1998; Maier and Remus, 2003).

2.10 KM Perspectives and Approaches

There are currently three major schools of thought on what knowledge management is (Poynder, 1998). One school suggests that knowledge management is primarily an information technology issue, with networks of computers and GroupWare being the keys. If you build extensive computer networks and communication tools that allow group collaboration, people will be more inclined to share information and knowledge. A second school suggests that knowledge management is more of a human resource issue with emphases on organizational culture and teamwork. A strong, positive organizational culture is critical to promoting learning, development and the sharing of skills, resources, and knowledge. The third school promotes the development of processes to measure and capture the organization's know-how. Processes do not necessarily need to involve the use of information technology.

Koch (2002, 2003) characterized the positions within KM into cognitive, functionalistic, cultural, and socio-political perspective. Cognitive and functionalistic positions can be characterized as mainstream, since they tend to dominate the discourse, whereas cultural and socio-political perspectives have emerged as the second generation of efforts.

Mainstream approaches to knowledge management originate form positions as diverse as innovation economics, information system science, strategic management and others (Blumentritt and Johnston, 1999; Scarbrough et al., 1999). It seems that Nonaka and Takeuchi (1995) as well as Davenport and Prusak (2000) have become central reference points. The essential elements of mainstream knowledge management can therefore be distilled from Nonaka and Takeuchi (1995) contribution. Briefly, Nonaka and Takeuchi articulate predominantly rationalistic and functionalistic views on knowledge and the possibilities of modeling it, capturing it, and storing it. Their categorization of types of knowledge and understanding of transformation between them (visualized as a spiral) seems to indicate that knowledge and the management of knowledge is a straightforward possibility. The distinction between tacit and explicit, between personal and codified seems very operational. Moreover, the transformation of tacit, implicit, knowledge into explicit and transformable knowledge is in Nonaka et al.'s view, an important but also manageable task

(Alder, 1995). Some even describe it as "easy" to transport explicit knowledge (Hipp and Gassmann, 1999).

Nonaka's categories have been followed by other taxonomic approaches, which all signal neat ordering of knowledge production but appear little empirical underpinning (Robertson et al., 2001). Nonaka et al., predominantly describe and understand organizations as orderly, goal-oriented and harmonic. Although some space is left for autonomy and what is called fluctuation, the main line is to see organizations in a system theory-oriented way. The concepts of Nonaka et al. do not directly mention IT, but the approach clearly underpins the legitimacy of IT-solutions in managing knowledge.

Mainstream KM literature embodies a non-problematical view on knowledge and the categories of knowledge. In contrast, there are a growing number of sociologically and anthropologically informed approaches emerging. These are considerably more cautious in their approach to knowledge (Prichard et al., 2000; Scarbrough et al., 1999; Coombs and Hull, 1998; Hull, 1999). This group draws on approaches informed by different variants of interpretive sociology, sociology of scientific knowledge, and anthropology referring to, but also criticizing the concept of "communities of practice" (Wenger, 1998). A central commonality of the emerging positions is the assertion that IT and mainstream KM miss the point in focusing on knowledge codified in distinct elements suitable for IT-storage and ordering. A central difference is, however that the cultural approaches assume a relative harmony in knowledge production in the "community of practice", where the participants share goals and aims, whereas the socio-political position has an eye for the negotiation of knowledge and the potential conflict on knowledge claims.

According to the cultural position, knowledge is embedded in a culture consisting of shared systems of meaning, rituals, verbal and physical symbols (Alvesson, 1995). Knowledge is related to and attached to a set of practices, and is actually potentially meaningless if disentangled from these practices. The understanding is thus picturing knowledge as a heterogeneous assemblage of tangible and non-tangible elements and as something strongly contextual.

Figure 2.5 provides an overview of several approaches concerning the investigation of the several parameters of KM (Lytras and Pouloudi, 2003). The first group addresses the knowledge assets parameter. This parameter includes investigating the nature of knowledge and classifying the types of organizational knowledge. The second group addresses the knowledge activities parameter. These activities include the transformation from data to information to knowledge as well as the interaction and interrelationships between the various types of knowledge such as the interaction between tacit and explicit knowledge. The third group addresses the proposed KM life cycles. These life cycles provide a distinction of the several phases that constitute KM in organizations. The fourth group addresses the organizational factors parameter. This constitutes investigating the organizational factors that affect KM. Factors include technology, culture, strategies, HR, measurement, and organizational infrastructure.

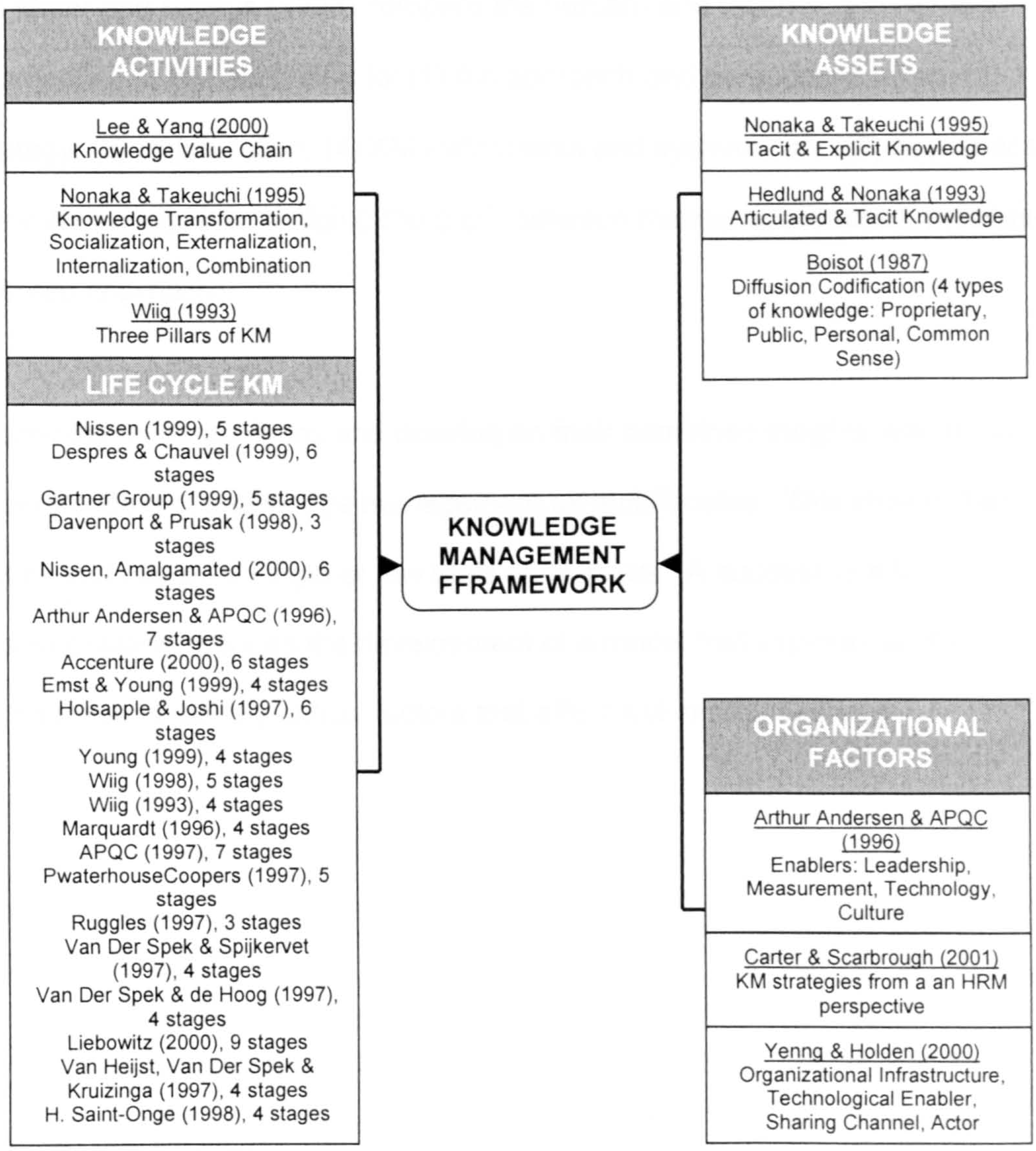


Figure 2.5: An intensive KM literature mapping

Source: Lytras and Pouloudi (2003)

Recently, an increased number of researchers have recognized and propagated the need for an interaction between the various approaches for successful implementation of KM, and a "socio-technical" approach emerged (Offsey, 1997; Meso and Smith, 2000; Bollinger and Smith, 2001; Koch, 2003; Chourides et al., 2003; Shankar et al., 2003; Maier and Remus, 2003). In Table

2.3 Maier and Remus (2003) compare the human- and technology-oriented approaches to KM according to: (1) the approach and perspective taken; (2) strategy; (3) organization; (4) KM instruments and systems; and (5) economics. They then suggest a "bridging the gap", between the two approaches, process-oriented approach.

Examining these positions and drawing on their combined insights lead to an understanding of knowledge management as multifaceted. This implies that KM cannot rely on a single or few tools or enablers. A successful KM implementation requires the development of a model that explores all KM approaches to identify critical factors that affect KM in organizations.

Dimensions	Technology-oriented KM	Human-oriented KM	"Bridging the gap" KM
(1) Approach			
Orientation	Technology-oriented	Human-oriented	Process oriented; knowledge processes integrate both orientations
Perspective	Engineering, cognitive	Cultivation, community	Socio-technical systems engineering
Definition of knowledge	Documented knowledge, separable form people	Knowledge exclusively in the heads of people	Documented knowledge is connected to the knowledge in the heads of people and embedded in social networks according (knowledge) processes
(2) Strategy			
KM strategy	Codification	Personalization	Boundary spanning
Goals	Improve documentation and retention of knowledge, acquisition of external knowledge, turn implicit into explicit knowledge	Improve communication, training of newly recruited, improve knowledge sharing, improve personal development	Improve visibility of knowledge, improve access to and use of existing tacit and explicit knowledge, improve innovation, change culture
(3) Organization			
Roles	Author, knowledge (base) administrator, knowledge broker	Knowledge worker, expert, mentor, network chair, community manager, moderator	Knowledge partner and stakeholder, boundary spanner, coordinator for KM, subject matter specialist, owner/manager of knowledge processes
Tasks	Storing, semantic release and distribution, refinement, deletion/archiving of knowledge, acquisition of external knowledge	Establish, foster and moderate communities, document skills and expertise, organize knowledge sharing events	Develop knowledge maps connecting knowledge elements and people, develop profiles, develop knowledge portals, personalize organizational knowledge base
Culture	Technocratic	Socio-cultural	Socio-technical, discursive

"Continue"

Dimensions	Technology-oriented KM	Human-oriented KM	"Bridging the gap" KM
(4) KM Instruments and systems			
Instruments	Document and content management	Skill management, knowledge communities, knowledge networks	Knowledge maps, lessons learned/best practices management, continuous improvement
Contents	Knowledge about organization, processes, products; internal studies, patents, on-line journals	Employee yellow pages, skills directories, directories of communities, knowledge about business partners	Ideas, proposals, lessons learned, best practices, community home spaces, valuations, comments, feedback of knowledge elements
Architecture	Integrative KMS	Interactive KMS	KMS bridging the gap
Functions	Publication, classification, formalization, organization, search, presentation, visualization of knowledge elements	Asynchronous and synchronous communication, collaboration and cooperation, e-learning, community support	Profiling, personalization, contextualization, recommendation, navigation from knowledge elements to people
(5) Economics			
Evaluation area	Content, integrative KMS	Communication, social networks, interactive KMS	Knowledge processes, content, communication, KMS bridging the gap
Evaluation Categories	System quality, information and knowledge quality, user satisfaction, impact on individuals	Communication quality, knowledge-specific services, use, user satisfaction, impact on collectives	All evaluation categories

Table 2.3: Comparison of KM approaches

Source: Maier and Remus (2003)

2.11 KM Life Cycle Models

The attempt to model knowledge activities in a life cycle model is interesting since the distinction of several phases permits the further analysis of requirements for the support of KM activity in each phase. Interesting research that investigate this aspect are Nissen et al. (2000), as well as Hahn and Subramani (2000).

Figure 2.6 presents an adaptation of Nissen et al.'s (2000) work concerning the integrated analysis and design of knowledge systems and activities. Four frameworks are reviewed and an amalgamated model consisting of six phases was produced. While Rubenstein-Montano et al. (2001a) provide a systematic analysis of 15 more life cycle models that have been proposed. Figure 2.7 provides a synopsis of the investigated KM models. These models provided basis for the KM cycle suggested as part of the KM model presented in this work.

A critical overview of these frameworks permits one to claim that several terms are used in order to describe the same knowledge activity. Additionally, some of the items described can also be grouped into one activity. A synthesis of the various ideas is provided by Lytras et al. (2002).

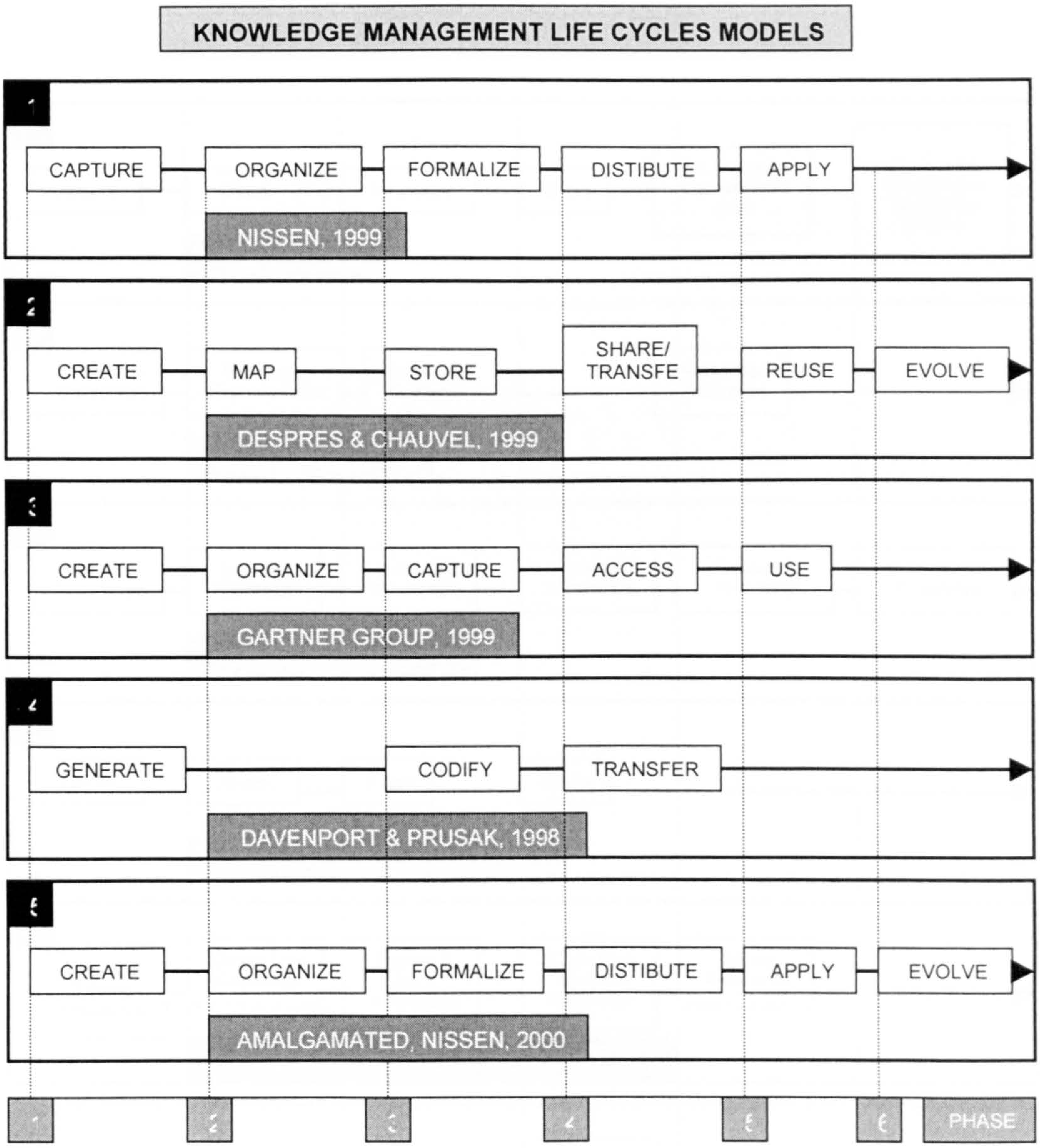
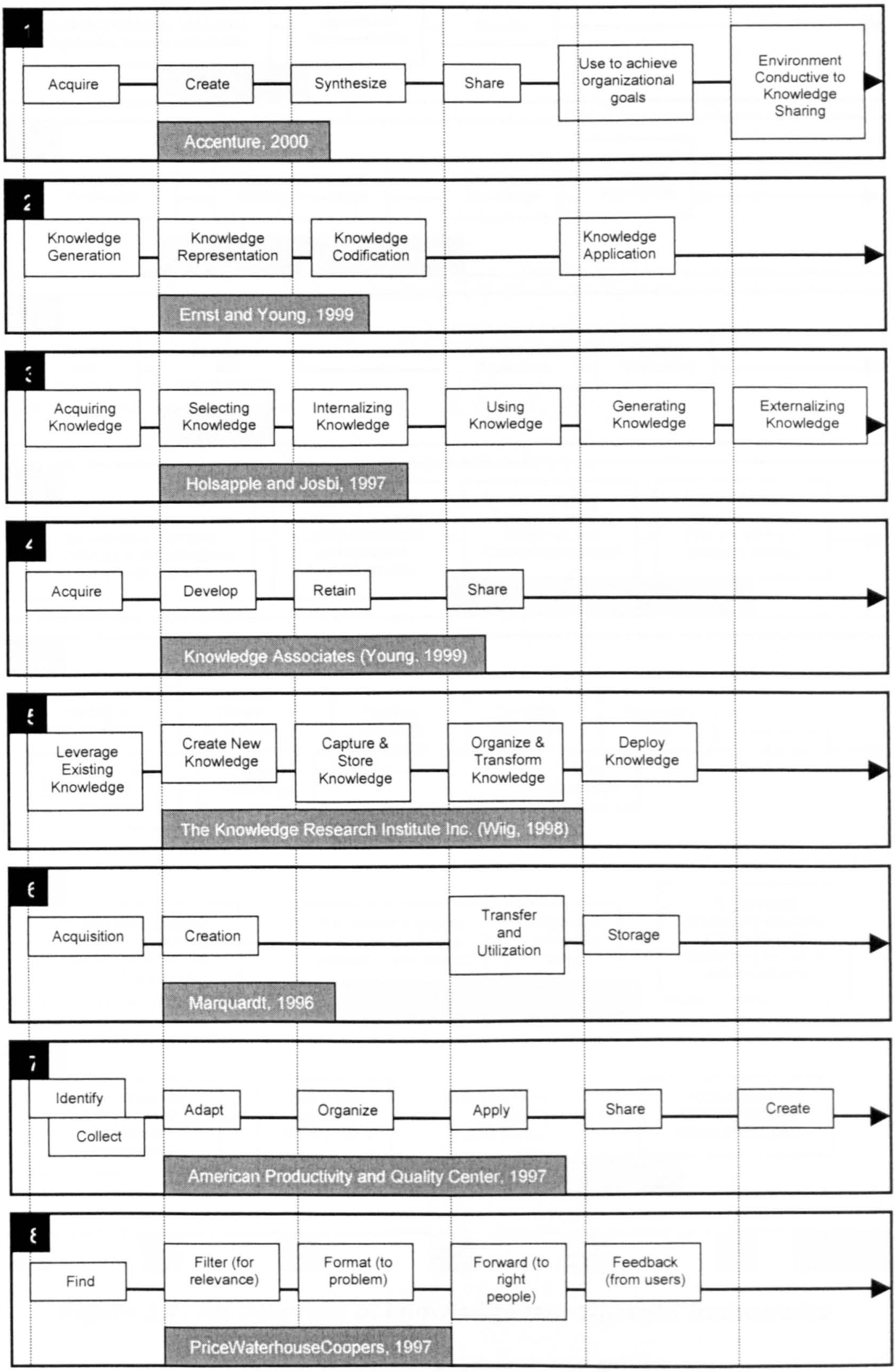


Figure 2.6: KM frameworks

Source: Nissen et al. (2000)

KNOWLEDGE MANAGEMENT LIFE CYCLES MODELS



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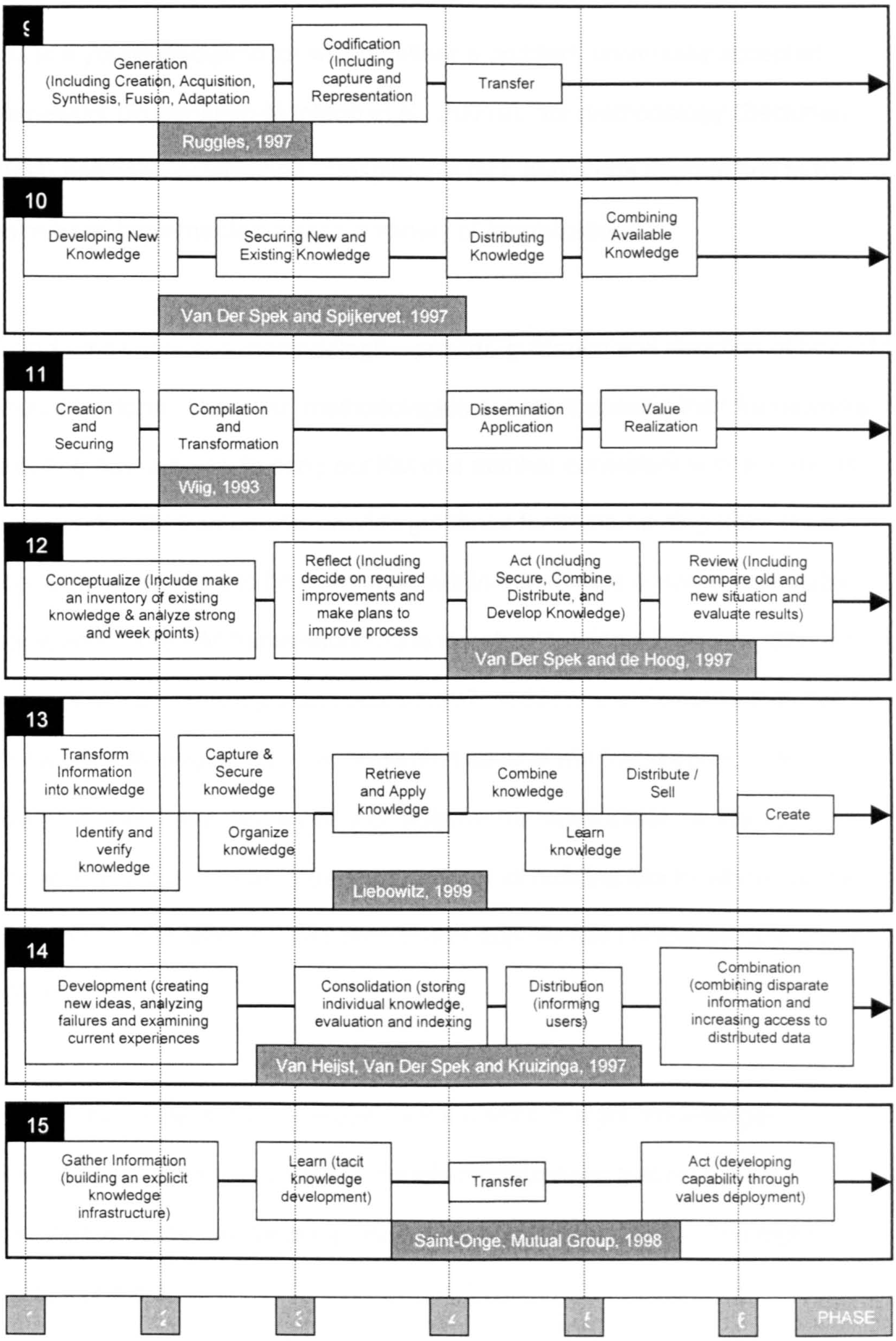


Figure 2.7: An overview of knowledge management frameworks

Source: Rubenstein-Montano et al. (2001a)

2.12 KM Frameworks and Methodologies

KM is a young discipline for which neither a codified, universally accepted framework (Rubenstein-Montano et al., 2001a), nor methodology (Beckman, 1998) has been established. Despite this fact, numerous approaches to KM have been implemented across a variety of organizations.

Both frameworks and methodologies provide guidance and direction of how KM should be done. However, methodologies are more specific than frameworks, detailing how actually to carry out KM in a manner consistent with a particular framework. KM frameworks provide guidance for implementing KM. Thus, methodologies ought to be developed within the context of some acceptable framework. The KM frameworks in the literature tend to emphasize different aspects of KM. Holsapple and Joshi (1997, 1998) of the Kentucky Initiative for Knowledge Management have presented several KM frameworks. For example, they have developed a descriptive framework that, similar to the Theseus Institute (1999), provides a number of building blocks which can be sampled from in order to build prescriptive approaches (Holsapple and Joshi, 1998).

Additionally, Teleos has developed a framework of eight "knowledge-management dimensions" which identify organizations that recognize knowledge as the key for competitive success (Chase, 2000). The eight dimensions are:

1. success in establishing an enterprise culture;
2. top management support for managing knowledge;

3. ability to develop and deliver knowledge-based goods/services;
4. success in examining the value of the enterprise's intellectual capital;
5. effectiveness in creating an environment of knowledge sharing;
6. success in establishing a culture of continuous learning;
7. effectiveness of managing customer knowledge to increase loyalty/value; and
8. ability to manage knowledge to generate shareholder value.

This is a comprehensive framework in which each dimension is comprised of myriad processes and sub processes. Other frameworks focus on the KM life cycle as presented in the previous section. However, there is no generally accepted framework for KM as a discipline (Rubenstein-Montano et al., 2001a). Beckman (1999) and Rubenstein-Montano et al. (2001a) review existing frameworks.

There are several methodologies that have been presented in the literature as well. Following is a presentation of some of theses methodologies knowing that no claim is made to be exhaustive. Wiig (1999b) lists "major KM building blocks", including:

1. Obtain management buy-in.
2. Survey and map the knowledge landscape.
3. Plan the knowledge strategy.
4. Create and define knowledge-related alternatives and potential initiatives.
5. Portray benefit expectations for KM initiatives.

6. Set KM priorities.
7. Determine key knowledge requirements.
8. Acquire key knowledge.
9. Create integrated knowledge transfer programs.
10. Transform, distribute, and apply knowledge assets.
11. Establish and update KM infrastructure.
12. Manage knowledge assets.
13. Construct incentive programs.
14. Coordinate KM activities and functions enterprise-wide.
15. Facilitate knowledge-focused management.
16. Monitor KM.

The building blocks are not necessarily all to be implemented at any one time, but rather should be used as appropriate for a particular situation. Wiig (1999b), while not explicitly presenting the building blocks as a methodology, further details of what is meant by each component, such that they can be carried out to achieve an objective, constitute a methodology.

Wiig et al. (1997) methodology emphasizes knowledge flows and bottlenecks. Their discussion is within the context of review, conceptualize, reflect, and act framework:

1. *Review* – monitor organizational performance internally and against external benchmarks. Lessons Learned can be a useful tool.
2. *Conceptualize* – organize the different levels of knowledge in the organization. Identify knowledge assets and link them to business

processes that use them (a list of survey techniques are provided). Analyze strong and week points in the knowledge inventory. A set of knowledge "bottlenecks" should be identified in this phase.

3. *Reflect* – establish a plan to address and mitigate the knowledge bottlenecks. Prioritize the parts of the improvement plan.
4. *Act* – implement the improvement plan. Different parts of the organization may be responsible for enacting different parts of the plan.

Monsanto built its approach to KM on existing literature (Junnarkar, 1999). The five processes include:

1. Connecting people with other knowledge people.
2. Connecting people with information.
3. Enabling the conversion of information to knowledge.
4. Encapsulating knowledge, to make it easier to transfer.
5. Disseminating knowledge around the firm.

Dataware Technologies, Inc. (1998) provided a fairly detailed methodology for KM:

1. Identify the business problem.
2. Prepare for change – obtain executive support and make the shift to a sharing culture.
3. Create the team (of people responsible for leading KM).
4. Perform a knowledge audit – identify what knowledge is missing and organize the knowledge.
5. Define key features required for the technological infrastructure.

6. Phase in KM activities in seven steps:
    - Improve the return on investment on existing knowledge assets.
    - Enhance the process of locating applicable knowledge.
    - Increase the accuracy and speed of classifying knowledge.
    - Provide substantially enhanced functionality, security, and performance for the growing KM activity in the organization.
    - Start capturing valuable tacit knowledge that was previously lost to attrition.
    - Enable faster access to critical knowledge.
    - Quickly find people in the organization who have specific knowledge.
7. Link people to knowledge – knowledge directory and content management.

Xerox Corporation (1999) has developed the X5 methodology, which emphasizes the linkage of KM to business goals. The five steps are as follows:

1. *Discovery* – identify business goals, challenges, and opportunities.
2. *Definition* – determine key requirements and scope of the project.
3. *Start-up* – detailed project plan is developed.
4. *Delivery* – implement the plan.
5. *Evaluation* – ensure results meet expectations and facilitate knowledge transfer.

Liebowitz (1999) and Liebowitz and Beckman (1998) present their work of KM life cycles as methodologies. Listed below, the steps of each method dictate particular tasks, but detailed procedures for accomplishing each task are not provided.

Liebowitz (1999) discusses a nine-step approach to KM:

1. Transform information into knowledge.
2. Identify and verify knowledge.
3. Capture and secure knowledge.
4. Organize knowledge.
5. Retrieve and apply knowledge.
6. Combine knowledge.
7. Create knowledge.
8. Learn knowledge.
9. Distribute/sell knowledge.

Liebowitz and Beckman (1998) discuss an eight-step approach for KM:

1. Identify knowledge.
2. Capture knowledge.
3. Select knowledge.
4. Store knowledge.
5. Share knowledge.
6. Apply knowledge.
7. Create knowledge.
8. Sell knowledge.

Rubenstein-Montano et al. (2001b) examined these KM methodologies and argued that there are three key limitations to these methodologies: (1) lack of detail, (2) lack of an overseeing framework, or (3) failure to address the entire KM process. The third limitation refers to the failure of the methodology to address all relevant aspects of KM, and instead focuses on one or several parts. Table 2.4 summarizes the strengths of these methodologies; checkmarks indicate the aspects included in each methodology (Rubenstein-Montano et al., 2001b). Furthermore, Rubenstein-Montano et al. (2001b) proposed the SMARVision methodology in an effort to overcome these limitations. The SMARTVision methodology is composed of five general phases: strategize, model, act, revise, and transfer (Figure 2.8). The methodology also provides details of each phase; specific procedures, sub-procedures, and outputs. A summary of those details is shown in Table 2.5. However, Rubenstein-Montano et al. (2001b) acknowledged that SMARTVision also has limitations in that not all aspects of KM are adequately addressed. For example, the distinction between tacit and explicit knowledge is made, but it is not adequately addressed. They also outlined the need for more research in the area of KM methodologies.

Methodology	Framework	Detail	Strategy	Culture	Learning	Explicit Vs Tacit	Tasks
Wiig (1999)		✔	✔	✔			✔
Wiig et al. (1997)	✔						✔
Dataware Tech., Inc. (1998)		✔		✔		✔	✔
Liebowitz (2000)					✔		✔
Liebowitz and Beckman (1998)							✔
Junnarker (1999)						✔	✔
Xerox Co. (1999)			✔		✔		

Table 2.4: A sampling of existing methodologies

Source: Rubenstein-Montano et al. (2001b)

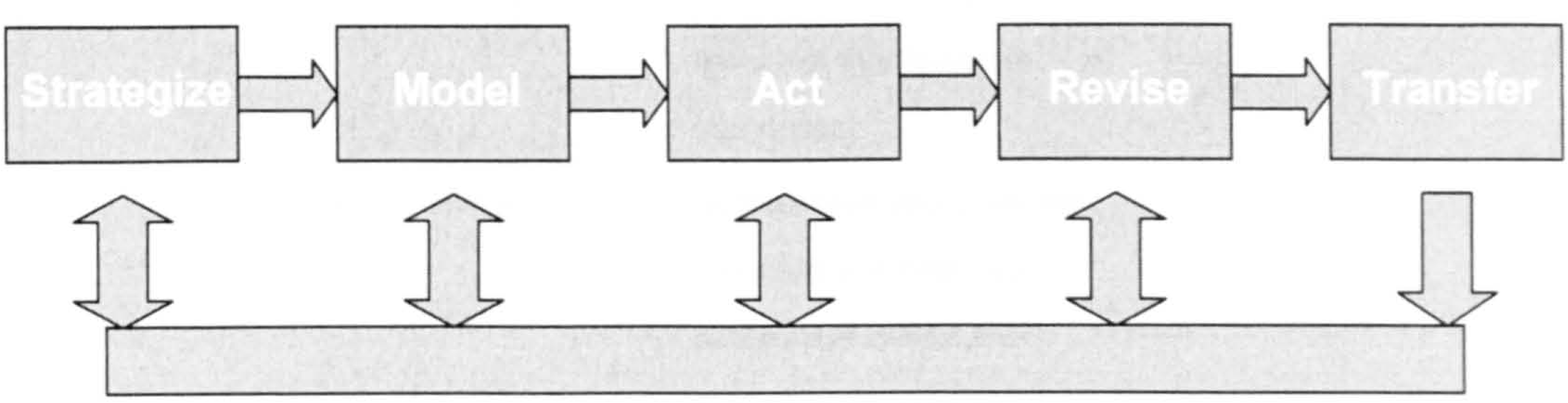


Figure 2.8: The SMARTVision knowledge management methodology

Source: Rubenstein-Montano et al. (2001b)

Phase	Procedure(s)	Sub-procedure(s)	Outputs
Strategize	1. Perform strategic planning	(a) Determine key knowledge requirements (b) Set KM priorities	• Business needs analysis document • Cultural assessment and incentives document
	2. Performance business needs analysis	(a) ID business problem(s) (b) Establish metrics of success	
	3. Conduct cultural assessment and establish a motivation and reward structure to encourage knowledge sharing		
Model	1. Performance conceptual modeling	(a) Conduct knowledge audit (b) Do knowledge planning	• Knowledge audit document • KM program plan • Requirements specifications document
	2. Perform physical modeling	(a) Develop the physical architecture	
Act	1. Capture and secure knowledge	(a) Collect and verify knowledge (b) Evaluate the knowledge	• Knowledge acquisition document • Design document • Visual and technical KM system prototypes
	2. Represent knowledge	(a) Formalize how the knowledge is represented (b) Classify the knowledge (c) Encode the knowledge	
	3. Organize and store knowledge in the KM system		
	4. Combine knowledge	(a) Retrieve and integrate knowledge from the entire organization	
	5. Create knowledge	(a) Have open discussion with customers and interested parties, both internal and external to the organization (b) Perform exploration and discovery (c) Conduct experimentation	

"Continue"

Phase	Procedure(s)	Sub-procedure(s)	Outputs
	6. Share knowledge	(a) Distribute knowledge (b) Make knowledge easily accessible	
	7. Learn knowledge and loop back to step 1 of this phase		
Revise	1. Pilot organizational use of the KM system		• Evaluation methodology and results document
	2. Conduct knowledge review	(a) Perform quality control (b) Perform relevance review	• KM system prototype II • User's guide for KM system
	3. Perform KM system review	(a) Test and evaluate achieved results (b) Revaluate/test against metrics	
Transfer	1. Publish knowledge		• Maintenance document for KM system
	2. Coordinate KM activities and functions	(a) Create integrated knowledge transfer programs (b) Notify where knowledge is located and lessons learned (c) Perform serious anecdote management	• Fully functional KM system • Post-audit document • Lessons learned document
	3. Use knowledge to create value for the enterprise	(a) Sell (b) Apply (c) Use	
	4. Monitor KM activities via metrics		
	5. Conduct post-audit		
	6. Expand KM initiatives		
	7. Continue to learn and loop back through the phases		

Table 2.5: Details of the SMARTVision methodology

Source: modified from Rubenstein-Montano et al. (2001b)

More recently, Al-Ghassani et al. (2002) presented a framework developed within the CLEVER (Cross-sectoral Learning in the Virtual Enterprise) project at Loughborough University. The framework introduces a methodology that supports KM at both tactical and strategic levels in order to aid organizations, especially in the construction and manufacturing industries, in developing KM strategies. The methodology was encapsulated into a prototype software system. The framework addresses its objectives through four main stages illustrated in Figure 2.9. The first stage, "identify KM problems", aims to clarify the overall KM problem within a business context to deliver a refined KM problem and a distilled set of KM issues from the overall problem. The second stage, "identify current and required KM characteristics", aims to identify the current and required status of a range of knowledge dimensions to highlight the problem areas, which need more focus as to deliver a set of concern or specific KM components of the problem. The third stage, "identify critical knowledge migration paths", aims to identify a set of the most critical paths for each specific KM problem and an overall set of paths for the whole problem. The last stage, "select generic KM processes", aims to help in selecting the appropriate KM processes which, when tailored to a particular organization's need, will help implementing KM. Each stage consists of a main template, guidelines, and a glossary. Each of the CLEVER stages has aims and outcomes. The specific aims and outcomes are shown in Table 2.6. The CLEVER project is focused on automating the framework through encapsulation in a software system (Al-Ghassani et al., 2002).

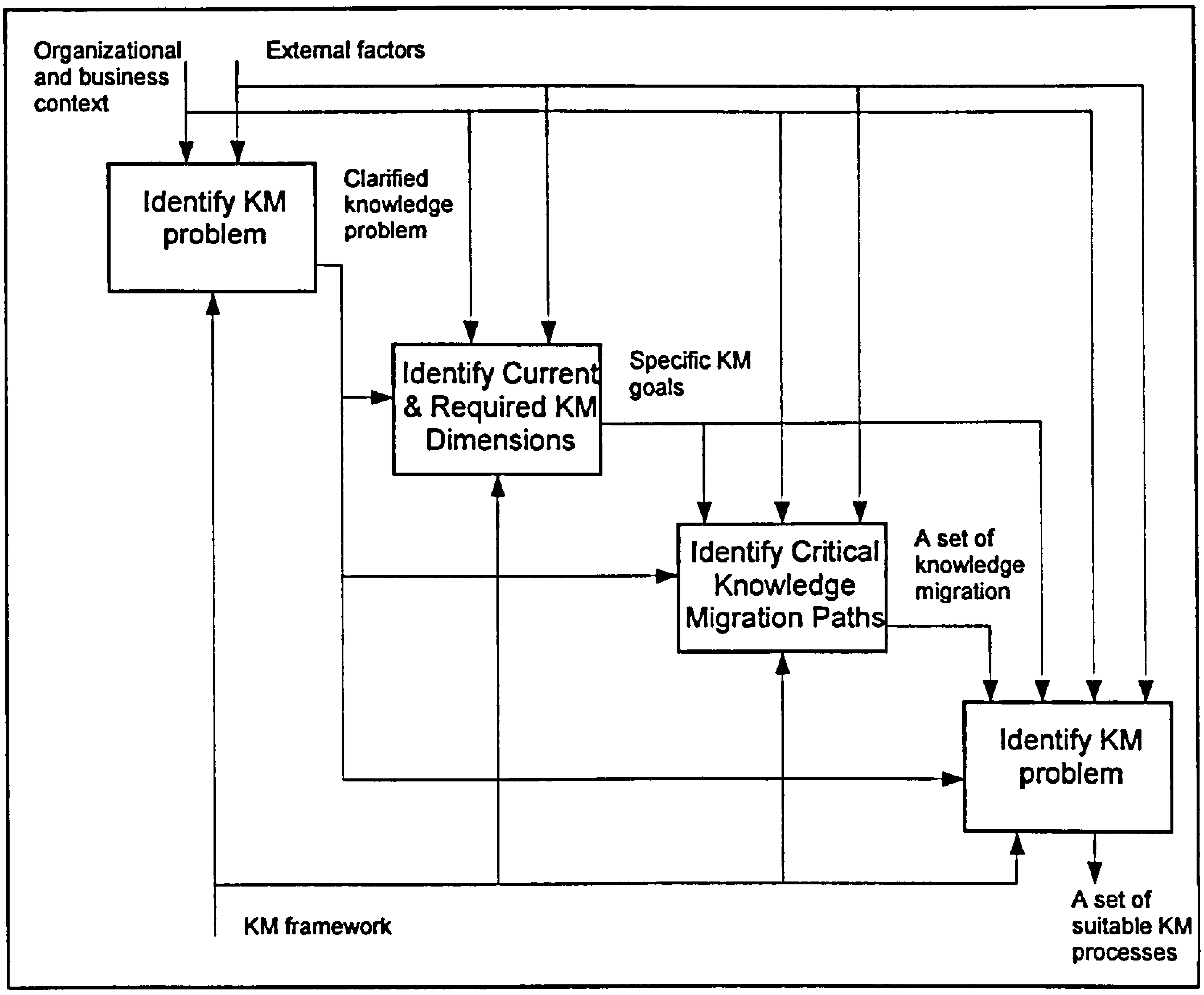


Figure 2.9: The CLEVER framework for implementing KM

Source: Al-Ghassani et al. (2002)

Stage	Aim	Outcomes
The Problem Definition Template	To define the overall KM problem within a business context	• Clarification of the KM problem • Distillation of a set of KM issues from the overall problem
Overview of 'To Be' KM Solution	To identify required status on a range of knowledge dimension and to highlight areas of future focus	• Set of concerns or specific KM components of the overall problem on which focus is required
Critical Migration Paths	To identify critical migration paths for each specific KM problem (or dimension of interest)	• Set of key migration paths for each specific KM problem • Overall set of migration paths for the whole KM problem
Appropriate KM Processes	To help in selecting the appropriate KM process to move along each migration path	• Set of appropriate KM process(es), which, when tailored to a particular organization's needs, will address the stated KM problem

Table 2.6: Specific aims and outcomes of CLEVER

Source: Al-Ghassani et al. (2002)

In addition to the KM methodologies presented, methodologies for specific or tangential parts of KM have also been discussed in the literature. For example, a number of organizations such as Skandia, NCI Research, and Merck have developed methodologies for measuring intellectual capital (Leibowitz and Buckman, 1998). Daudelin and Hall (1999) present a process for learning, and Myers and Swanborg (1998) have a method for packaging knowledge so it is "insightful, relevant, and useful". Furthermore, the Canadian Imperial Bank of Commerce has developed a methodology just for managing tacit knowledge (Saint-Onge, 1996), NASA and Stanford worked jointly to develop methods and tools aimed at capturing design knowledge (O'Leary, 1997), and Hayes-Roth et al. (1983) proposed a method for acquiring knowledge. The Delphi Group (2000) has a KM methodology, KM2, for conducting the knowledge audit part of KM, and it integrates both tacit and explicit knowledge.

There are also several broadly scoped endeavors that, while not methodologies, inform the development of new KM approaches. For example, the Theseus Institute has developed a taxonomy for KM which provides an overall picture of existing KM tools and approaches from which organizations can develop their KM initiatives (Despres and Chauvel, 1999). Furthermore, the Esprit IT Learning and Training in Industry (LTI) program of the European Commission has co-funded 16 projects that deal with the adoption of KM strategies and the need to develop a learning organization culture within an increasingly knowledge-based, European industrial infrastructure (Kalif, 2001). Some of the projects include: ENRICH (Enriching Representations of Work to Support Organizational Learning), ETOILE (Environment for Team, Organization and Individual Learning in Emergencies), KLEE&CO (Knowledge and Learning Environments for European and Creative Organizations), KNOW-WEB (Web in Support of Knowledge Management In-Company), and KNOWNET (Knowledge Management with Intranet Technologies).

Some of these projects are developing KM methodologies and strategies. In order to facilitate knowledge exchange between these projects, KALIF (run by Kenniscentrum CIBIT in The Netherlands and the European Consortium for the

Learning Organization) was created to optimize knowledge sharing and lessons learned between these projects (ELCO, 1999).

Despite the number of KM methodologies suggested in the literature, there is still no generally accepted methodology to guide organizations in implementing KM (Beckman, 1998; Levett and Guenov, 2002; Rubenstein-Montano et al., 2001b). Although, not necessarily all the proposed methodologies possess the shortcomings suggested by Rubenstein-Montano et al. (2001b). It is clear that there is a need for KM methodology that provides details and addresses all relevant aspects of KM.

2.13 Summary

This chapter introduced part of the literature reviewed during the course of this research. It first presented definitions, levels, and states of knowledge outlining the distinction between data, information and knowledge as well as the one between explicit and tacit knowledge and the interaction between them as described in the literature. It then introduced KM definitions which are arising from differently focused studies suggesting that KM is multidisciplinary. A consistent theme in all proposed definitions of KM is that it provides a framework that builds on past experiences and creates new mechanisms for exchanging and creating knowledge. The Chapter then presented the benefits of KM to organizations as described by academics and practitioners in the literature. This was followed by the literature concerned with KM in engineering organizations where the importance and benefits of KM to engineering organizations as well as the engineering knowledge that is critical to achieve business goals were described.

The Chapter then presented the various approaches and perspectives to KM described in the literature. These varied from technological approaches through cultural and human-oriented approaches to the more recently propagated "socio-technical" approach. This was then followed by presenting the various KM life-cycles suggested in the literature which provide a distinction of the several phases of the KM life-cycle and the requirements for the support of KM activity in each phase. Finally, the Chapter ends by presenting a description of the KM frameworks and methodologies proposed in the literature either to guide the implementation of KM or to aid in specific or tangential parts of KM. Most of the available frameworks and methodologies have been criticized in the literature for suffering shortcomings. Hence, there is neither a universally accepted framework nor methodology to guide the implementation of KM in organizations

CHAPTER 3

KNOWLEDGE MANAGEMENT SUCCESS FACTORS AND KEY ISSUES

3.1 Introduction

In recent years, knowledge management has become a critical subject of discussion in the business literature. Both business and academic communities believe that by leveraging knowledge, an organization can sustain its long-term competitive advantage (Bhatt, 2001). As reveled in Chapter 2, researchers and academics have taken different perspectives on KM, ranging from technological solutions to communities of practice and the use of best practices. For example, a majority of business managers believe in the power of information and communication technologies in facilitating KM, as they argue that IT can provide an edge in harvesting knowledge from piles of old buried data repositories. Others, however, contend that knowledge resides in human minds and, therefore, employee training and motivation are the key factors to KM. More recent research suggest that successful implementation of KM evolves around integrating all the critical factors which are important for the success of KM in organizations (Bollinger and Smith, 2001; Bhatt, 2001; Rus and Lindvall, 2002; Koch, 2003; chourides et al., 2003).

This chapter explores critical factors and key issues that affect the successful implementation of KM, in theory and practice, as described in the literature. The Chapter presents the various KM tools and enablers. It then introduces KM performance measurement. The Chapter then investigates the link between

KM and organizational learning, learning, and e-learning. This includes a presentation of four instructional design theories. The Chapter ends by investigating the practice of implementing KM in engineering organizations by presenting three published case studies.

3.2 KM Tools and Enablers

There is no consensus on which tools and activities characterize KM. But across the contributors one can point at a set of generic areas with certain common activities. These areas are: corporate and strategic management; information technology; human resources; culture; organization structure; and office design. Follows in this section is a discussion on these areas and their impact on KM as described in the literature.

3.2.1 Corporate and Strategic Management

Themes relating to strategy, competitiveness, and planning can be identified in the KM literature. Curren et al. (1992) propose that KM is a key factor that 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, and Meso et al. (2002) state that knowledge has strategic significance to the sustainable competitive position of a firm. Additionally, Quintas et al. (1997) state that KM is a vital catalyst for innovation. Skyrme and Amindon (1997) identify what they believe to be the success factors which organizations are able to achieve through successful KM programs:

- Competitive advantage;
- Customer focus;
- Improve employee relation and development;
- Innovation; and
- Lower cost.

In a recent paper Shankar et al. (2003) proposed for the KM implementation, the use of the "G-spot" methodology to convert organizational goals into implemental tactics. The term G-spot stands for "Goals – Strategies – Plans – Objectives – Tactics" (Figure 2.8) (Greenberg, 2001). Thus, strategic planning for KM should begin with the definition of a set of end goals that KM aims to achieve. These could be, for example:

- sustained preservation and leverage of knowledge to develop an intelligent organization;
- enhanced agility of business processes to remain responsive to market conditions; and
- greater market leadership.

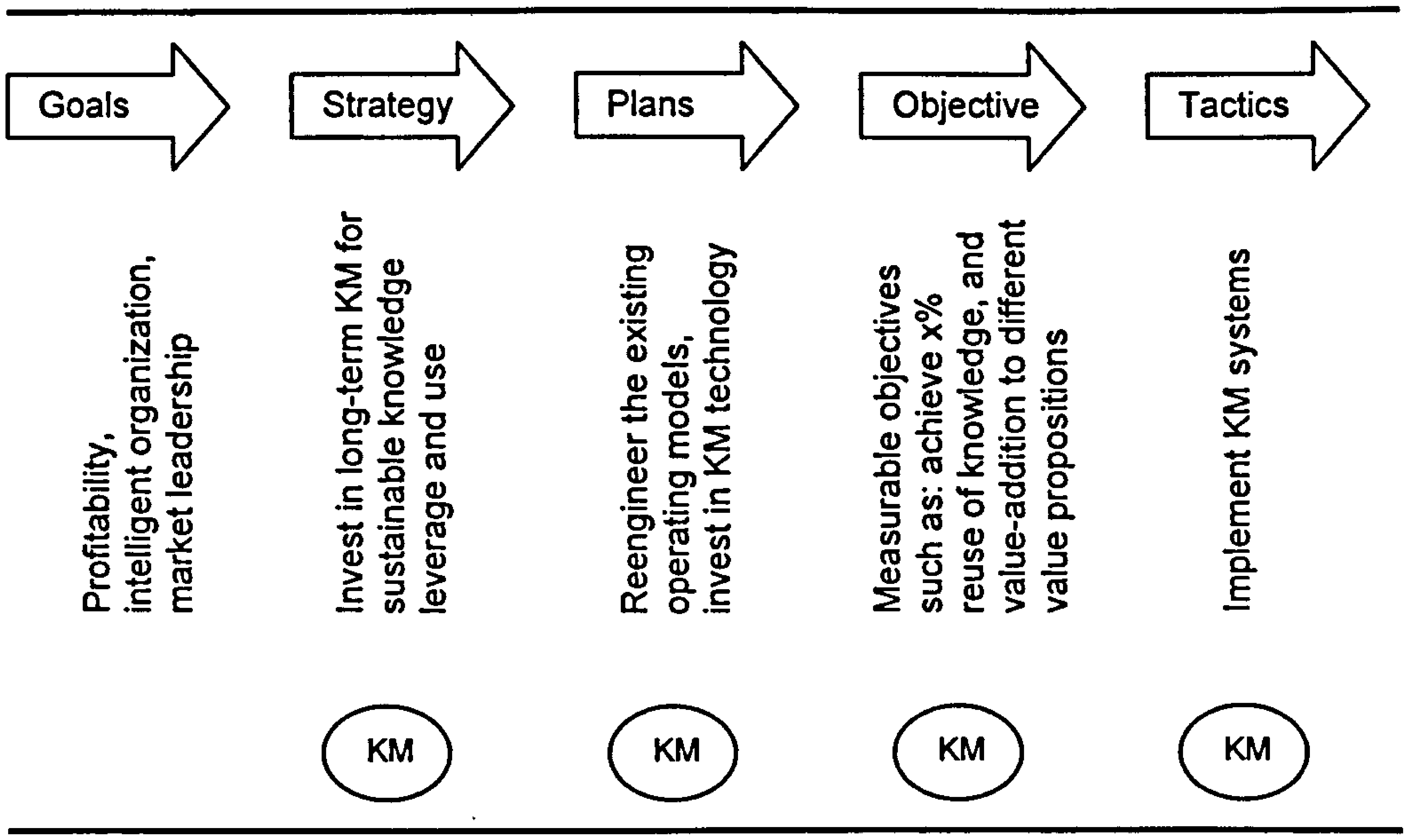


Figure 3.1: Knowledge Management G-spot

Source: Shanka et al. (2003)

The KM strategy to achieve these goals should strive to identify and "clearly" demarcate the organizational knowledge across various scopes of organizational working. These scopes, or the value propositions, are needed to identify the leveraging points of various forms of knowledge, which are contained in these scopes and can lead to added value in products and services. KM plans should identify the operating models that can leverage the knowledge implied by these value propositions. The operating models can be reengineered to leverage the knowledge aspects in each of the value propositions. According to Shankar et al. (2003), for an engineering firm organizational knowledge can be demarcated into the following six value propositions:

- *Product or service leadership*

Product or service leadership involves delivering the best products and services that push performance boundaries. Product information needs to be provided to production processes to enable shorter lead times (Obank et al., 1995; Ottum and Moore, 1997).

- *Operational excellence*

Operational excellence leads to delivering solid products and services at the best price and with the least inconvenience. Database systems should be designed and integrated to allow information exchange in complex situations to avoid ambiguity about a product definition (Wilson, 1994).

- *Supplier relationship*

Better supplier relationship helps organizations to strengthen the supply chain by making it more responsive, agile, lean, and customer focused. Companies should learn from their past and institutionalize their knowledge rather than take and ad hoc approach to alliances (Rothenberg, 2000; Twigg, 2002; Parise and Sasson, 2002).

- *Customer intimacy*

Customer intimacy involves cultivating relationships to gain customer knowledge and then deliver what specific stakeholders want (Omar et al., 1999).

- *Employee capability*

Employee capability involves leveraging human intellectual capital in service, design, and delivery (Sveiby, 1992, 1997).

- *Concern for the environment*

The increasing pressure on engineering firms to develop environment-friendly products adds an additional value propositions to the firm.

The choice of which KM strategy to pursue is typically based on other strategic thrusts and the value discipline that the enterprise pursues, challenges it faces, and opportunities it wishes to act upon (Wiig, 1997a). It is essential to be clear about what the benefits would be for the organization and what impact is expected on its strategies before a significant investment is made on implementing KM (Soliman and Sponner, 2000).

3.2.2 Information Technology

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. Ruggles (1997) and Lueg (2001) argue that knowledge building is dependant upon IT. This position supports Huffman et al. (1990) who states that organizations must develop the capability for organizing and disseminating data in vital key business areas, or face the inevitable consequences of missed opportunity and a decline in competitiveness. Frappaolo (1998) stresses that organizations need to capitalize on the staring advances in systems and communication technologies.

Wiig (1999a) presents that the rate of developments in IT capability will continue to escalate and will increase to prospects of organizations that are able to grasp the opportunities this presents.

Information technology (IT) was initially considered the central tool of KM (Ruggles, 1998) and the KM literature still is dominated by this position (Robertson et al., 2001a). The literature suggests a maximum of one-third of a KM strategy should be devoted to technology with the remaining two-thirds being people-related (Davenport and Prusak, 2000; Stewart, 2000). Recent survey evidence from KPMG (2000) suggests that in practice many KM programs are being led from an IT perspective. Chourides et al. (2003) suggest that if strategy and people are the principle drivers for KM then it can be argued that IT is a fundamental enabler.

Information systems include technologies such as intranets, group-ware, list servers, knowledge repositories, database management, data-warehousing, data mining and knowledge action networks (Blumentritt and Johnston, 1999; Ruggles, 1998). In Table 2.4, Bollinger and Smith (2001) present various information technology tools used for KM; however, noting that these tools do not necessarily fit all organizations.

Tool Category	Tool
Hardware technologies	Investment in information technology (IT) Networks Intranet
Software and database tools	Knowledge-based systems (KBS) Collaborative hypermedia for documentation of discussion Learned lessons databases Data warehouses Databases for classification, codification and categorization of information Storage of e-mail threads to create a repository of best practices Corporate memory databases also known as knowledge archives Corporate yellow pages such as the Deere & Co. "People who know" project (Stewart, 1997) Employees home pages on an intranet
Collaboration tools	Electronic meeting systems Video-conferencing GroupWare Electronic bulletin boards
Intelligent tools	Decision support tools using neural networks Virtual reality Genetic algorithms Intelligent agents Internet search engines Knowledge mapping

Table 3.1: Computer information technology tools for knowledge management

Source: Bollinger and Smith (2001)

3.2.2.1 IT Applications

The technology-centered organizational knowledge management systems in use today are employing one or a combination of ten key technologies: groupware, messaging, Web browsers, document management, search and retrieval, data mining, visualization, push technology, group decision support, and intelligent agents (Hibbard, 1997; Chaffey, 1998; Messo and Smith, 2000).

Document Management Systems allow workers to find existing documents relevant to the task at hand. Essentially, these are multisource search and information retrieval systems that tie into an organization's intranet (and may extend to the public Internet).

Capability Management Systems allow an organization to "know who knows what" (Stader and Macintosh 1999). Essentially, these are databases of suitably structured CVs or resumes; as such, they are implementable with off-the-shelf data base software. The goal is to put people together by matching one person's need for expertise with another person's listed skills. Organizations like Chevron and Hughes Space & Communication, undertook knowledge mapping and produced guides to in-house experts (a "yellow pages" directory that directs the user to the people in the firm who know about particular topics of interest) (Jarrar, 2002).

Lessons-learned Knowledge Base Systems let workers tap into past experiences, by storing that experience as structured cases. These systems allow sophisticated queries, typically supporting "fuzzy" retrieval of "similar" cases. Although simple systems can use just conventional database software, full functionality requires special-purpose, case-based reasoning for knowledge-based system software.

Groupware software packages are advanced decision support systems developed to enhance collaborative group work, between geographically dispersed professionals. Examples of groupware software products being marketed as KM systems are Lotus Notes, Network Delivery Knowledge, and Fulcrum Knowledge Network. Lotus Notes is the most widely used.

Lotus Notes is a document database that enables the communication between colleagues, the collaboration among teams, and the coordination of strategic business processes within an organization. It can contain both structured and unstructured content, thereby surpassing limitations that relational databases impose on an organization. Notes use replication technology to allow users in diverse locations to access the same knowledge. It supports e-mail, pull and push technologies, and work flow automation. The software also provides up to four levels of security: authentication, access control, field-level privacy, and digital signatures (IBM, 1998; Kurchak Associates, 1998; Fulcrum, 1998; Hibbard, 1997). Chevron team learned that it could save $20 million a year by adopting the best practices in the field with its implementation of Lotus-Notes and making a central group to capture and distribute information throughout the organization (APQAC, 1999).

BP reported saving in the region of $300,000 in one day through utilizing video-conferencing. In 1995, work on a BP mobile drilling ship in the North Sea came to a halt. Some equipment had developed a fault. Normally, either a drilling equipment expert would have to be flown out by helicopter from the main land or the ship brought back to port, both options are time consuming and expensive. Instead, the ship's drilling engineers heaved the faulty part in front of a small video camera, which was connected to one of BP's Virtual Teamwork stations. They called up the office of a drilling equipment expert in Aberdeen via a satellite link. He was able to use video technology to look at the faulty piece of equipment, diagnose the problem, and explain to the engineers on the ship how to carryout the repairs. This resulted in carrying out the repairs in one day rather than four days leading to the saved money (BP, 1998).

Discussion Forum Systems promote knowledge dissemination within communities of practice. Workers subscribe to forums relevant to their interests, exchanging questions and answers, lessons-learned, announcements, and industry gossip. Such systems are easily implementable with both freely available Web software and commercial products.

Web-based technologies entail employing a Web browser to access knowledge resources on the Internet or on intranets that link geographically dispersed professionals. These technologies are popular with most organizations for several reasons. First, they allow for the in-house development of KM systems, hence building some proprietary characteristics into the system. Second, they allow for the development of a naturally expanding, flexible, and easy to use KM system. This encourages employees to take advantage of the system. Third, because it is very simple to develop Web pages, the employees themselves do most of the development of the KM systems. This not only minimizes the cost of developing KM systems, it also enhances employee participation and commitment to the system. Finally, Web technologies adapt the natural way of communication between individuals. They surpass organizational hierarchies, formal communication policies, physical barriers, and social groupings to make available to everyone knowledge that is articulated by any other professional (Hibbard, 1997; IBM, 1998; Musciano and Kennedy, 1996; Meso and Smith, 2000).

The Ford Motor Company is a clear example of a firm that is re-inventing its corporate architecture by investing heavily in technologies for KM systems. It is using KM systems to redefine the auto manufacturing industry, gain competitive stronghold in emergent electronic markets, and get closer to its customers. The firm has established the *autoexchange* mart – an information technology-intensive KM and electronic commerce system intended to shift the car manufacturing model from the conventional "push" business model to the emergent "pull" model. In the "pull" model, the consumer determines the precise configuration of the car before it is manufactured. Thus, consumers get highly customized products while the firm saves substantial amounts of capital that would otherwise be tied up in large inventories of finished products. Further, auto designers, financiers, marketers, and production engineers are able to gain insightful knowledge about the customers, customer needs, trends in customer tastes and the evolution to consumer behavior that allows them to remain in front of the innovation curve (Kerwin, 2000).

3.2.2.2 Classification of Applications

In Figure 2.9, Hoffman and Patton (1996) present various knowledge techniques, tools, and technologies, loosely characterized by their complexity/sophistication and their intensity along the human/machine continuum. They suggest that the goal of KM is to make the use of these techniques, tools, and technologies less human-intensive, and to develop products and services that incorporate complexity and sophistication, which is appropriate for specific knowledge work and is hidden so far as possible from users.

Table 2.5 presents Syed (1998) view on how well some of the computer-based applications and tools can support various KM activities (gathering, organizing, refining/combining/sense-making, and communicating/disseminating knowledge).

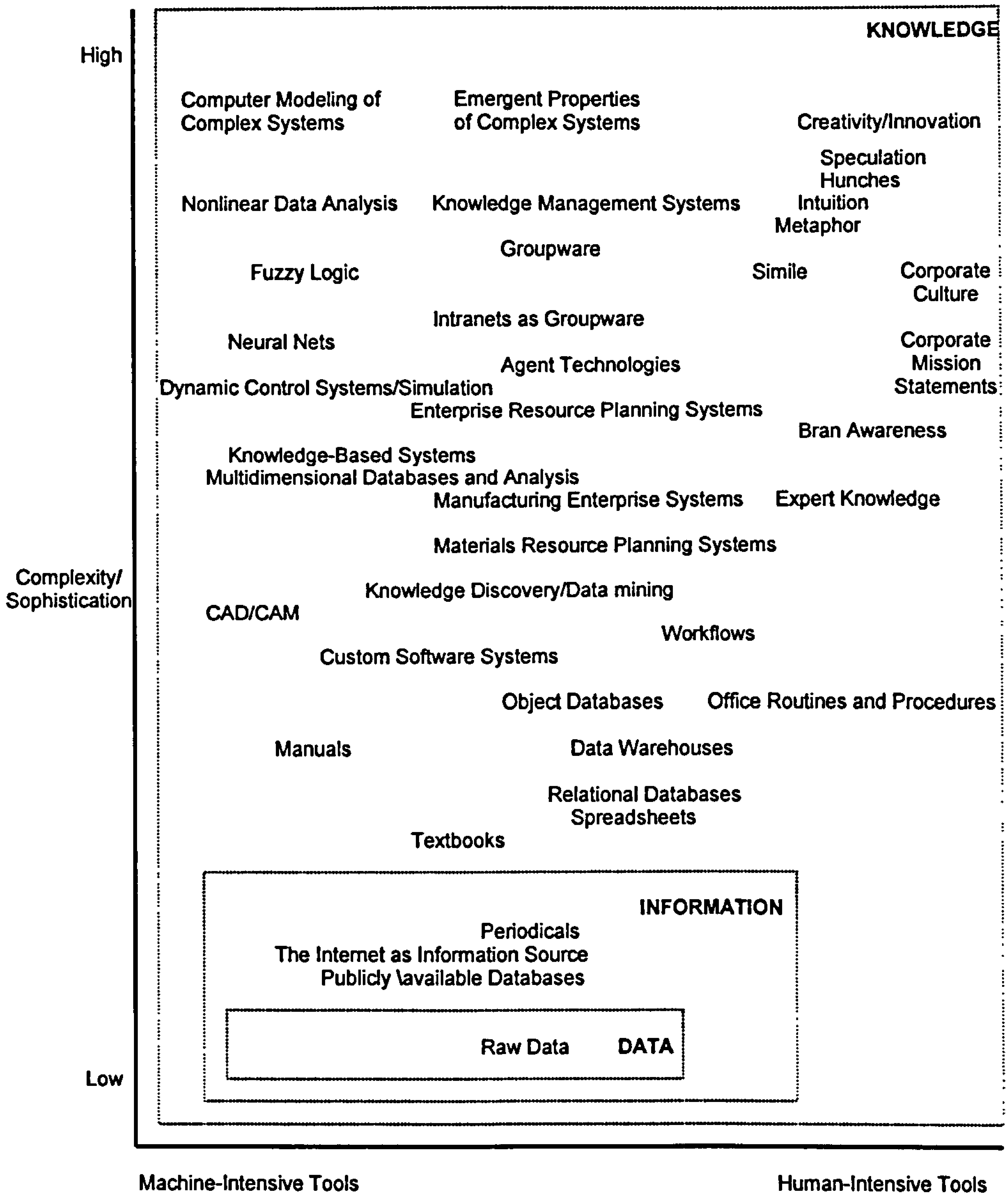


Figure 3.2: Knowledge techniques, tools, and technologies

Source: Hoffmann and Patton (1996)

Applications or tools	Gathering	Organizing	Refining/combining/ sense making	Communicating/ disseminating
E-mail				√√√√
Groupware, e.g. Collabra, Lotus Notes, MS Exchange		√	√ - √√√	√√√√
Knowledge Management Tools, e.g. Questmap, Semiomap	√√	√√	√ - √√√√	√
Knowledge Management Systems, e.g. Backweb, ChannelManger, Intraspect, KnowledgeX, Winicite	√√	√√	√ - √√√	√√ - √√√
Document Management Systems	√√	√√√		√√
Enterprise Resource Planning Systems	√√	√√	√√	√√
Data Warehouses	√√√	√√√	√√√	√√
Knowledge-based Tools, e.g. Expert Systems, Case-Based Reasoning	√√	√√√	√√√	√
Analytical Tools		√	√ - √√√√	√
Notes: Blank = nil; √ = poor; √√ = Below average; √√√ = Average; √√√√ = Above average; √√√√√ = Excellent. A hyphenated entry denotes a range implying that the contribution depends on the tacit knowledge of users				

Table 3.2: Characteristics of interactions and key requirements for facilitations

Source: Syed (1998)

3.2.3 Human Resources

Although some analysts believe that information technology is a key driver for knowledge management, others disagree with this view and believe that KM is about people not technology, and to start form a "computer" perspective would ensure the failure of KM. For instance, a recent Victorian government report made the point that technology is the "pipeline and storage system for knowledge exchange" but of itself is not knowledge management (Victorian Law

Reform Committee, 1999). In addition, Eginton (1998) and Sbarcea (1998) reported that some firms have invested heavily in technology to underpin their KM strategy, but have still planned the technology infrastructure to support and deliver the required knowledge capability, rather than being driven by the imperatives of information technology.

Prusak (1999) argues that successful KM will revolve around strong leadership commitment. Quinn (1992) believes that the economic and producing power of a modern corporation lies in its intellectual capital and service capabilities instead of its hard assets. Quinn also points out that the value of most products and services now depends on "knowledge-based intangibles" such as technical know-how, product design marketing presentation, understanding customers, personal creativity and innovation.

Employees are the key source of the intellectual capital acquired and managed by an organization's KM system. Further, the employees propel the organizational learning process. They articulate personal tacit knowledge into the explicit knowledge resident in the organization's databases, systems, and operating technologies. In so doing, they make personal knowledge available for corporate use. Further, they tap into the corporate pool of explicit knowledge, internalizing it into personal tacit knowledge. This new knowledge is then articulated back into the corporate databases, systems, and operating technologies, further expanding the corporation's intellectual assets (Quinn et al., 1996, Nonaka, 1991; Davenport et al., 1998; Sviokla, 1996; Michalisn et al., 1997).

Employees' productivity depends on a complex combination of factors: motivation, reward, skill levels, experience, health and even emotional factors. Human resources relate to developing competency profiles, designing recruitment and training, and to designing reward systems (Davenport and Prusak, 1998; Sverlinger, 2000).

Soliman and Spooner (2000) suggest that human resources departments could drive the KM process through assistance in avoiding:

- poor recruitment and selection;
- confused or uneven organizational structure;
- inappropriate management philosophy;
- lack of control;
- poor training;
- low motivation and individual stress;
- unfair rewards and personal stagnation; and
- lack of succession planning and development.

According to Soliman et al. (1999), additional roles for the human resources departments in driving the KM interventions could be linked to assisting staff who are consistently experiencing difficulties such as:

- lack of progress towards goals;
- inappropriate leadership;
- failure to make sound decisions;
- interpersonal hostility;
- role confusion or alienation; and

- high turnover, absenteeism.

Clarke and Staunton (1989) provided a model of the knowledge management process that could be useful for mapping human resources knowledge. Their modified model, shown in Figure 2.10, provides a guide to four key concepts that could be mapped through the human resources management function. The four concepts are: construction, embodiment, dissemination, and use of knowledge. Figure 2.10 illustrates the interaction between the human resources management function and each of the four knowledge concepts.

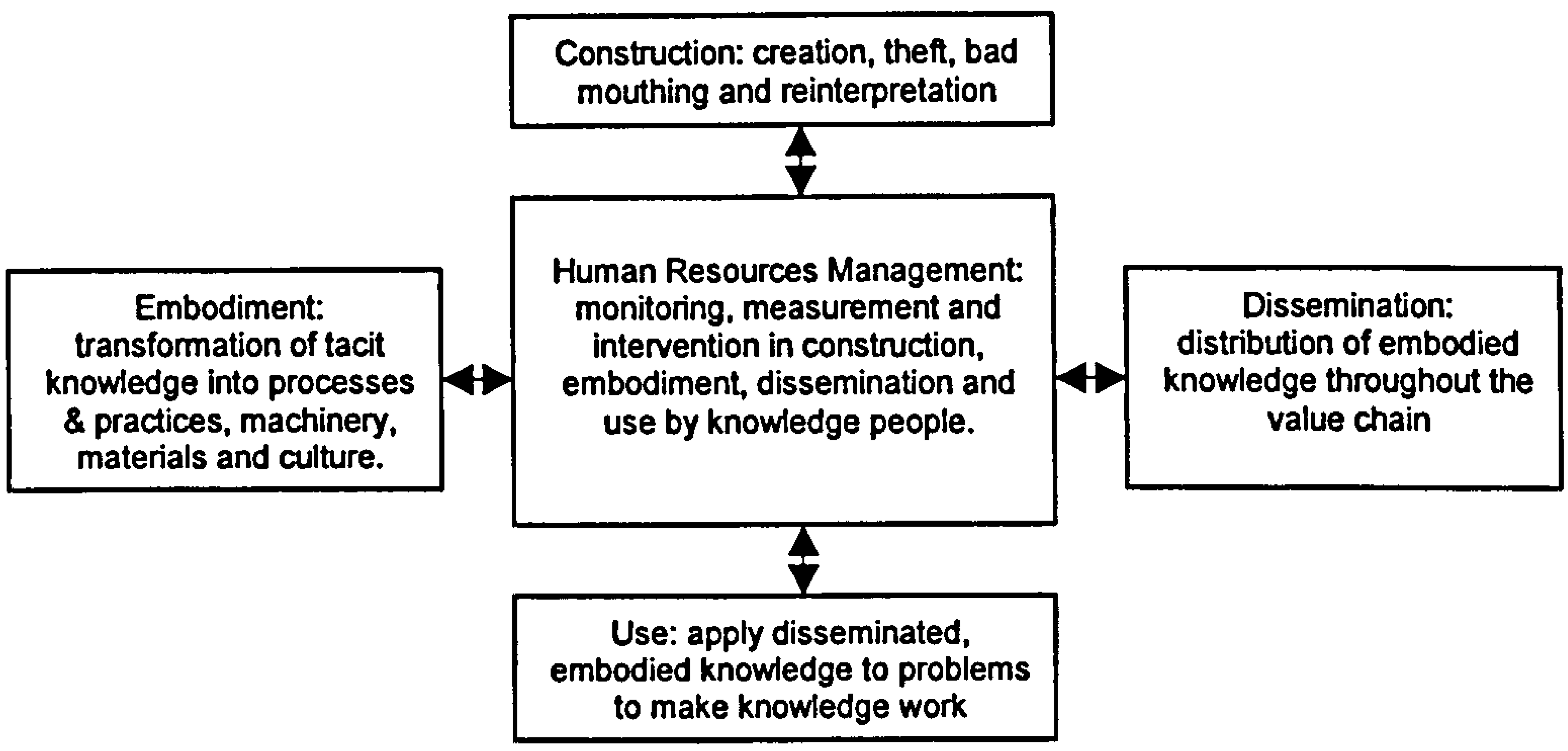


Figure 3.3: Model of human resources management role in constructing, disseminating, using and embedding employees' knowledge

Source: Clarke and Staunton (1989)

Aligned with this, several authors point to the need for emphasis on training and educational programs (Soliman and Spooner, 2000; Goh, 2002; Koch, 2002; Szymczak and Walker, 2003). Goh (2002) suggests that effective knowledge transfer is dependent upon high skills and competence. Boeing is an example of a company that emphasizes the development of its employees. The company supports the investment in people through reimbursement of tuition and short course fees as well as learning materials with the aim of developing well trained and educated employees. In 2001, for example, Boeing financially supported 1200 of its employees to earn their degrees from accredited institutions (Szymczak and Walker, 2003).

Leading consulting companies have continued to maintain a lead in investing in their employees as a core element of their strategic competitive advantage. Strategy consulting firms such as Bain, Boston consulting Group and McKinsey have developed elaborate information-technology enabled KM systems that accentuate dialogue between individuals rather than knowledge objects in databases. They make effective use of communities of practice, brainstorming sessions, one-to-one conservations, apprenticeship, and group-work technologies to keep their employees actively engaged in perpetual organizational learning (Hansen et al., 1999). Microsoft is another example of a firm that invested in its people. It has, over the past decade, quietly assembled over 245 of the brightest researchers from around the globe and provided them with the resources to conduct leading-edge research and development of future software products (Stross, 1997).

3.2.4 Culture

Although new technology makes sharing knowledge easier than ever, organizational culture might not promote it. Some cultures even overly encourage individualism and ban cooperative work. Lack of "knowledge culture" has been cited as the number one obstacle to successful knowledge management (Agresti, 2000).

Culture refers to the shared beliefs, norms, ethics, and practices within an organization. A knowledge friendly culture is one in which the employees highly value learning and exhibit a positive orientation to knowledge. It is one in which experience, expertise and rapid innovation are held to be more important than hierarchy. Such a culture deeply embraces knowledge and the opportunities that come with learning. A knowledge unfriendly culture, on the other hand, is one that neither values nor rewards knowledge (Meso and Smith, 2000).

There are very strong arguments suggesting that successful KM will revolve around creating the right culture and environment (Hibbard and Carrilo, 1998); creating the right organization conditions (Bhatt, 2000). Bhatt (2001) argues that KM refers to changing corporate culture and business procedures to make sharing of information possible. Scarbrough et al. (1999) state that," organizations will need to examine social and cultural values, motivation and rewards, trust and willingness to share, individual and team behaviors". Davenport (1995) has long argued that successful management of the human factors will be the key to achieving dramatic gains in knowledge development, and vital to this will be the creation of a supportive environment that will facilitate trust and sharing.

Nonaka and Konno (1998) refer to this as setting the right context for KM to develop. They explain the ancient principles of "Ba" which can be thought of as a shared space, or common place (virtual, physical, and mental) for developing relationships. Within "Ba" both tacit and explicit knowledge can be freely created, developed, and shared. Beliefs and values are re-enforced, and a common language is formed among participants. When "Ba" is mature, knowledge becomes open and freely transferable.

Pemberton and Stonehouse (2000) suggest that the culture existing within a learning organization places a great emphasis on learning and knowledge. This is facilitated by creating an atmosphere of trust within which individuals feel empowered to experiment with new approaches to business, which often resulting in the development of new core competencies.

According to Pemberton and Stonehouse (2000) a learning culture embodies most of the following:

- A clear organizational vision;
- Leaders who are "designers, teachers and stewards" (Senge, 1992);
- A desire for continuous improvement;
- Attaches a high value to knowledge;
- Encourages questioning and experimenting through empowerment of individuals;
- Creativity, risk taking and tolerance of mistakes;
- Builds trust to encourage sharing of knowledge within the organization and with selected partners;
- Emphasizes frequent contact and good communication;
- Encourages socialization and the development of a concept of community;

- Experiential learning of tacit knowledge; and
- External vision to learn from the environment in which the business operates.

These views are amplified by the work of Mintzberg et al. who list celebration of success, absence of complacency, tolerance of mistakes, belief inhuman potential, recognition of tacit knowledge, openness, trust, and being outward looking as vital features of a successful organization (Mintzberg et al., 1998). Harvey and Denton (1999) lend further support to the importance of culture quoting the chief executive of Mayflower as saying:" to compete globally in our business you need to be rich in technology, and to be rich in technology you need knowledge and a culture which prizes knowledge" (Harvey and Denton, 1999).

Southwest Airlines is an example of a firm that has developed a world-acclaimed positive corporate culture that has contributed significantly to its corporate success. In the words of Southwest Airline's founder, Herb Keller, "Southwest's competitors can do everything it does – fly one type of aircraft, serve no meals, transfer no luggage, give no assigned seats, fly mostly short hauls, and always charge the lowest fares – but they cannot copy its culture". Indeed, Southwest Airlines has ranked among the top ten corporations best to work for in the USA over the past few years (Colvin, 1997). It has also remained a dominant player in the very competitive airline industry. Its culture allows its employees to acquire knowledge quickly both from its clients and from fellow employees. It allows employees to use the knowledge instantaneously as they make decisions, and encourage employees to disseminate their knowledge to colleagues. Its culture rewards learning and development of others. As such Southwest's employees are able to provide high levels of customer satisfaction, thus generating the repeat business that keeps it competitive (Colvin, 1997).

Organizations must not only encourage but also reward employees who share their knowledge, search for knowledge, and use other's knowledge. To encourage sharing and reusing knowledge, Xerox recommends creating a "hall of fame" for those people whose contributions have solved real business problems. Xerox rewards staff that regularly share useful information and identifies them as key contributors to the program (Rus and Lindvall, 2002). Bruce Karney, evangelist of a Hewlett-Packard KM initiative, gave out free Lotus Notes licenses and free airline miles to prospective users (Davenport, 2002). Infosys rewards employee contribution and use of knowledge with "knowledge currency units" which they can convert into cash. The online expertise provider ExpertExchange rewards experts with points for answering questions and recognizes those with the most points on the front page of their Web site (Rus and Lindvall, 2002).

3.2.5 Organization Structure

The structure of an organization is what follows from a division of the work, the tasks and the responsibilities, both horizontally and vertically. It is the total of the various ways in which the work is divided into separate tasks and the way in which these tasks are then coordinated (Beijerse, 2000).

There is considerable evidence that traditional hierarchical and bureaucratic organizational structures, heavily reliant on rules and procedures, hinder the development and transfer of knowledge by stiffing initiatives, risk taking and innovation, and with a tendency to reward length of service rather than inventiveness. Furthermore, the different levels and rigid horizontal and vertical divisions in a hierarchical structure hamper the building, diffusion, co-ordination and control of knowledge. Communication of knowledge is also increasingly distorted by passage through levels in a hierarchy and need to cross functional boundaries (Nonaka and Takeuchi, 1995; Beijerse, 2000; Bhatt, 2000; Meso and Smith, 2000; Pemberton and Stonehouse, 2000).

There is a dominant agreement that the solution to many of these problems comes in the form of a flatter organizational structure with reduced cross-functional boundaries. Yet, because the development of new knowledge is dependent on the interchange of ideas between specialists in the same field, there is also the need to establish various functional groupings. Conversely, organizational knowledge must be holistic to ensure that specialist knowledge from related areas is fully integrated.

A matrix structure is one of the suggested ways to accommodate this, which, while blurring lines of responsibility, assists the promotion of a holistic view of knowledge. Alternatively, cross-functional project teams or task groups can be established within a more conventional organization structure. The use of cross-functional teams and project groups has been viewed as a critical tool in creating and disseminating knowledge by both researchers and practitioners

(Nonaka and Takeuchi, 1995; Beijerse, 2000; Bhatt, 2000; Meso and Smith, 2000; Pemberton and Stonehouse, 2000).

In essence, this is recognized by Hopper (1990) who discusses American Airlines approach to knowledge management, centering on the structure and culture of the organization, with the empowerment of individuals, at all levels, to participate in the knowledge-building process (Hopper, 1990). However, while specialist departments continue to exist and are charged with the responsibility for the generation of knowledge, changing internal structures and a culture of integration now pervade the organization (Pemberton et al., 2000).

General Electric is another example of a firm that has developed a "social architecture" that enables it to keep ahead of its competitors in almost all the markets it serves. The organizational infrastructure at GE has facilitated the maturing of this social architecture by allowing a seamless flow of knowledge across the employees regardless of their position, authority, or geographical postings. Hence, suggestions from anyone in the firm are quickly assessed through a specific process called "Work out" (Layne, 2000).

Quinn (1992) suggests that network organizational structures are perhaps the most appropriate for supporting a learning culture, having fewer hierarchical features and existing in a variety of forms. While there is no single structure that uniquely supports learning, empowerment of the individual together with the flat network structures, which foster cross-functional communication and where functional barriers are low, appear to facilitate KM more effectively. Network structures also permit crossover of organizational boundaries and may often include collaborating businesses. Such partnerships allow the sharing of organizational knowledge and, at the same time, assist in building new knowledge.

Zellner and Fornahl (2000) proposed formal cooperation among the firm and other external actors like other firms or research institutes as a main source of acquiring knowledge. Provided that the formal corporation is deemed necessary by the parties involved as that depends on a whole range of factors, not least those related to knowledge content traded.

Parallel to this there is a focus on the role of communities of practice (CoP). CoP are semi-informal groups of people who share their ideas and expertise, similar to professional organizations (Manville and Foote, 1996; Hibbard and Carrillo, 1998; Stewart, 1997). These groups encourage the development of a learning organization. The important knowledge is in the greater group and how it behaves (Dove, 1998). By storytelling and collaboration through chatting, participants can tap into each other's knowledge, thus transcending the organization's documented knowledge (Brown and Duguid, 2000). Communities of practice are usually drawn to each other by social and professional interests; they are not mandated to meet and discuss issues (Stewart, 1996). The community of practice concept has been adopted by a number of organizations. CoP platform is currently being prototyped for the purpose of the Delft Cluster project. Delft Cluster is a program partly financed by the Dutch government. An important part of this program is setting up modern ways of KM for researchers and practitioners (Price and Mynett 2000).

3.2.6 Office Design

Researchers including Koch (2003) suggested that the organization's office design can enhance the transfer of knowledge between employees. Design relates to a shift from traditional open office landscape and cells, where individuals either work in parallel on tasks assigned to them or in singular offices. The traditional form was an underpinning of a hierarchy, where managers and senior expert employees have their own office, whereas clerks, junior employees and others work in open spaces. In the new office design concept, direct support of different knowledge activities is sought (Lambot, 1998; Holtman et al., 2001). The office is supposed to support group interaction, intensive individual knowledge work (cells) and networks.

3.3 KM Performance Measurement

The issue of how to measure the success of a knowledge management approach is one which is still being explored by organizations, researchers, and management consultants. Most of the solutions offered are geared towards, for example, profit-making commercial firms; measuring intellectual capital and the intangible assets on a company's balance sheet (Edvinsonn and Malone, 1997; Sveiby, 1997).

Many pieces of research have taken place in the performance measurement (PM) domain (Neely et al., 1997; Harbour, 1997; Crawford and Cox, 1990). A PM system can be defined from three points of view (Shane, 1998):

(1) It is a philosophy of continuous learning, using the performance measures to make adjustments to the course of an organization in order to achieve the vision of the company.

(2) It is a continuous and ongoing process that begins with the setting of objectives and the development of the vision and mission.

(3) It is a structure in which strategic, tactical, and operational actions are linked to processes to provide the information required to improve the program or service on a systematic basis.

PM systems consist of a number of measures, which can be categorized in different ways. One of the most referenced is Kaplan and Norton's Balanced Scoreboard (BSC) (Kaplan and Norton, 1996). The BSC measurement model integrates the financial measures that have been used previously as the only performance measurement factor, with other types of measures to form a four-dimension scoreboard. The other three dimensions of the BSC (customer, internal business process, and learning and growth) complement the financial measures. The financial dimension includes measures of past performance, while the other three dimensions include measures of the drivers for future performance.

The BSC realizes the importance of the intangible assets opposite to the traditional financial perspective. It also proposes how PM systems should be linked to the business objectives and addresses two kinds of measures: first, lag indicators or core outcomes in the strategic level; and the second, lead indicators or performance drivers in the operational level. Del-Rey-Chamorro et al. (2003) suggests that although no methodology to develop performance measures is proposed and the issue of how to derive lead indicators from lag indicators is not resolved, the BSC model fits the measurement of such an intangible asset as knowledge.

Some specific work has been done in the particular domain of PM related to KM. Bohn (1994) in his article "Measuring and managing technological knowledge", proposes a framework for levels of technological knowledge. This framework can be used to more precisely map, evaluate, and compare levels of knowledge. Moore (1999) developed a set of matrices for measuring and forecasting knowledge work. Moore described the thinking involved in developing software as knowledge work. His set of measures was oriented to software companies, evaluating knowledge work with respect to software characteristics. On the other hand, a paper related to a project called Knowme on the quality of current KM has been published (Hendriks et al., 1999). They have developed a framework in which companies can measure their current situation with respect to intellectual capacity and related management structure, in other words, measure how good their KM is.

Chandler (1999) proposes six-step framework to align macro KM (where "how the business will achieve the KM targets" is determined at this level) to micro KM (what to target in KM activities according to the company's mission statement and other strategies). The purpose of this framework is to allow organizations to determine what factors at the operational level should be measured to fulfill the strategic objectives of the business. Although these pieces of work address some issues to measure the level of knowledge within organization, their results do not provide any indication about how effective KM solutions are. Roy et al. (2000) proposed a framework in which "how to develop performance indicators for KM" solutions are presented. In a more recent work, Del-Rey-Chamorro et al. (2003) presented a framework of Key Performance Indicators (KPI) at the strategic and operational levels and suggested a link between the two.

Performance measurement systems have been commonly accepted as a manner of monitoring business performances and cover most of the domains of management. In order for organizations to measure their KM performance, there is a need to link the contribution of KM activities to the business objectives through clear KPI's.

3.4 KM and Organizational Learning

3.4.1 Organizational Learning

Theories of organizational learning owe much to the work of Argyris, Schon, and Senge. Argyris and Schon introduced the concepts of "single-" and "double-" loop learning, while Senge developed the ideas of "adaptive" and "generative" learning (Argyris, 1977, 1992; Argyris and Schon, 1978; Senge, 1992). Single-loop learning simply involves the correction of errors through a feedback loop. This is very similar to Senge's concept of adaptive learning which centers on evolutionary changes in response to developments in the business environment and which are necessary for a survival of an organization. Such learning does not deliver competitive advantage but is essential to survival. Double-loop learning is cognitive and goes beyond the immediate solution of problems by developing principles that may inform and determine future organizational behavior, and lead to new ways of doing business (Argyris and Schon, 1978; Argyris, 1992). Generative learning is concerned with building new competencies, or identifying and creating opportunities based on leveraging existing competencies, to generate new business opportunities.

Organizational learning is the process of continued innovation through the creation of new knowledge (Quinn et al., 1996; Nonaka, 1991). It is an ongoing process that takes place as employees engage in knowledge work (Davenport et al., 1998). Nonaka (1991) states that organizational learning emanates from the iterative process of articulation and internalization. Articulation occurs when an employee's tacit knowledge is captured as explicit knowledge and internalization occurs when this captured explicit knowledge is then transformed into another employee's tacit knowledge. Therefore, organizational learning occurs at the intersection of tacit and explicit knowledge during the interaction of the various employees, departments or teams in a firm (Nonaka, 1991).

3.4.2 KM and Organizational Learning

The ever-increasing interest in knowledge in recent years has been accompanied by a renewed discussion of organizational learning and knowledge management and, more specifically, the potential for an organization to generate competitive advantage on the basis of its knowledge assets. Harvey and Denton (1999) put forward several reasons for this including:

- The shift in the relative importance of factors of production away from capital towards labor, particularly intellectual labor;
- The ever more rapid pace of change in the business environment;
- Widespread acceptance of knowledge as a prime source of competitive advantage;
- The greater demands being placed on businesses by customers;
- Increasing dissatisfaction among managers and employees with the traditional, command and control management paradigm;
- The intensely competitive nature of global business.

At the same time, developments in communication and information technology have transformed the ability of organizations to acquire, store, manipulate, share and disseminate knowledge, resulting in new management styles and shifting cultural and structural paradigms.

The volatility of the environments in which organizations operate has made the creation and sustainability of competitive advantage an even more demanding task. Equally, the recognition of knowledge as the single most important source of competitive advantage, in conjunction with new approaches to organizational learning and knowledge management supported by innovative management and technological infrastructure, has developed alternative avenues through which firms can build and sustain superior performance. It is now possible for organizations to achieve greater flexibility and adaptability through continuous organizational learning and the improved management of their knowledge assets on which their core competencies are based (Pemberton and Stonehouse, 2000).

As Nonaka (1991) acknowledges, in an uncertain economic and business environment, "knowledge is the one source of lasting competitive advantage". Thus, in an increasingly hypercompetitive environment, focusing on organizational learning and knowledge management is seen as a critical route for the rapid development and effective use of knowledge assets that are superior to those of competitors. In short, organizations that learn quicker than their competitors, and as a consequence deploy their knowledge assets more effectively, are better placed to create and sustain a competitive edge.

Meso and Smith (2000) argue that sustainable competitive advantage results from innovation. Innovation in turns results from creation of new knowledge. New knowledge is created in the process of organizational learning. Therefore, KM can be viewed as the creation of competitive advantage through continued organizational learning.

Pemberton and Stonehouse (2000) argue that only by concentrating on the critical elements of the learning process itself will organizations be able to achieve sustainable competitive advantage through knowledge-based competencies. Central to this is the development of cultures, structures, infrastructures and systems which accelerate and sustain the process of organizational learning, and which improve the efficiency and effectiveness of knowledge management.

One of the most important roles of organizational learning and knowledge management is to ensure that individual learning leads to organizational knowledge. Successful learning organizations create an organizational environment that combines organizational learning with knowledge management. Moreover, whereas organizational learning is primarily concerned with the continuous generation of new knowledge to add to existing stocks of assets, knowledge management is primarily centered on the formalization, storage, sharing, and distribution and co-ordination of existing knowledge assets throughout the organization, building and exploiting core competences that yield superior performance. An inherent feature of both is the sharing of ideas to create and develop new knowledge, enhanced by conductive organizational structures and culture and supported by effective knowledge management systems.

3.5 KM and Learning

3.5.1 Knowledge and Learning

In order to understand the interaction between KM and learning, a distinction needs to be drawn between knowledge and learning. Knowledge, it self, may be a stock or a resource, while learning is an ongoing activity. Learning, including the "pursuit of knowledge", can become a vocation (Coulson-Thomas, 1997). Knowledge is a noun, learn is a verb. The first is enabled by the second. Knowledge when learnt is known. Until that point it is merely information. Knowledge can exist separately from people; learning is the acquisition of knowledge by people. The bridge between the two is "learning" which transforms knowledge into action (Clark, 2003).

Learning is a fundamental part of KM because employees must internalize (learn) shared knowledge before they can use it to perform specific tasks. The interface between knowledge and learning is often expressed as the difference between explicit and tacit knowledge (Nonaka and Takeuchi, 1995). Knowledge spread from individuals to groups and throughout the organizational level by capturing and sharing individual knowledge and turning it into knowledge the organization can access. Individuals eventually perform tasks to achieve organizational-level goals. Therefore, the iterative knowledge processing and learning activities at the individual level are of outmost importance (Rus and Lindvall, 2002). As Peter Senge says "organizations only learn through individuals who learn. Individual learning does not guarantee organizational learning. But without it no organizational learning occurs" (Senge, 1992).

3.5.2 KM and e-learning

The merge between learning and new technologies such as the Internet resulted in e-learning. E-learning is instruction that is delivered electronically via the Web or through multimedia platforms. The Bank of America in Gaede (2002) defines e-learning as the convergence of learning and the internet, while Cisco systems define e-learning as "Internet-enabled learning". Additionally, e-learning is seen as the delivery of individualized, comprehensive, dynamic learning content in real time, aiding the development of communities of knowledge, linking learners and practitioners with experts (Igonor, 2003).

While the emphasis on e-learning is on the "e" promising the learner the ability to learn anywhere and anytime due to the power forces of computer and communications technology, other derivable benefits for the developers of e-learning products include: cost reduction, increase in effectiveness, increases retention, increased consistency and increased flexibility and access (Gaede, 2002).

Tom Barron (2001) reviews the marriage of e-learning and KM as follows "Take an e-learning course. Chunk it into discrete learning bits. Surround it with technology that assesses a learner's needs and delivers the appropriate learning nuggets. Add collaborative tools that allow learners to share information. What do you get? Something that looks a whole lot like knowledge management". A further review of Barron's proposition reveals that quality e-learning indeed manages knowledge. Alternatively, e-learning should have knowledge filtered and delivered to the right audience.

These strong arguments suggest that learning is a crucial part of knowledge management since individual learning is what transfers information (explicit) into knowledge (tacit). Instructional design theories play a key role in delivering effective learning. In the case of e-learning there has been recently arguments suggesting that some e-learning courses provide merely information as they are lacking instructional design to support the learning process (Merrill and the ID_2

Research Group, 1996; Wiley, 2000). This leads to the investigation of the learning and instructional design theories in the literature, particularly theories offering support to e-learning.

Following is a presentation of four instructional design theories, described in the literature, providing guidance to ensure effective learning and thereby enhancing KM. These are Gagne's Conditions of Learning, Merrill's Component Display Theory, Reigeluth's Elaboration Theory, and Merrill's Instructional Transaction Theory. The last being developed specifically to support e-learning.

3.5.3 Conditions of Learning (Gagne)

This theory stipulates that there are several different types or levels of learning. The significance of these classifications is that each different type requires different types of instruction. Gagne (1965, 1985) identifies five major categories of learning outcome:

- verbal information;
- intellectual skills;
- cognitive strategies;
- motor skills; and
- attitudes.

The theory also outlines nine instructional events and corresponding cognitive processes:

1. Gaining attention (reception)

2. Informing learners of the objectives and activating motivation (expectancy)
3. Stimulating recall of prior knowledge (retrieval)
4. Presenting the stimulus material (selective perception)
5. Providing learning guidance (semantic encoding)
6. Eliciting performance (responding)
7. Providing feedback (reinforcement)
8. Assessing performance (retrieval)
9. Enhancing attention and transfer (generalization)

For each outcome/event category he then identifies the conditions necessary for learning to be efficient and effective. These conditions of learning comprise his prescriptive theory of instruction.

Gagne suggests that learning tasks can be organized in a hierarchy according to complexity. The primary significance of the hierarchy is to identify prerequisites that should be completed to facilitate learning to each level. Prerequisites are identified by doing a task analysis of learning / training task. Learning hierarchies provide basis for the sequencing of instruction.

3.5.4 Component Display Theory (Merrill)

Component Display Theory (CDT) classifies learning along two dimensions: content (facts, concepts, procedures, and principles) and performance (remembering, using, generalities). The theory specifies four primary presentation forms: rules (expository presentation of generality), examples (expository presentation of instances), recall (inquisitory generality) and practice (inquisitory instance). Secondary presentation forms include: prerequisites, objectives, helps, mnemonics, and feedback (Merrill, 1994).

The theory specifies that instruction is more effective to the context that it contains all necessary primary and secondary forms. Thus, a complete lesson would consist of objective followed by some combination of rules, examples, recall, practice, feedback, helps and mnemonics appropriate to the subject matter and learning task. Indeed, the theory suggest that for a given objective and learner, there is a unique combination of presentation forms that results in the most effective learning experience.

A significance aspect of the CDT framework is learner control, i.e., the idea that learners can select their own instructional strategies in terms of content and presentation components. In this sense, instruction designed according to CDT provides a high degree of individualization since learners can adapt learning to meet their own preferences and styles.

3.5.5 Elaboration Theory (Reigeluth)

According to the elaboration theory, instruction should be organized in increasing order of complexity for optimal learning. For example, when teaching a procedural task, the simplest version of the task is presented first; subsequent lessons present additional versions until the full range of tasks are taught. In each lesson, the learner should be reminded of all versions taught so far (summary/synthesis). A key idea of elaboration theory is that the learner needs to develop a meaningful context into which subsequent ideas and skills can be assimilated (Reigeluth, 1999).

Elaboration theory proposes seven major strategy components:

(1) an elaborative sequence;

(2) learning prerequisite sequences;

(3) summary;

(4) synthesis;

(5) analogies;

(6) cognitive strategies; and

(7) learner control.

The first component is the most critical as far as elaboration theory is concerned. The elaborative sequence is defined as a simple to complex sequence in which the first lesson epitomizes (rather than summarize or abstract) the ideas and skills to follow. Epitomizing should be done on the basis of a single type of content (concepts, procedures, principles), although two or more types may be elaborated simultaneously, and should involve the learning of just a few fundamental or representative ideas or skills at the application level.

3.5.6 Instructional Transaction Theory (Merrill)

Instructional transaction theory extends the conditions of learning (Gagne, 1968) and component display theory (Merrill, 1994) so that the rules are sufficiently well specified to be able to drive automated instructional design and development. ITT consists of a descriptive theory of knowledge, a descriptive theory of strategy, and a prescriptive theory of instructional design (Merrill and the ID_2 Research Group, 1996).

The descriptive theory of knowledge consists of knowledge objects "learning objects" and knowledge interrelationships. ITT describes knowledge in terms of three types of knowledge objects: entities, activities, and processes. Interrelationships among knowledge objects include: components, properties, abstractions, and associations between entities, activities, and processes. The descriptive theory of strategy includes transaction shells and conditional parameters. Transaction shells consist of rules for selecting and sequencing knowledge objects. It also consist of a sequence of massages to knowledge objects which cause them to display a multimedia resource representing the knowledge object, display their name or description, change their location, or change their property values and consequently the multimedia resources associated with there changed property values. ITT identifies several classes of instructional strategies including: identification, execution, explanation, judging, classifications, generalization, and transfer.

The prescriptive theory consists of rules for selecting the knowledge objects, rules for sequencing knowledge objects, rules for selecting instructional transactions, rules for sequencing instructional transactions, algorithms for enacting instructional transactions, and rules for changing conditional parameters to adapt instruction to individual learners.

3.6 Implementing KM in Engineering Organizations "State of the Practice"

Engineering organizations led the way in practicing and implementing KM realizing the potential of KM to improve business performance and support organization's strategies. The business press widely publicized early successes at consulting firms such as Booz Allen, applications engineering companies like Buckman Labs, and oil companies like BP (Lucier and Torsilieri, 2001). Other engineering organizations also reported benefits and money saved through KM practices. For example, Chevron reported saving over $20 million a year by comparing information on the operation of gas compressors in fields from all over the world (Stivers and Joyce, 1997); Schlumberger reported saving more than $40 million per year as well as improving response time by 95% for resolving technical quires, and by 75% for developing engineering modifications globally through their InTouch system (Schlumberger, 2002), Dow Chemical reported saving $4 million during the first year and expecting to generate more than $100 million in the second by arranging a "knowledge map" and understanding where all there patents lay (Calukin, 1997; Davenport et al., 1998). However, parallel to this success, many organizations have tried and failed to implement KM (Scarbrough and Swan, 1999). The majority of such failures go unreported in the literature as organizations are much more likely to report their successes.

In this section, a detailed review of three cases described in the literature is presented. These are Buckman Laboratories, British Petroleum (BP), and the case of CommCo. The aim is to explore the conditions surrounding the implementation of KM as an organizational practice recognizing that important lessons can be gleaned from examples of both good and bad practice. It should be noted that the cases are presented as they are described in the literature.

3.6.1 Buckman Laboratories

The case of Buckman Laboratories is described based on Pan (1999), Scarbrough et al. (1999), and Ellis and Melissie (2002). This case demonstrates how the temporal interplay of three key factors proved critical in Buckman Laboratories' KM program, namely Information Technology (IT), culture, and Human Resource Management (HRM). Buckman Laboratories reported achieving important tangible benefits from the management of knowledge, including dramatic improvement in customer response times and product innovation rates.

Buckmn Laboratories is a $300 million chemical company serving industries in 102 different countries selling 1,000 different specialist chemicals. It was established in 1945 as a manufacturer of specialist chemicals for aqueous industrial systems. In 1989, Bob Buckman made a personal pledge that knowledge would become the foundation of his company's competitive advantage. Three years later, the implementation of the K'Netrix knowledge network marked the realization of this vision.

When Buckman Laboratories embraced KM in the early 1990s, top management knew it would take more than sophisticated technology and leading-edge software to promote coherence and promote success. To be precise, managers at Buckman Laboratories believed that it would take the following three key factors to implement KM successfully: advance KM systems and tools, continuous cultural change, and KM-focused HRM. Buckman Laboratories' KM program (from 1992-1998) focused on improving these three factors.

3.6.1.1 KM Systems and Tools

In 1992, Buckman Laboratories consolidated the Information Systems and Telecommunications departments to set up the Knowledge Transfer Department (KTD). Within the KTD, a research and development technical information centre, which was formally used as a clearing-house for technical questions from worldwide offices, was renamed as the Knowledge Resource Centre (KRC). Together with the KRC, the KTD is responsible for the design and ongoing management of the network. One the other hand, the monitoring and processing of the knowledge generated within the various sections of Buckman forums are overseen by forum specialists and the industry section leaders.

By the end of 1992, Buckman Laboratories has invested $8 million to lay the groundwork for its new knowledge transfer system. In a short period of time, for a total of $75,000 per month in access charges and the provision of an IBM ThinkPad 720 with modem to each employee, all Buckman staff were able to make single phone call that established a point-to-point contact with headquarters and provided immediate access to global information services.

Based on this, K'Netix, Buckman's global knowledge transfer network was introduced, and seven forums were established (three customer-focused forums and four regional-focused forums) to coordinate Buckman's on-line sharing of knowledge.

The knowledge creating and sharing systems known as K'Netix are divided into two basic categories: organizational forums and codified databases. Taking a global best practice approach, the systems interconnect knowledge bases worldwide to provide a pivotal resource for Buckman Laboratories associates. The resulting network enables the electronic sharing of knowledge both between associates and also from them to their customers. The most knowledgeable experts at all levels of the organization are therefore kept in touch with each other, encouraging group problem solving and the sharing of new ideas and knowledge (Buckman, 1998). All 1300 of the organizations' associates worldwide have CompuServe Ids and passwords (though only about 1000 have their own laptops and PCs), and they use the network for both intra- and inter-company communication. This single knowledge network aims to encompass all of the Buckman company's knowledge and experience, empowering Buckman representatives to focus all of their company's capabilities on customer challenges.

3.6.1.2 Towards a Knowledge Enterprising Culture

The greatest challenge to implementing effective KM is that of the transformation of employees from knowledge hoarders to knowledge sharers. Power and influence in organizations arise from being a knowledge source. At

Buckman Laboratories, the possibility of resistance to change came mainly from middle management because they had been traditionally perceived as information gatekeepers. The radical cultural change introduced by Bob Buckman had strong implications for the power structure of middle management. In the past, middle management sought to control the flow of information to employees. However, today with the global KM system, employees are allowed and encouraged to speak freely about their opinions outside the chain of command.

Managers at Buckman Laboratories are continuously concentrating on helping their people succeed in today's turbulent world. They are becoming the mentors of the organization, which at the same time helps to eliminate the role of information gatekeepers. The adjustment or "re-learning process" was painful and strenuous. However, resistance to change was carefully monitored and minimized by top management setting clear examples and showing continuous patience.

As the cultural inertia slowly dissolved, the formation of social networks or "communities of practice" emerged in Buckman Laboratories (Brown and Duguid, 1991). The use of virtual communities of practice enhanced information flow and knowledge transfer within the organization. Over the past few years, communities of practice have evolved informally, acting to promote the sharing of information of specific customer problems as well as gather knowledge for widespread corporate use.

3.6.1.3 The Impact of Reward

Although Buckman Laboratories doesn't offer regular financial rewards for posting knowledge, a careful selection of rewards has been utilized along the way. Thus, a one-time event at a fashionable resort was arranged for the 150 employees who had contributed the most widely used knowledge. At the event, employees helped to scope out the future of the KM initiatives. Those chosen received laptop computers and participated in a number of KM related discussions. Although those who were not selected for the event were left disappointed, overall participation in the knowledge sharing forums rose immediately. Complementing this process, the "punishment" component is more subtle, but inherently just as pervasive. In the early implementation period of K'Netix, top management would write to those who were not welling to participate in the sharing activities asking why they did not wish to contribute; and suggesting that they should understand that previous ways of working were now becoming defunct and that change was necessary to secure the organization's future success.

3.6.1.4 The Role of Human Resource Development

Traditionally, the human resource department is responsible for training and education, career development, providing and developing appropriate human resources. Since 1996, Buckman Laboratories Learning Centre (Bulab learning centre) has been developed with an emphasis on allowing associates to manage their own personal and career development, and on bringing new knowledge and skills to its employees in a cost-effective manner. While its knowledge transfer mechanism has been effective in creating and sharing its organizational knowledge, training and education at Buckamn Laboratories continued until 1996 to be delivered in the traditional hierarchical "teacher and student" classroom fashion. In 1996, Buckman Laboratories decided to utilize information technology and give its associates greater opportunity to receive electronic learning events and opportunities to grow. This led to the creation of a multi lingual, on-line learning centre. The learning center's content ranges from short training and reference materials to advanced academic degrees.

3.6.1.5 Summary

Buckman Laboratories case study illustrates that much of the valued added by the technical changes associated with KM results not from the technology itself but from the new arrangements and roles of the organization, its management, and the people who can make the best use of the technology. It clearly indicates that KM must be embedded in the way in which people work. Buckman Laboratories' approach to incorporate KM practices into its culture to ensure that it achieves its mission to compete strategically on knowledge.

3.6.2 British Petroleum (BP)

The case of BP is described based on BP (1998) and Gorelick et al. (2004). BP is considered one of the leaders in KM, having developed a robust and systematic framework for performance through learning. BP has appeared in the winner's listing of the global Most Admired Knowledge Enterprises award (see http://www.knowledgebusiness.com) for each of the five years the award has been given. Internally, BP recognizes that "knowledge is one of the most important assets and potentially the company's greatest source of sustainable competitive advantage" (Prokesh, 1997). BP initiated a KM implementation program in 1997 as a catalyst to accelerate and strengthen BP's continuous change efforts that began in 1990. Towards the end of the decade, BP had a flat organization, entrepreneurial business units, and a web of alliances that positioned BP to face the challenge common to all companies competing in the global information age, which is using knowledge more effectively than their competitors. Lord John Browne, the CEO, had recognized very clearly the need to align a knowledge strategy with the overall business strategy and drove BP's KM program.

3.6.2.1 Preceding KM

In 1990, BP understood that a program of both continuous and radical change was required in order for the company to survive in the competitive energy industry. The fundamental goal was to change the way in which individuals and teams within BP behaved in order to increase performance and distinguish them from competition. The first level of change was an emphasis on performance results and teamwork, encouraging open behavior. The tools were a potpourri of change initiatives – total quality management (TQM), business process reengineering, breakthrough thinking, and teamwork supported by numerous consultants.

In 1995, a significant organizational change occurred in BP's structure. It went from a traditional hierarchy to a federal organization. The federal structure has a small central core with large semi autonomous units outside the core. The leadership in the central core provides enterprise-wide vision for all units.

However, for each unit in the federation, separate performance contracts are negotiated that drive strategy and operating tactics.

3.6.2.2 Virtual Team-working

To encourage the cross-business unit teamwork and open communication essential to the federal structure, the virtual team-working (VT) project was initiated. This project aimed to facilitate the creation of virtual teams, with geographically separated members, brought together by video-conferencing. The model for this initiative was to address people, process, and technology issues simultaneously. Thus the project deliverables were a technological solution plus a coaching process that facilitated people connecting from disparate locations using PC video-conferencing. The VT project won a Computerworld Smithsonian Award. The successful VT project helped influence the establishment of a Common Operating Environment (COE) initiative that created a standard technology platform and set of tools. It paved the road for standard PC functionality and the intranet at BP. This allowed any employee to access information anytime from anywhere, a major enabling factor in BP's KM.

In addition to the federal structure and the technology platform already implemented, BP modified the federal structure in 1996 to add Peer Groups. Peer Groups are a structure of encouraging networking, cooperation, and communication across the business units that face similar challenges. Although the business units have individual performance contracts, the Peer Groups were required to accept additional challenges (performance contract items) from the BP Group corporate centre. These items would be difficult or impossible to deliver without collaboration and sharing knowledge across business units.

As the VT project rolled out, the team told stories about successful implementations. They used every opportunity to demonstrate how to use the VT system to teach people how to do work differently. A concrete measure of the VT project's success was Peer Groups paying for VT capability (equipment and coaching) from their budget. Top management recognized and reported the added value of the VT project.

3.6.2.3 KM Team

In 1997, BP set up a central KM team (KMT) with a budget, objectives, and vision and with a remit to develop a KM solution for the organization. The KMT developed a three-stage implementation program to (1) raise awareness, (2) demonstrate success through pilots, and (3) embed the methodology in the organization. The team's duration and success were determined by their accomplishment against these objectives and were evaluated year by year by the managing directors.

Once the KMT team was formally announced, the next step was to quickly create the right team and then to develop a vision, mission, and objectives. The vision was for BP to know what it knows, learn what it needs to learn, and uses knowledge to create overwhelming sustainable advantage. The strategy to achieve this mission was to focus on people, process, and technology to create:

- Right Conditions (KM is a vital part of everyone's agenda)

- Right Means (People have convenient, easy access to what they need to know, and how their business fits into the broader BP context)
- Right Actions (People instinctively seek, share, and leverage know-how and new ideas)

The team continued the efforts by looking outside BP for KM tolls and practices. They adopted the term "knowledge Asset" to indicate knowledge that had been made accessible to add value to the business. The team narrowed the focus to a three-element framework, with an emphasis on reuse of knowledge to deliver today's performance. The three-element framework was:

1. Getting the organization ready for KM – raising awareness, learning, and engagement
2. Managing knowledge in the form of assets
3. Leveraging knowledge and expertise

The team monitored the progress with quarterly progress reviews. By mid-1997 some progress was already evident. Awareness of the value of reusing knowledge – by demonstrating that if one reused knowledge, they could deliver today's performance better, cheaper, and faster – had been firmly created. The team also recognized that people responded when it was obvious that they would gain personally by participating in a knowledge effort. For example, the shift workers in a refinery turnaround became keen advocates when they realized that sharing and reusing knowledge would make their job easier and safer.

With awareness raised and the three-step process available, the team focused in engaging the organization with the intent of introducing pilot projects. The team interviewed members of various business units to identify implemented KM tools and investigate the need for new tools. Implemented KM tools were enhanced and utilized and new tools to capture and share knowledge were established in various business units. These included After Action Review (AAR), Lessons Learned Systems, and developing a web site that provides information on KM, as well as the focus on communities of practice. Parallel to this, the team had an intention to train nearly a hundred knowledge managers working in the business by the end of 1999. They had developed a list of people who understood the philosophy and framework to work with.

3.6.2.4 Summary

BP has reported added value and money saved through KM initiatives, and is cited in the literature as a leader in successfully implementing KM. It is evident from the case of BP that this success is due to a number of factors including: management support and commitment, creating the right environment to support KM, the role of managers and the KM team, establishing a supporting flat organizational structure characterized by teamwork, focusing on people's role, and having the needed IT infrastructure.

3.6.3 CommCo

The case of CommCo was conducted by Hsiao (1999) and discussed in Scarbrough and Swan (1999). This case describes an example of unsuccessful KM implementation, exploring why a well-designed knowledge project failed to bear fruit. This case shows that the effective introduction of a knowledge project requires the building not only of a knowledge infrastructure, but also closing the "knowledge gap"; that is, the discrepancy between different perceptions of what KM means in practice.

This case study presents a well-devised KM project, the Cyberspace University, operated by CommCo, a European multinational telecommunications firm. Although advanced information technology and integrated plans were prepared for this implementation, the project ultimately failed to derive the intended results. This case illustrates the important role of the "knowledge gap" in the transfer of KM practices. In particular, it highlights the intricacies of the conflicting perceptions that individuals will react as they expect, when the intended change is first proposed. Hence, the transfer of knowledge practices should involve an effort to examine the context-specific social dynamics, so as to specify the underlying values that govern organizational members' actions. In this way it is possible to close knowledge gaps, bring about effective organizational learning, and insure the successful implementation of KM projects.

3.6.3.1 The Cyberspace University Project

As a result of domestic deregulation of the telecommunications sector and increasing global competition, CommCo has undertaken a series of change initiatives to counter the challenges arising from both external environment and the internal process of transformation. The central concern was to transform the old centralized structure into a network organization that would facilitate highly competitive global operations. One particular initiative, the Cyberspace University, emerged as a key strategy to fulfill this ambition. This knowledge project aimed to build a platform on which CommCo, operating in more than fifty countries, could effectively share the company's experience and knowledge on a worldwide basis with a view to reducing repetitive investments, encouraging innovation and, in a broader sense, sustaining long-term competitiveness.

To CommCo, there were four primary reasons for adopting such a cyberspace (Internet-based) learning initiative. These are:

1. *Speed.* To institute a virtual learning centre can take about twenty months, while the time needed to build a global training centre may be more than five years.
2. *Cost.* Virtual learning can greatly reduce the traveling expenses associated with a traditional classroom-based approach. It can also overcome restrictions on the number of participants.
3. *Exploit IT fully.* Therefore, CommCo could expect to run their global operations without the frequent face-to-face meetings within the hierarchical decision-making process.
4. *Bring people closer together.* The quality of personal communication can be enhanced by using technologies such as video-conferencing.

Building upon previous Internet-based projects, the Cyberspace University sought to integrate CommCo by developing a knowledge-sharing platform. The aim was to establish CommCo as a centre of excellence with three major missions in mind:

- Shift from technical-oriented training to business education, incorporating development in general management skills.
- Develop CommCo into a learning organization through which knowledge sharing and knowledge creation could be instituted.
- Bring together the resources of CommCo training centers all over the world.

CommCo's corporate provision for training and development was organized around three major functions. The first function was the Education Department that ran routine courses for employees from all over the world. The second function consisted of a KM team responsible for the implementation of the Cyberspace University. The third function was a human resource department, supporting the overall process of organizational change in order to enable the transfer of the Cyberspace University.

3.6.3.2 Building a Knowledge Infrastructure

In order to support this vision, CommCo devised an integrated plan for building a knowledge infrastructure designed to sustain the sharing, creation, and exploitation of knowledge. In terms, of technological architecture, the KM team decided to us Lotus Notes as the technical platform for accommodating knowledge sharing practices by serving as an intra- and inter-firm communication. In addition, a three-step knowledge transfer process was used to support the implementation:

1. the integration of "bridging programs" to consolidate training courses in specific business and functional units of senior managers;

2. taking account of the key strategic drivers in the design of these bridging programs in order to reflect the performance management initiatives requested by the management team; and
3. the consequent attempt to establish an architecture of the Cyberspace University, where experts around the world communicate, share, and create knowledge across time and space.

This transfer process was supported by "learning communities", a method of organizing employees into special interest groups and establishing learning activities within groups. Regional offices were encouraged to set up "learning Communities" in order to foster a knowledge sharing culture. At the same time, three further activities were undertaken in pursuit of this aim. First, the "learning portfolio" aimed to consolidate more than 1,200 courses shared globally. Second, the initiative of "future capability"; this involved regularly surveying regional offices in order to identify "capability gaps". The Education department would then develop new courses based on these gaps. Third, the "idea exchange" that was established to share knowledge in the areas of new products, innovative projects, clever ways of working, and overcoming obstacles. By offering summarized case studies in the database.

In addition, a federal organizational structure was created to involve regional managers in the KM project. These managers were given a "dual responsibility" which meant that they had to act in the interests of both the local business unit and the federal enterprise. The Education department set up a series of training programs for regional managers. The HR department also created a function of change management to provide services to regional managers as part of its in-house change management role. Organizational change was designed to align existing human resource development and KM practices.

3.6.3.3 Emergence of a Knowledge Gap

All the signs pointed to the subsequent success of the CommCo KM project, Cyberspace University. However, major problems arose from the project's cultural context and neglect of the importance of the "knowledge gap". Soon after a triad (education, knowledge, and organizational change) approach was introduced to CommCo, significant resources were invested and company-wide change began. The KM project was informally terminated in 1996. Hsiao (1999) examined the situation and related the project's failure to the following:

- Senior management's primary concern to change the organizational culture was through performance management. In their view, this goal depended on a change of employees' attitudes and the need to focus employees' attention on a set of finance-based performance indices.
- The KM team seemed to pay most of their attention to the technical transfer of knowledge practice. They were more concerned with setting up a technological architecture, integrating the education and training database, introducing learning communities, and implementing real-time competence building from expanding the course database. Also, the team thought that regional managers seemed to care more about their local business generation and appeared to neglect business practices.
- HR consultants tended to take on small projects and finish them as soon as possible. As a result, most consulting projects tended to last from one

week to two months, and most proposed solutions tended to concentrate on education and training. Additionally, HR consultants also worried about the imposed need to achieve performance measurement. It seemed to them that the senior management team was not supportive of their role as change agents.

- The viewpoint of the regional managers reviled another dimension to the knowledge gap. Regional managers had difficulties in recognizing HR consultants' role as change agents. Furthermore, they were mainly concerned with own local business performance and the need to attain the performance targets set for them. As there was no incentive to participate in the KM project, at the end of the year regional managers still had to face the unrelenting pressures to achieve profits.

3.6.3.4 Summary

This case highlights the role of a knowledge gap in the building of a knowledge infrastructure. The failure of KM at CommCo has been linked to the managers' inability to recognize this gap between the perceptions of key internal stakeholders. The case illustrates that implementing an effective KM project depends on building the knowledge infrastructure as well as closing the "knowledge gap". This in turn requires managers to be aware of the various critical factors effecting the successful implementation of KM.

3.6.4 Concluding Remarks

Case studies described in the literature underline the diversity of KM in practice. These range from software development and the electronic transfer of knowledge, through consultancy firms where knowledge is created primarily through people, to large multinational engineering companies where knowledge sharing needs to break through geographic barriers (Scarbrough and Swan, 1999; Jarrar, 2002; Koch, 2003; Gorelick et al., 2004). However, a thorough review of these cases allows one to point out a common set of critical KM success factors. The following concluding remarks reflect the cases of Buckman Laboratories, BP, and CommCo presented in this section:

- KM is a process shaped by implementation and involving change in work practices.
- The success of KM implementation and practice in organizations requires the integration of various factors. Technology alone does not guarantee success.
- Management commitment and support are important for the success of KM.
- It is important to align KM goals and practices with organizational business strategy. KM solutions must be linked to organizational goals and objectives. KM solutions must also be realized through plans that address all the key issues to ensure the success of KM.
- It is crucial to have/create a culture that supports knowledge development and sharing to succeed in managing knowledge.
- A flat organizational structure characterized by teamwork and communities of practices facilitates KM.
- HRM shapes the effectiveness of KM through the selection, motivation and retention of people.
- Information technology capabilities need to be utilized to support KM.

- KM success requires allocating tasks and assigning roles and responsibilities. Employing a special team to design and manage the overall KM process, in some cases, is required.
- Managers have a key role in implementing KM. They need to understand their role, be aware of their responsibilities, and practice their leadership.

3.7 Summary

This chapter presented critical factors, described in the literature, which affect the successful implementation of KM in engineering organizations. The roles of corporate and strategic management, information technology, human resources, culture, organizational structure, and office design in facilitating KM to achieve business goals were described. This included presenting the various information and communication technologies available to facilitate KM, their applications, and classifications. It also included outlining the importance of people's role in facilitating KM whether through leadership, motivation and managers' role or through investing in employees as a core element of an organization strategic competitive advantage. Additionally, the importance of having a knowledge friendly culture to facilitate the development and sharing of knowledge was highlighted.

The Chapter also presented key issues relating to KM practice as described in the literature. This included the issue of how to measure the success of a KM approach as well as the work done linking performance measurement to KM. This was followed by a discussion on the link between KM and organizational learning and their common role of advancing individual learning to organizational knowledge. The Chapter then presented a discussion on the link between KM and learning. This included investigating the relationship between knowledge and learning as well as highlighting the fundamental role of learning in facilitating KM. It also included investigating and outlining the role of e-learning in facilitating KM as well as the importance of instructional design theories in ensuring effective learning. This led to investigating and presenting four instructional design theories: Conditions of Learning, Component Display Theory, Elaboration Theory, and Instructional Transaction Theory.

The Chapter ended by exploring the practice of implementing KM in engineering organizations. This included presenting three published case studies: Buckman Laboratories, BP, and the case of CommCo. The case studies underline the diversity of KM in practice and help in identifying a common set of critical success factors.

CHAPTER 4

RESEARCH METHODOLOGY AND EXPLORATORY WORK

4.1 Introduction

Research can be defined as a systematic and designed effort to investigate a specific problem that needs a solution. It consists of a series of steps designed and followed, with the goal of finding answers to issues of concern. It is the entire process by which people attempt to solve problems (Sekaran, 1984). The methodology the research follows must consist of defined logical rules and procedures if the finding of the research is to be accepted (Neuman, 1997).

The hallmarks of scientific research, according to Sekaran (1984), are: sense of purpose, rigour, testability, replicability, accuracy, objectivity, generalisability, and parsimony. Scientific research is dependent on the concepts of theory and empirical research. Two approaches for search are the inductive and deductive. The inductive approach is where theory comes after research. The deductive approach is where theory comes before research. The inductive approach is based on starting from the particular moving to the general. In the deductive approach the researcher starts with a general view and moves to the particular (Neuman, 1997).

This chapter will introduce the design of this research and the logic behind its selection. It will also introduce the different design issues in some detail. The Chapter will also present the exploratory work conducted in eight organizations and the outcome resulted. Overall, the Chapter will walk-through the methodology path the research followed until completion.

4.2 Research Design

Research design relates to the purpose of the study, the type of investigation, the setting of the study, what sampling design should be used, and how the data are to be collected and analysed (Sekaran, 1984). There are different types of research design that are used for various research purposes. Those types can be generally classified into three categories:

- Historical design
- Experimental design
- Non-experimental design

4.2.1 Historical Research Design

Using this type of research, the researcher examines aspects of social life in a past historical time or across different cultures. S/he combines theory with data collection which uses a mix of evidence including existing statistics, documents (books, newspapers, etc.), observations, and interviews (Sproull, 1988; Neuman, 1997).

4.2.2 Experimental Research Design

Experimental research design is a type of research where the researcher deliberately controls and manipulates the independent variables to affect the dependant variables in a desired way so that the effects could then be measured and analysed. Experimental designs are set up to study cause/effect relationships among variables. Casual studies usually have varying degrees of artificial constraints imposed on them which interrupt the natural sequence of events.

Experimental design can be of two types, classic/true experimental and quasi-experimental. The classic experimental is used where the researcher has more control over variables, while the quasi-experimental is used in situations where classical design is difficult or inappropriate (Balian, 1982; Sekaran, 1984; Sproull, 1988; Neuman, 1997).

4.2.3 Non-experimental Research Design

In research where a definitive cause and effect relationship between variables is not necessary or not possible to be established, then a non-experimental correlational research is performed. Since there often exist multiple factors that influence each other rather than one variable causing another, the researcher might become more interested in finding those factors that are associated with the research problem than establishing causality. The non-experimental research design is used when control over variables is not possible (Sekaran 1984; Sproull, 1988).

Although research methodology is the general principle behind research, and research method is the actual technique implemented in the practice of data collection, methodology and method cannot be separated (Sproull, 1988; Neuman, 1997). Non-experimental research design can be categorised in two types, quantitative and qualitative.

1. Quantitative Research

Quantitative research is used mainly to test a theory by testing individual hypotheses. Those hypotheses are attempts to establish relationships between variable or concepts. Concepts in quantitative research are described by distinct variables. The primary data collection methods used are survey methods such as questionnaire and structured interview, which are quantifiable. Research analysis is performed by using statistics, tables, or charts, and link what they express to the hypotheses (Balian, 1982; Neuman, 1997).

Survey methods

The choice of data collection methods depends on many factors, such as the resources available to the researcher, the time span of research, the accuracy required in the study, the expertise of the researcher, and cost associated with each method. Also, in the global environment, survey research has proved to be very practical, taking into consideration future research; it allows research to be replicated in cross-cultural studies which usually span many nations. In such a context, the survey questionnaire, as an example, is a very valuable method of data collection considering the cost and difficulties other methods may endure. It provides a means for cross-cultural comparison.

<u>Questionnaire</u>

A questionnaire is a prewritten set of questions of respondents to record their answers. It is an efficient data collection technique when the researcher knows exactly what is required and how to measure the variables under study. Questionnaires can be administrated personally or sent by mail. The personally administrated questionnaire is used when the survey is confined to a local area. The main advantage of mailed questionnaire is its convenience when a wide geographic area needs to be covered. Questionnaires allow researchers to obtain data fairly easily, responses are easily coded, and they are not expensive. Their main disadvantage is their lack of depth and flexible adaptation to the divergent circumstance of respondents. In addition, this type of survey method has another disadvantage which is the probability of inaccurate data caused by subjects, bias, lying, or omitting information (Sekaran, 1984; Sproull, 1988; Neuman, 1997).

Structured interview

Structured interview is conducted when the exact information needed from the respondent is known. The interviewer refers to a list of questions during the course of the interview. The structured interview could be face-to-face or by telephone. It allows the interviewer to ensure the proper understanding of the questions by the respondents through verbal and nonverbal feedback or reactions. The structured interview has an advantage in the global setting. Due to the variations in language skills between respondents, the presence of the researcher to ensure proper understanding of the questions is sometimes essential. The main disadvantages of the interview method are its high cost compared with the questionnaire and the need for the researcher to conduct the interview personally, which limits the number of responses. As in the questionnaire method, this method has another disadvantage which is again the probability of inaccurate data caused by respondents' bias or omitting information (Balian, 1982; Sekaran, 1984; Sproull, 1988; Neuman, 1997).

2. Qualitative Research

Qualitative research differs form quantitative research by its way of generating information. It concentrates on a particular situation where depth is more important than generalisation. In qualitative research, research questions are posted rather than hypothesized. Concepts take the form of themes, and data take the form of words of participants from interviews and participation. Many methods are associated with qualitative research such as participant observation and unstructured interviews (Sproull, 1988; Neuman, 1997).

Unstructured interview

Unlike the structured interview, the researcher conducting an unstructured interview does not have a sequence of questions to ask the interviewee. The main objective is to have some issues and variable surface, which will call for in-depth follow-up investigation. Using this method, the researcher first starts by asking broad, open-ended questions, then as the themes formulate, more focused questions are asked. The main disadvantages of this method are its time consumption, high cost, and the difficulty transcribing an analysis data. As in other survey methods explained earlier, the disadvantage of subjects' bias or omitting information could lead to distorted data (Balian, 1982; Sekaran, 1984; Sproull, 1988; Neuman, 1997).

Case Study

Case study is a widely used research method in management research which includes knowledge management research field (Scarbrough and Swan, 1999; Beijerse, 2000; Huosong et al., 2003; Koch, 2003; Gorelick et al., 2004). Yin

(1989) defines case study as "An empirical enquiry that investigates a contemporary phenomenon within its real life context, when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used". Leidner and Jarvenpaa (1993) also indicate that "Case study research is appropriate in situations where the research question involves a 'how', 'why', or exploratory 'what' question, where the investigator has no control over actual behavioural events".

Case study method is suitable in tracking a singular phenomenon as a case. It is considered as an umbrella for a family of research methods that focus an inquiry around a single instance. It typically involves the use of multiple data collection techniques such as documents, archival records, interviews, direct observation, participant observation, and physical artefacts. This is performed for a set period of time (Cohen and Manson, 1994; Leidner and Jarvenpaa, 1993; Yin, 1989). Case study is commonly used for developing generalisations to theoretical propositions. It is a particularly powerful technique to answer 'how' and 'why' questions.

The researcher, when using case study, should investigate the research problem through the eyes of the subjects being investigated which could be based on a predefined model (Leidner and Jarvenpaa, 1993). Case study research approach is especially appropriate in new topics areas (Scarbrough and Swan, 1999; Gorelick et al., 2004), and can be used for both theory testing and theory generation (Bryman, 1995; Yin, 1989).

3. Triangulation

Triangulation or multimethod approach refers to the technique of integrating qualitative and quantitative data collection and analysis methods into one framework. It could be looked on as measuring an object or a relationship from different angles or viewpoints. The main reason for using triangulation is that measurement improves when diverse indicators are used. Having different measurements of a variable from diverse methods implies greater validity. Also, in a single research, measuring different variables might need the use of different methods (Sekaran, 1984; Neuman, 1997).

4. Sampling

There are two major sampling types: probability and non-probability sampling. In the probability sampling, elements have a known chance of being selected as subjects in the research. In non-probability sampling, elements don't have a predetermined chance of being selected. Time, type of information needed, availability, and generalisability are the main determinants for selecting a sampling technique. If generalisability is the important issue then probability sampling should be used. In the instances where time rather than generalisability is the important issue, non-probability sampling is used. Also, when the information needed in the research could be obtained from specific targets then non-probability sampling is used. The same also applies when the only available sources of information are specific elements.

Probability sampling has different techniques, some of which are listed below:

- Simple random sampling

- Complex probability sampling
- Stratified random sampling
- Cluster sampling

Non-probability sampling also has many techniques:

- Convenience sampling
- Purposive judgment sampling
- Snowball sampling
- Quota sampling

Judgment sampling involves choosing subjects who are in the best position to supply needed information. It is used when a limited category of people have the required criteria such as specific educational background, or they have the required information where they are expected to have expert knowledge. In such cases, probability sampling is purposeless and not useful (Sekaran, 1984).

4.3 Selecting Research Approach

Selecting the most appropriate research approach to achieve the research aim depends on the specific research questions. Neuman (1997) explains "It takes skill, practice, and creativity to match a research question to an appropriate data collection technique".

In making the choice of research approach to answer research questions best, the following points suggested in similar ways by Balian (1982), Sproull (1988), and Neuman (1997) have been taken as a guide:

1. Determine what type of data required (opinions, attitudes, perceptions, hard data, etc.)
2. Determine the depth or generalisation needed.
3. Determine what resources are available (time, money, etc.)
4. Determine the degree of control and ability to manipulate variables.

In this research, because the researcher does not have the ability to control or manipulate variables affecting the successful implementation of knowledge management in engineering organizations, experimental research design is excluded.

4.3.1 Research Approach

Kaplan and Duchon (1988) state: "Researchers develop categories and meanings from the data through an iterative process that starts by developing an initial understanding of the perspectives of those being studied. That understanding is then tested and modified through cycles of additional data collection and analysis until coherent interpretation is reached. Thus, although qualitative methods provide less explanation of variance in statistical terms than quantitative methods, they can yield data from which process theories and richer explanations of "how" and "why" processes and outcomes can be developed". In addition, Benbasat et al. (1987) consider case study approach to be appropriate for new research areas, and where respondents are of importance to the study.

The aims of this research are to produce a holistic model for the effective integration of the factors affecting the successful implementation of KM in engineering organizations, produce a framework that assist organizations in identifying their KM needs and requirements, and propose guidelines for organizations to progress through their week elements for successfully implementing KM. The lack of research that adopts this holistic perspective of KM makes this study a new area of research. In addition, the diversity and complexity of the factors that affect the successful implementation of KM call for the need to address "how", and "why" questions and to explore the "what". The theory adopted for this research recognizes that the factors which underpin this study; strategy, culture, people, technology, and organizational structure, need to be understood in depth. In addition, the proposed model introduces the interaction between the previously stated five factors in a new light. This calls for a qualitative non-experimental approach that serves better in an in-depth study and in understanding a new phenomenon. Also, since the factors cover different aspects of the organization, this calls for the utilization of different methods of data collection. Case studies with triangulation of data collection methods are thought to be the most appropriate for this research. The research uses observation, structured interviews, unstructured interviews, historical data collection, and document review.

It must be stated that different data collection methods prove to be more effective than others in the different organizations studied. For example, some organizations were more reserved in allowing the researcher to review their documents and historical data than others.

In order to further generalise the model and achieve greater validity, the qualitative in-depth case studies are integrated with a quantitative questionnaire that resulted in a triangulation approach. In order to cover a wide geographic area, mailed questionnaire is thought to be the most appropriate method.

4.4 Methodology of Study

4.4.1 Choice of Research Methods

This research has adopted the triangulation approach by integrating the in-depth case studies with the use of a questionnaire, and by employing the multiple research methods of observation, historical data and document review, along with structured, semi-structured, and unstructured interviews. The main reason for using triangulation is that measurement improves when diverse indicators are used, i.e. having different measurement of a variable from diverse methods implies greater validity. Also, in a single research, measuring different variables might need the use of different methods (Sekaran, 1984; Neuman, 1997).

Because this research was initiated by exploring factors that affect successful implementation of KM in engineering organizations, open-ended interviews with senior mangers have been used. This method was chosen because it allows the respondents to express their views freely in the manner they choose. It is also a good tool for data collection when in-depth understanding of a specific point is wanted (Neuman, 1997). The unstructured interviewing was conducted after completing the initial literature review where KM perspectives and approaches, life cycle models, frameworks and methodologies, and application to engineering organizations were reviewed and the initial model was formed. The main objective of this step was to explore the issues concerning the successful implementation of KM and to identify gaps and factors stated in the literature concerning KM successful implementation in engineering organizations.

To solicit the opinions of people involved with KM in engineering organizations regarding the usefulness and practicality of the research model in real situations, purposive judgment sampling technique is used. Informed people regarding the KM implementation under study were chosen in the exploratory interviews as well as each of the case studies.

In a global environment, qualitative research has proved to be fruitful and practical. In such a context, the qualitative case study approach, as an example, is a very valuable method of data collection considering the possible limitations of other methods. Because of the variations in language and communication skills between respondents in studies conducted in the global setting, case study methods, such as face-to-face interviews along with observation, have an advantage over other methods such as questionnaires. It allows the presence of the researcher to ensure proper understanding of the questions. This is more obvious at the initial stages of this study where the subjects of the study are derived from different countries of different native languages. English, however, is the common language among them, but there exist variations in their level of understanding of English. As a consequence, the research method chosen for this study was case study research that implies triangulation of methods.

However, having obtained a clear understanding of those being studied through the in-depth case studies, and in order to further generalize and validate the model the quantitative method was used in the form of mailed questionnaires.

4.4.2 Steps of Study

The steps of the research were as follows (Figure 4.1):

1. Review of KM literature including KM perspectives and approaches, life cycle models, frameworks and methodologies, benefits, and application to engineering organizations.
2. Preliminary research problem identification that resulted in outlining issues to be explored through exploratory work and further literature review.
3. Exploratory work conducted in eight engineering organizations.
4. Initial findings on the successful implementation of KM in engineering organizations.
5. Review of more literature on critical factors for successful implementation of KM, published case studies of KM implementation in engineering organizations, and KM key issues.
6. Establishment of the "SCPTS" three-layer KM model.
7. Conducting detailed case studies in three engineering organizations to test and modify the model resulting from the previous step.
8. Presenting the final recommended model.
9. Further generalize the model and achieve greater validity with the use of a questionnaire.
10. Establish guidelines for model use.

11. Presenting summary and conclusion of the research.

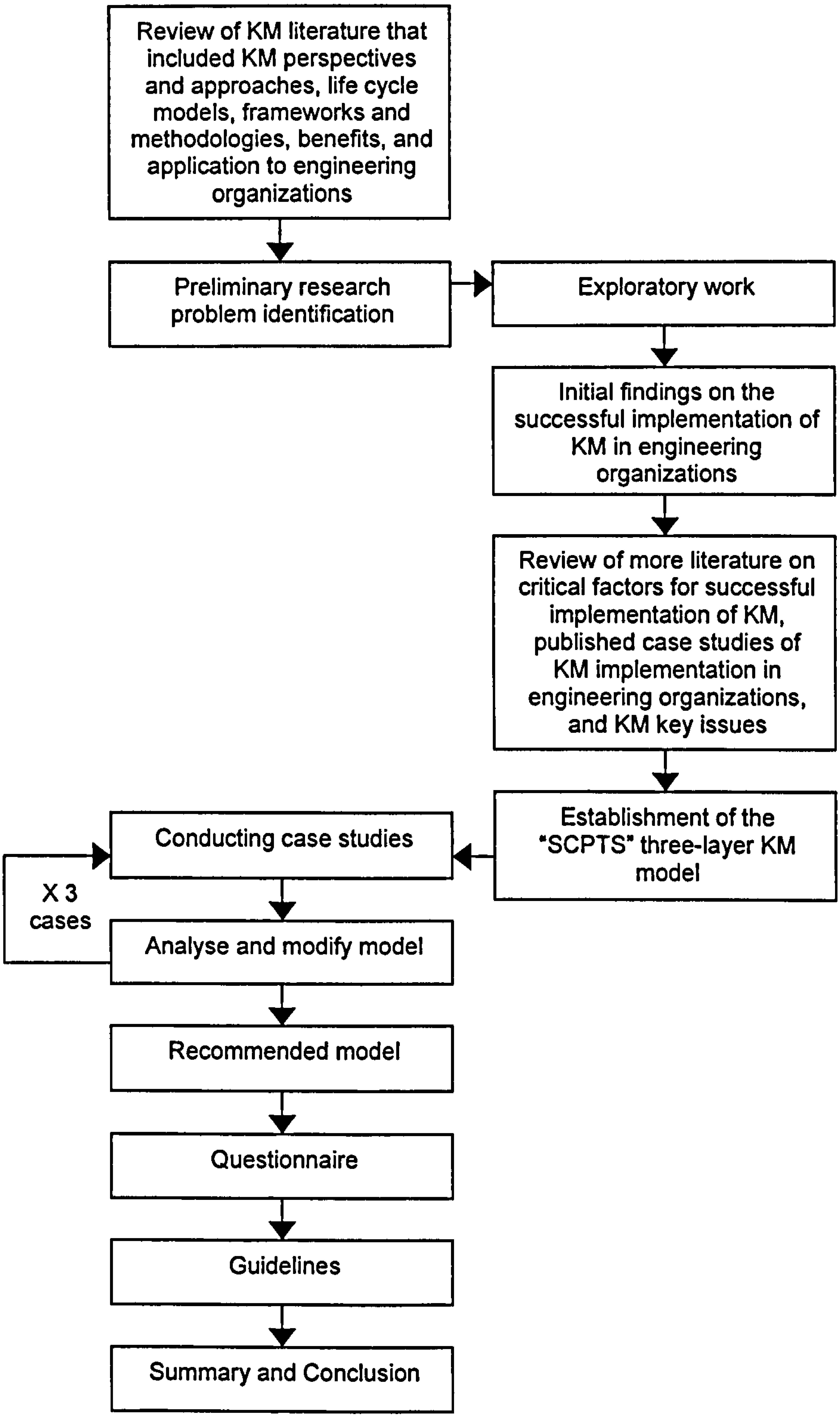


Figure 4.1: Research Design

4.4.3 Exploratory Work

The exploratory work took place after the initial literature review, during which KM approaches and perspectives, life cycle models, benefits, and issues relating to KM in engineering organizations were reviewed. The main objective of this stage was to explore the issues concerning the successful implementation of KM and to identify the gaps and factors stated in the literature concerning KM success in engineering organizations. It also helped in directing the subsequent literature review as well as setting the foundation for establishing the "SCPTS" three-layer KM model. Additionally, the exploratory work has allowed for better planning of the case studies which tested and validated the KM model.

The exploratory work was conducted by interviewing managers at various levels in eight engineering organizations. The main objective was to explore the factors that affect KM success, using a draft of a KM model inspired by the literature reviewed. This study also aimed to explore the issues concerning the possibilities to conduct the intended case studies, i.e. accessibility privileges and the type and status of KM in these organizations.

The open-ended interviews were informally aimed to obtain opinions, views, and thoughts of issues relating to KM. The questions were put to the managers in a discussion-like environment since it was thought to be the most suitable way for soliciting answers from people that are not used to dealing with researchers, and security issues are a priority in their minds.

The literature review presented many factors that affect the successful implementation of KM. Those factors include information technology, strategic planning, organization culture and structure as well as people. In addition, the literature presented various KM life cycle frameworks and identified the types of knowledge available in organizations. Those issues were the subject of verification in the exploratory study to find out what role they play in the practical world and whether other related issues exist.

4.4.4 Exploratory Work Findings

The findings of the exploratory work can be summarized in the following:

- All interviewed managers agreed on the potential and importance of KM in adding value to engineering organizations. Managers suggested that successful KM can lead to:
    - Obtaining and maintaining competitive advantage
    - Improving performance
    - Improving quality
    - Saving time and money
    - Becoming a learning organization
- Strategic planning is important for successfully implementing KM in the organization
- It is important to get people to share their knowledge and create the supporting environment for KM to succeed
- It is important to utilize technology to enable KM
- It is important to have an organizational structure that supports KM

- In six out of the eight companies, managers thought that knowledge is being generated in their organization and the focus should be in developing and sharing this knowledge
- Successful KM must provide means for documenting and sharing the tacit knowledge of employees experiences and knowledge gained from projects and should not only be limited to managing explicit knowledge

Those findings indicated the need for further literature review to explore, extensively, the factors affecting the successful implementation of KM as well as published case studies of KM implementation in engineering organizations. The findings were also utilized in establishing the "SCPTS" three-layer KM model.

4.4.5 Development of the Model

Following the initial literature review and the exploratory work, a preliminary KM framework was established identifying potential factors affecting KM in engineering organizations. These included strategic management, human resources, technology, organizational structure and culture as well as the types of engineering knowledge and the KM life cycles. This led to further literature review to fulfil the need for better understanding of these factors and the relationships between them. Additionally, there was a need for further literature review to examine the practice of implementing KM in engineering organizations through published case studies and explore key issues relating to KM such as performance measurement, e-learning, and organizational learning. Guided by the KM framework and the exploratory interviews conducted, and having completed the literature review, a draft of the "SCPTS" three-layer KM model was constructed.

Later, the model was tested and validated by conducting three case studies in three different engineering organizations representing different sizes and sectors in a Middle Eastern country. The model went through iterative modifications during and at the end of the case study. A questionnaire was also prepared during the course of the model development and case studies. This questionnaire was then mailed out to engineering organizations in an effort to further generalize and validate the model.

4.4.6 Case Studies Selection

Sampling is the process of selecting a sufficient number of elements form a population. The reason for sampling is that in many situations it would be impractical to collect data from the entire population. Even when it is possible, the large amount of resources needed such as time, cost, and other human resources makes it largely problematic. In some instances, sampling leads to unreliable data because of the error possibility involved with fatigue (Sudman, 1976; Burgess, 1984; Sekaran, 1984).

The use of case studies in this research aims to test and validate the KM model in as close to "real life situations" as possible. While the elements and issues addressed by the model are "logical" and supported by the literature, it was important to experience the actual implementation of the model in real organizations' setting as much as possible. In addition, to solicit the opinions of the people involved with KM in engineering organizations regarding the usefulness and practicality of the model in real situations.

In this research, organizations selected as case studies were based in the Middle East, and are characterised under different sizes, sectors, and status of KM implementation. They fall under private and governmental sectors, and are in oil, computer, and consulting businesses. They are also characterised as large, medium, and small-size organizations. In addition, the companies were at different states of KM implementation.

The accessibility issue was important. During the exploratory study that was commenced months earlier, an account of the candidate organizations with their different status was noted, and permission to conduct the studies was solicited. Three of the eight organizations that participated in the exploratory study gave the initial agreement. Even though the organizations characterised different situations, no claim is made by the researcher that they are representative of particular population. Nevertheless, the diversity of situation would add more rigour to the testing and validation of the model and enrich the experience gained from those studies (Yin, 1989).

The three cases were conducted in three different engineering organizations: a major Middle Eastern oil company (Oilco), a computer network and software provider (Compco), and an engineering consulting company (Consultco). The three companies were all actively involved with KM.

4.4.7 Methodology of Case Studies

Case studies are used to ensure an empirically grounded qualitative understanding of the company's specific combination and configuration of knowledge management tools and activities as well as their experiences. This means that for the model to be tested and validated, data needed to be collected regarding the implementation and the status of KM in the studied organizations. These organizations, therefore, needed to be actively involved with KM and that was accommodated while conducting the exploratory work at the early stages of the research. When using the model in the case studies the focus was to compare current practices against the critical factors identified by the model in order to determine strengths and weaknesses, and identify any performance gaps. The opinions and experiences of the people involved regarding issues addressed in the model should also be noted. Interviews, observation, and documents relating to KM implementation and initiatives were the main sources used for data collection during the case studies investigation. Structured, semi-structured, and open-ended interviews were conducted on-site.

For case study data analysis, pattern-matching strategy was used (Campbell, 1975; Yin, 1989). The pattern-matching can be between theorized and observed variables, whether process or outcome variables. Also, pattern-matching strategy is especially potent if comparisons are made between two or more rival, hypothesized processes or outcomes and the observed processes or outcomes. Data collection is to be naturalistic, to favour process over outcomes, and to be intensely descriptive, leading ultimately to a rich, "thick" description of the program being investigated (Van Mannen, 1988).

Key informants in each company selected were contacted to schedule interview times. Most of the interviews were taped-recorded to ensure accuracy of written data and to enable better collection of evidence and analysis. Because of reservations expressed by some informants regarding tape-recording, notes were taken. Time of interviews varied, depending on the availability of the informants and the time slot they had. The time for a single interview varied between one and three hours with short breaks. Because of the particularities of each company and the availability of the people, the number of interviews varied from one company to another. For each company, multiple on-site visits were needed to finish interviewing. Follow-up was also made to seek clarifications or more information. Table 4.1 shows the number of interviews conducted in each of the three case studies as well as the positions of people interviewed.

The following points discuss the methodology followed in the case studies: First, conducting an open-ended interview with a senior manager to obtain general information regarding the implementation of KM in the company and the various KM initiatives as well as being introduced to key informant employees in the company and obtain permission to interview them.

Second, based on the initial interview, semi-structured and, in some cases, structured interviews were conducted with various people in each organization as needed. These interviews were aimed at understanding general issues regarding KM and establishing background of its implementation as well as

Organization	Number of Interviews	Positions of people interviewed
Oilco	12	Senior Manager IT Division Manager Senior Development and Training Advisor Field Manager Project Manager (2) Senior Supervisors (4) Engineers Engineering Record Administrator
Compco	8	Operation Manager Product Manager Human Resources Advisor (2) Engineers (2) Technicians helpdesk Operator
Consultco	8	Chairman (2) Department Heads Project manager Human Resources Personnel (3) Engineers

Table 4.1: Case study interviews

establishing the current situation of the various KM initiatives and key factors effecting KM. Additionally, obtaining and reading all available documentation regarding KM in the company or that considered necessary for the study. It is important to note that different people in each organization where informed in different areas of KM. For example, information about an organization's recruiting and training programs was obtained from human resources personnel in a semi-structured interview where the questions were focused on these issues. Similarly, information about information technologies deployed by an organization was obtained from IT personnel where the questions were focused on technological issues. Structured interviews, on the other hand, were used when exact information was needed from the respondents such as in the case of investigating employees' willingness to share their knowledge or their contribution and views on a particular KM system.

Third, after the interviews, the manager responsible for KM in each company was given a copy of the KM questionnaire, shown in appendix A, to be used as guidelines to identify the organizational situation. This was done in the manager's own time to be discussed in the next meeting with the researcher which was in the form of a structured interview discussing responses to the questionnaire.

Fourth, in the meeting, the manger's notes on the organizational status were discussed and ambiguities resolved. This was done with the background of the knowledge accumulated by the researcher from the previous experiences and meetings in the organization.

Fifth, the data generated from the previous steps was used to explore on issues and interrelationships of factors described by the model as well as identify new important elements. The model was therefore revisited once again by the researcher in light of all the previous steps. This coincided with modifying the model as a result of the knowledge and experiences attained during the course of the case study. This was followed by writing a full report on the case study.

Sixth, if during any stage, any data were found to require more clarification by the researcher, additional follow-up telephone conservation was made. This had led in a few instances to conducting an additional interview where telephone conservation was inadequate.

After conducting all of the three case studies, the model went through one last overall modification. Following this modification, all cases were re-evaluated according to the new resulting model. The proposed KM model and the case studies are presented in Chapter 5 and Chapter 6, respectively.

4.4.8 Questionnaire

During the course of conducting the case studies and developing the KM model, a questionnaire was developed to solicit the opinions of managers in engineering organizations on the agreement/disagreement of the various key factors proposed by the model and the status of KM in their organizations. This was an effort to further generalize and validate the model. Having completed the case studies and established the "SCPTS" three-layer KM model, a pilot questionnaire was presented to managers in four engineering organizations to solicit their opinions on the questionnaire and examine the feedback. After obtaining the feedback from the managers on the pilot questionnaire and made minor necessary modifications, the KM questionnaire was sent through mail/email to knowledge managers and senior managers in 426 engineering companies. The companies were of different sectors, sizes and were located in different countries within America, Europe, and the Middle East. The use of mail/email allowed the coverage of a large geographic area. Despite the fact that two follow-up letters were sent to remind and encourage potential participants to contribute, only 19 completed questionnaires were received. The KM questionnaire and its findings are presented in Chapter 7.

4.5 Summary

The Chapter presented the research design and methodology that was adopted by the study. It first introduced the different types of research design, which can be generally classified into three categories: historical, experimental, and non-experimental design. It presented the quantitative and qualitative research approaches. It also presented different data collection methods such as in-depth case study, observation, structured interviews, unstructured interviews, historical data collection, and document review. It also introduced triangulation and sampling techniques.

The Chapter than presented the research design and methodology applied by this research. It then introduced steps applied in this research and presented the exploratory work done. The Chapter concluded by presenting the methodology by which the "SCPTS" three-layer KM model was developed and tested.

CHAPTER 5

KNOWLEDGE MANAGEMENT MODEL

5.1 Introduction

Knowledge management is still a young field with almost as many definitions to the term than there are approaches or "schools" of authors contributing to the field (Quintas et al. 1997; McAdam and McCreety, 1999; Kakabadse et al., 2003). In Chapter 2, it was reveled that recently, KM has received increasing attention from researchers of a variety of disciplines, mainly organizational management, (organizational) psychology, strategy and management science, artificial intelligence, computer science as well as management information systems. Many frameworks and methodologies have been developed to guide organizations to use their knowledge, competences or shared memory in a more efficient way. A number of KM instruments both, organizational and information and communication technologies (ICT), have been proposed.

After a number of years of discussing various approaches to KM, two groups of KM researchers can still be distinguished; the human-oriented and the technology-oriented. However, more recently there seem to be an agreement that successful implementation of KM requires the interaction of these two approaches and the various KM tools and enablers (Offsey, 1997; Meso and Smith, 2000; Bollinger and Smith, 2001; Koch, 2003; Chourides et al., 2003; Shankar et al., 2003; Maier and Remus, 2003).

In spite of the theoretical dispute, there are already a large number of KM activities implemented in engineering organizations as discussed in Chapter 3. Maier and Remus (2003) argued that in the absence of a commonly agreed framework, methods or procedures for implementing KM, these initiatives seem to "absorb" all kind of theoretical approaches as well as practical activities, measures and technologies without thorough consideration as to its strategic or business value.

This chapter outlines the need for a KM model to assist engineering organizations in successfully implementing KM. It also presents the requirements of the needed KM model. The Chapter then presents a proposed model for successful implementation of KM in engineering organizations and describes its various elements.

5.2 The Need for a KM Model

Engineering organizations embrace vast amounts of explicit and tacit knowledge in various areas that are critical to achieve business goals, such as knowledge related to product development and process integration (Rus and Lindvall, 2002; Shankar et al., 2003). Managing this knowledge effectively promises to allow engineering organizations to save time and money, improve quality and performance, and provide a competitive advantage. Therefore, organizations need to successfully implement KM to capitalize on their knowledge and achieve those benefits.

Lawton (2001) suggests that implementing KM involves many challenges and obstacles. Three issues are particularly important:

- *Technology issues.* Software technology supports KM, but it is not always possible to integrate all the different subsystems and tools to achieve the planned level of sharing. Security is a requirement that the available technology does not often provide satisfactorily.
- *Organizational issues.* It is a mistake for organizations to focus only on technology and not on methodology. It is easy to fall into the technology trap and devote all resources to technology development, without planning for KM implementation.
- *Individual issues.* Employees often do not have time to input or search for knowledge, do not want to give away their knowledge, and do not want to reuse someone else's knowledge.

An analysis of KM failures reveals that many organizations who failed did not determine their goals and strategy before implementing KM systems (Rus and Lindvall, 2002). In fact, 50 to 60 percent of KM developments failed because organizations did not have a good KM development methodology or process, if any (Lawton, 2001). Some organizations ended up managing documents instead of meaningful knowledge. This is an easy mistake to make, because many tools advertised as KM tools address document management rather than knowledge management (Rus and Lindvall, 2002).

The importance of deploying a methodology that provides a systematic and specified process for acquiring, storing, organizing, and communicating engineering knowledge has been recognized by an increased number of engineering organizations (Price et al., 2000; Nonaka and Takeuchi 1995; Schott et al., 2000; Koch, 2002; Sainter et al., 2000; Rus and Lindvall, 2002). However, despite the growing interest in KM and the number of KM frameworks and methodologies proposed in the literature which tend to emphasize different aspects of KM, there is a lack of commonly agreed procedures and methods to guide KM implementation. The lack of clear guidelines led to considerable confusion, especially among practitioners, regarding the question of what exactly they would have to do in order to implement KM. Thus, there is a need for a structured methodology and a framework that guides organizations to successfully implement KM.

5.3 Requirements of the Model

The needed KM model should consider all relating issues and introduce a framework that provides engineering organizations with detailed requirements for successful KM implementation. These requirements can be summarized as follows:

- Classification of the various types of knowledge available in engineering organizations according to their knowledge processing requirements (i.e. knowledge acquisition, development, and distribution). Different types of knowledge need to be handled differently. For example, the requirements needed to acquire explicit knowledge are different from that needed to acquire tacit knowledge.

- Identification of the steps in the knowledge management life-cycle within engineering organizations and how they accommodate the different types of engineering knowledge.
- Outlining the importance of deploying a KM strategy in the organization and describing the characteristics of such a strategy.
- Describe how the organization's KM strategy can be transferred to the operational level.
- Identify the knowledge infrastructure that is essential for effective implementation of KM. Such an infrastructure should consist of culture, people, technology, and structure that facilitate the knowledge cycle architecture of identification, acquisition, development, and distribution.
- Describe how the elements of the knowledge infrastructure facilitate the engineering knowledge life-cycle and specify interrelationships.
- Provide engineering organizations with a framework that identifies the requirements which are necessary to facilitate their knowledge needs. Organizations can then assess their KM status and determine the areas of weaknesses "gaps". The route of progress then becomes visible as organizations can focus on improving their weaknesses.

5.4 "SCPTS" Three-Layer KM Model

A KM model is presented to accommodate the requirements outlined in the previous section and assist engineering organizations in successfully implementing KM. The proposed "SCPTS" (Strategy - Culture – People – Technology – Structure) three-layer KM model was constructed and customized based on extensive literature review and exploratory work as described in

Chapter 4. The model was then tested, refined, and validated by conducting three in depth case studies.

The "SCPTS" KM model consists of the following three layers as shown in Figure 5.1:

- The first layer classifies engineering knowledge according to their knowledge processing requirements and places them in three categories:
  - electronic library which contains an organization's explicit knowledge that is easily codified;
  - documented procedures and lessons learned which represent tacit knowledge that has been transferred into explicit knowledge; and
  - experience and know-how which refers to tacit knowledge that employees gain through their work experiences and is not easily codified.

- The second layer includes the steps needed to manage the elements of the first layer. This layer constitutes the KM life-cycle composed of:
  - knowledge identification;
  - knowledge acquisition and development;
  - knowledge distribution; and
  - knowledge measurement and review.

- The third layer includes the facilitators and infrastructure that support the elements of the second layer. These are:
  - strategy;

- organizational culture;
- people;
- technology; and
- organizational structure.

A description of the various layers and elements of the model is presented in the following sections.

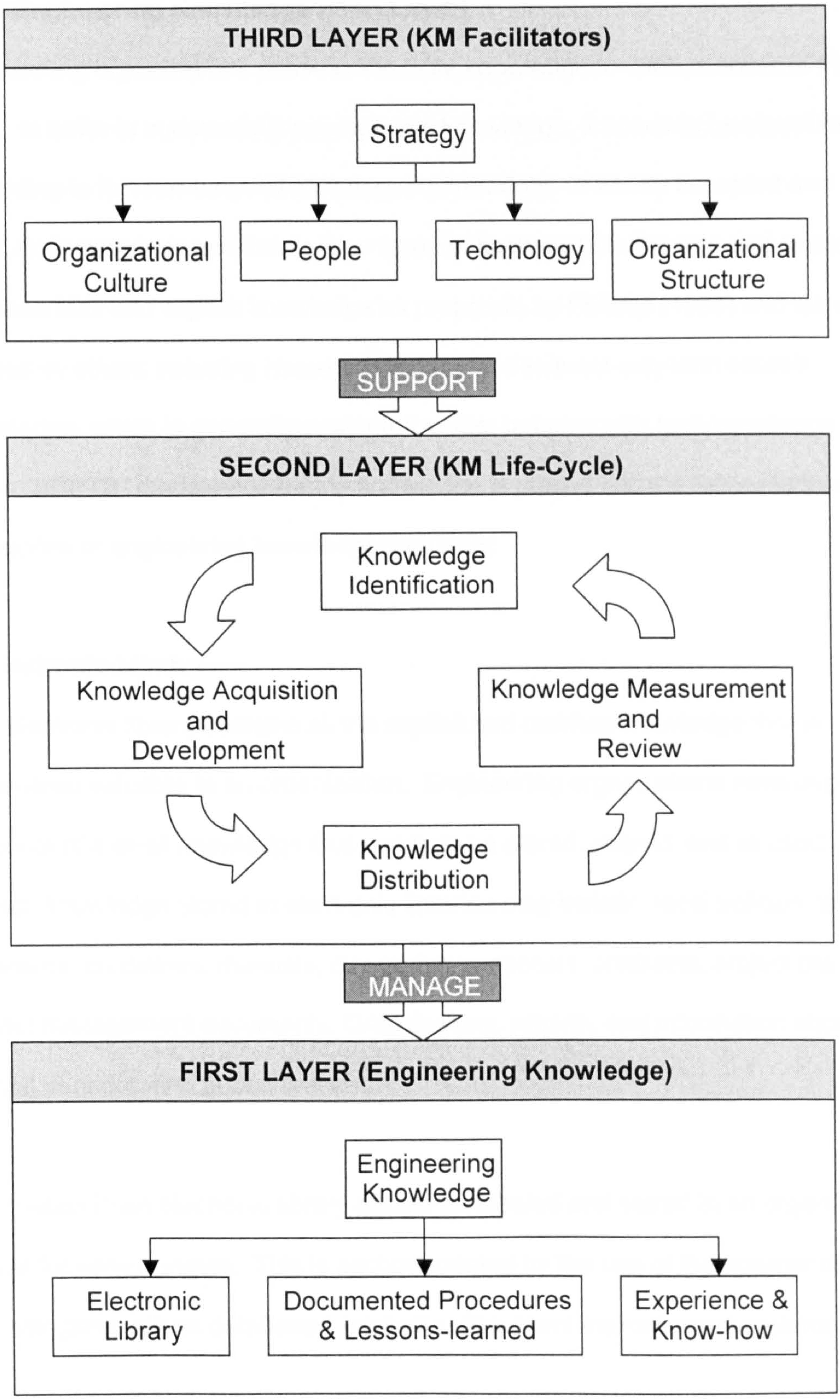


Figure 5.1: "SCPTS" three layer KM model

5.4.1 Engineering Knowledge (First Layer)

Engineering organizations possess valuable knowledge in various areas of their field. In order to successfully manage this knowledge, it needs to be classified according to its knowledge processing requirements. A widely accepted and used distinction between the various types of knowledge is the one that exists between tacit and explicit knowledge as proposed by Polanyi (1966) and later utilized by others including Nonaka (1991). KM deals not only with explicit knowledge, which is generally easier to handle, but also with tacit knowledge. In the "SCPTS" model engineering knowledge is placed into the following three categories or engineering knowledge elements:

1. Electronic Library

The electronic library contains all the explicit and codified knowledge that is considered valuable to an organization. Engineering organizations have large amounts of explicit knowledge that needs to be stored, shared, and re-used. Explicit knowledge stored in electronic libraries may include: local policies, laws, standards, guidelines, manuals, directories, proposals, contracts, project plans, project management documents, CAD designs, reports, and information about clients, vendors, and subcontractors.

Information in an electronic library should be labeled and stored in an organized format for easy retrieval. This is accommodated by the use of the appropriate technologies such as databases, intranets, document management systems, etc.

2. Documented Procedures and Lessons-learned

Engineering organizations rely heavily on work processes and projects to accomplish their tasks. During the commencement of these activities, tacit knowledge is generated through engineers' work experiences. This generated knowledge is an important resource for organizations and should be utilized for future use. The broad range of relevant knowledge and experiences resulting from work processes and projects may be depicted by the following examples:

- Knowledge and insights about procedures and dependencies that are needed to accomplish certain tasks. Such as a procedure to install or diagnose a certain device or equipment.
- Amendments to existing procedures. Experience gained from performing a certain procedure might identify the need to modify it. It might also provide tips of how to better perform a particular task or avoid certain mistakes.
- Solutions to problems encountered while performing a particular job as well as best practices.

The generated tacit knowledge is embedded in mental models, individual patterns, values, and insights and is extremely difficult to codify, document, and transfer to colleagues. Although not all tacit knowledge can be externalized into explicit knowledge that is easier to share, some of it can. Documented procedures and Lessons learned describe two ways to externalize tacit knowledge.

A documented procedure provides engineers with a set of temporally or logically ordered activities to reach a goal or complete a certain task. The procedures can be represented in a semi-formal computational symbolic notation, i.e. general activities and their relations are represented by formal symbols (boxes and vectors) and additional information is attached non-formally. An original procedure does not necessarily have to be a "real" procedure that has occurred in the past, but it can also be a potential solution of how things could or should be done in the future. In any case, the knowledge contained in a documented procedure should not be limited to the recording of static structures, i.e. network of activities, but should also include the capture of knowledge about why work had or has to be done in a certain way. Managing such knowledge empowers engineers to reuse it for the construction of procedures in innovative development projects. Documented procedures provide guidance, suggestions, and reference material to facilitate human performance of the intended tasks.

Lessons-learned is another form of capturing tacit knowledge and externalizing it into explicit knowledge. This special documentation allows engineers to record lessons learned form their work experience, share it, and make it available for future use. Lessons-learned documentation covers the full and detailed, descriptions of the identification and the solution of clearly explained problems. The questions raised and discussed during work reflection and can be documented in lessons learned can cover technical issues, organizational aspect or special social situations. Lessons learned should also include the description of failed approaches and those which are not chosen for implementation.

The documentation of a project is rarely meant for members of future projects. This type of documentation would represent methods and proceedings, outline precise problems, describe successful and unsuccessful solutions, mention persons to turn to and external experts, contain descriptions of successful co-operations and their success factors, hand down handling tricks etc. In this context especially descriptions of "lessons learned" would be helpful for following projects.

3. Experience and Know-how

Experience and know-how refers to the personal tacit knowledge that employees gain from their work experiences and is hard to verbalize or codify. This tacit knowledge may exist in the form of subjective insights, intuitions, and hunches. Engineering practice is a discipline that is enforced by the accumulation of skills gained through experiences. Additionally, engineering organizations depend heavily on knowledgeable employees (Peery, Staudenmayer, and Votta 1994). Therefore, it is particularly important for engineering organizations to recognize and manage tacit knowledge embodied in employees' experiences and know-how. This is critical as it empowers engineers to act more effectively in current situations and plan more efficiently future activities. Knowing what employees know is necessary for organizations to create a strategy for preventing valuable knowledge from disappearing.

5.4.2 Engineering Knowledge Interaction

The three engineering knowledge elements described in the previous section must be linked together to ensure continuous updating of an organization's stored knowledge. Knowledge stored in the documented procedures and lessons-learned should be used to update relevant explicit knowledge in the electronic library. Similarly, tacit knowledge of employees' experience and know-how should be used to update relevant knowledge in the documented procedures, lessons-learned, and the electronic library (Figure 5.2). For example, when knowledge gained from an engineer's work experience causes the need to amend a certain procedure or modify certain documents, actions are taken to update the effected engineering knowledge elements.

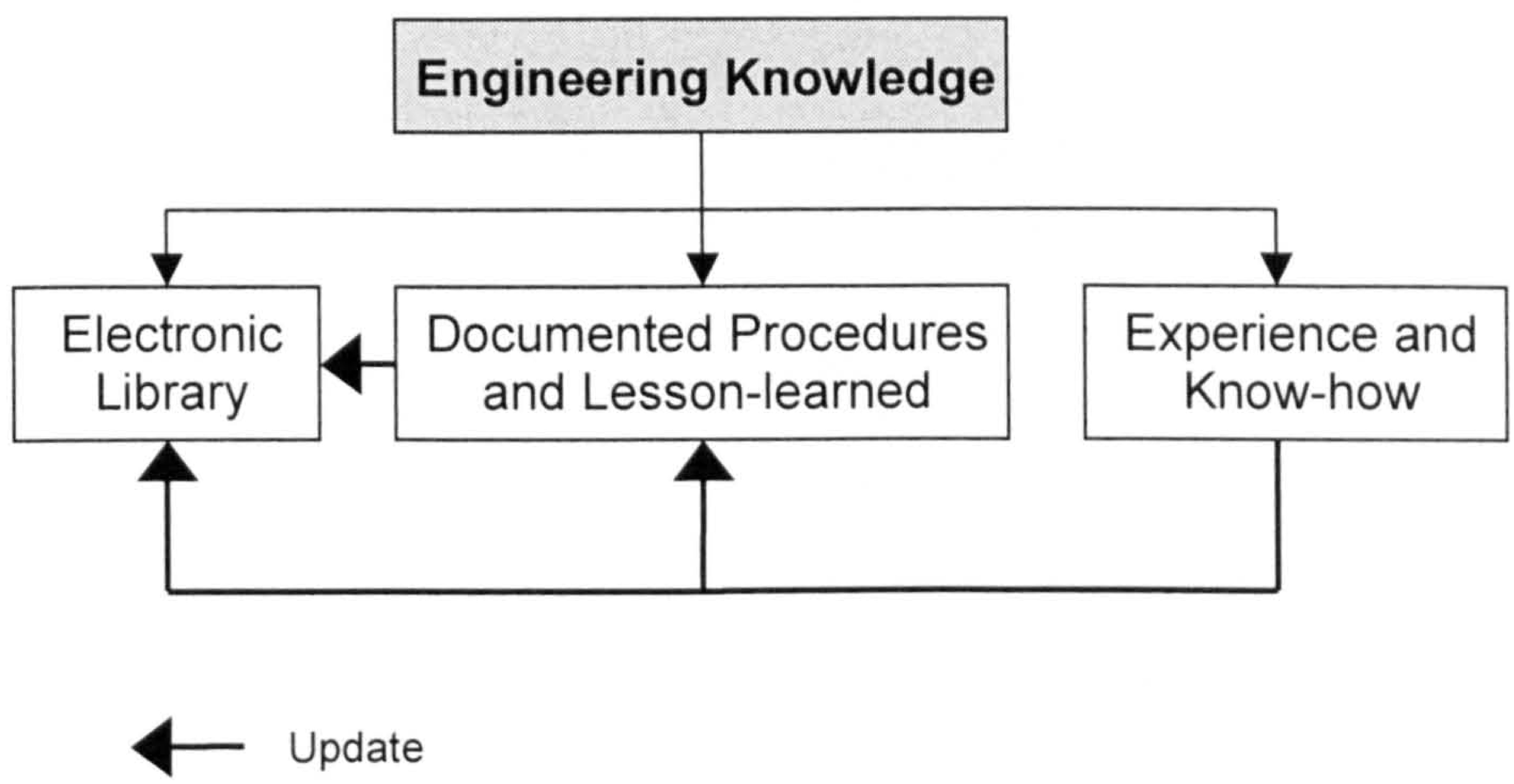


Figure 5.2: Engineering knowledge interaction

It should be noted that codified contents such as the components of the electronic library are merely information and need to be internalized into knowledge. Thus, the use of the term explicit knowledge in this context requires information to be delivered, to the recipient, in an understandable format to internalize into knowledge.

5.4.3 KM Life-Cycle (Second Layer)

The second layer of the "SCPTS" KM model consists of the steps needed to manage the engineering knowledge elements described in the first layer. These steps are the dynamics of managing knowledge and are defined as: knowledge identification, knowledge acquisition and development, knowledge distribution, and knowledge measurement and review. The four steps constitute organizations' KM life-cycle as presented in Figure 5.3. Following is a description of each step.

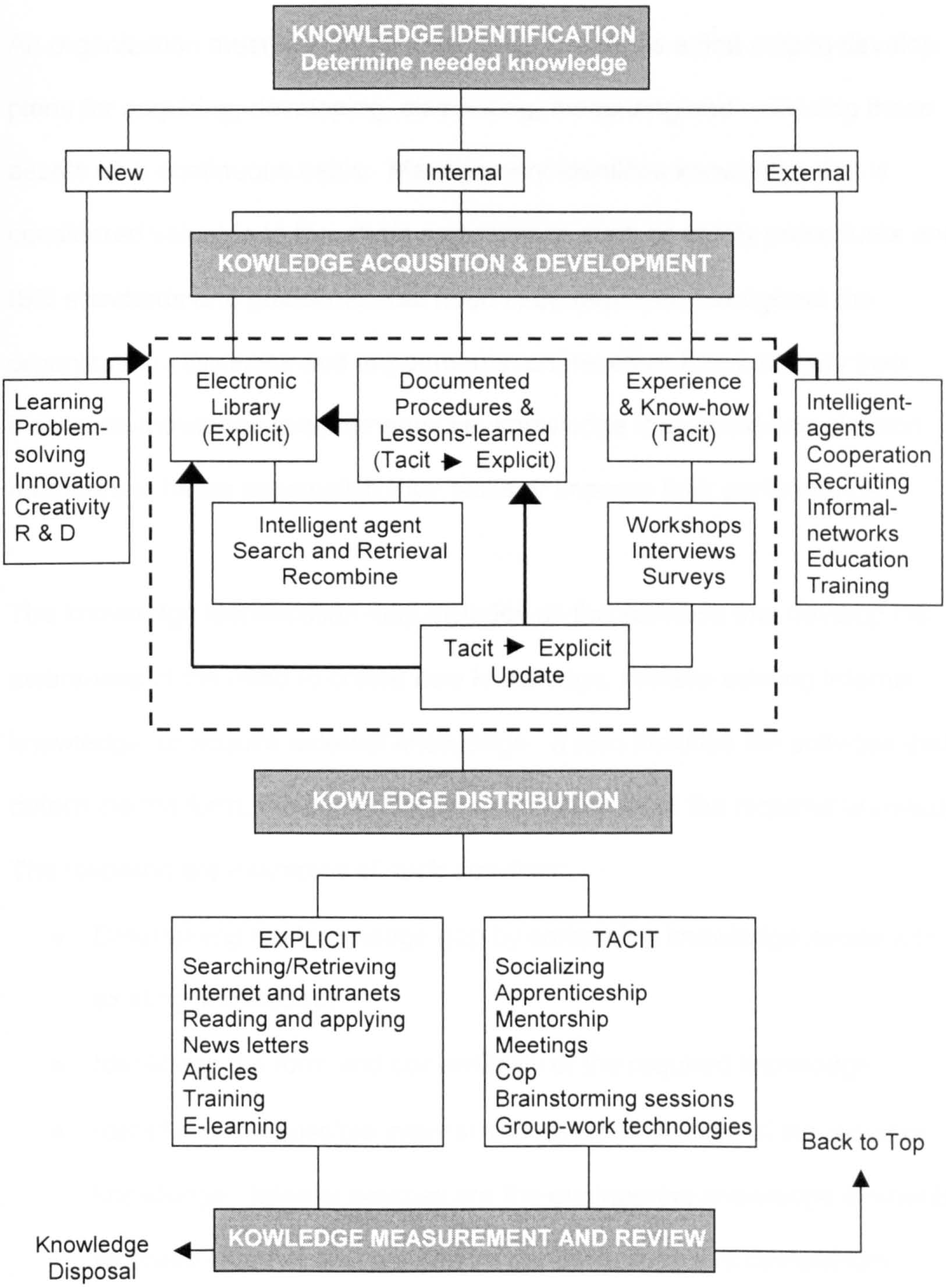


Figure 5.3: KM life-cycle in the "SCPTS" model

5.4.3.1 Knowledge Identification

An organization must identify its knowledge assets as a first step to develop plans for acquiring, developing, distributing, measuring and reviewing those assets on a continuous basis. Management identifies knowledge that is considered valuable to the whole organization such as safety procedures and ISO standards and guidelines that need to be deployed throughout the organization. Divisions and departments, on the other hand, identify their individual knowledge requirements, i.e. knowledge that would help division members to better accomplish their tasks or improve their performance.

The knowledge identification step includes all the activities that develop the awareness of the need to create new knowledge, retrieve existing internal knowledge, or acquire external knowledge. It also includes the activities that determine the form, the convertibility, and the owner of the required knowledge. The following are examples of such activities:

- Determining the knowledge gap by comparing knowledge needs with the existing knowledge;
- Identifying the form and convertibility of the required knowledge;
- Identifying the possible internal and external sources of the required knowledge. Internal sources are the engineering knowledge elements whereas external sources can be partners, suppliers competitors, vendors, etc;
- Identifying the need to create new knowledge.

5.4.3.2 Knowledge Acquisition and Development

Having identified the organization's knowledge requirements, an organization has to develop plans for acquiring and developing their knowledge needs before distribution. The knowledge acquisition and development step includes all the activities by which new knowledge is created, internal knowledge is retrieved, and external knowledge is acquired. It also includes the activities by which new and external knowledge are developed into the engineering knowledge elements, and the internal knowledge is combined and redeveloped. These activities include:

- creating new knowledge. Members of an organization create new knowledge through learning, problem solving, innovation, creativity, and R & D;
- acquiring external knowledge. Organizations acquire external knowledge through intelligent agents, cooperation with external partners, recruiting knowledgeable employees, informal networks (informal relations with external knowledge sources such as consultants), and employees' training and education;
- retrieving internal explicit knowledge from the electronic library, documented procedures and lessons-learned. Retrieving this explicit knowledge requires the application and usage of technological tools, later described in this chapter, such as search engines, databases, and customized software tools;
- combining and reconfiguring internal explicit knowledge to generate new knowledge. For example, modifying documents stored in the electronic library or using the stored lessons-learned to create new knowledge;

- externalizing convertible tacit knowledge gained from employees experience and know-how to documented procedures and lessons-learned;
- externalizing tacit knowledge through workshops, interviews, and surveys;
- updating and organizing the knowledge contained in the electronic library, documented procedures, and lessons learned;
- developing new, external, and recombined internal knowledge into the engineering knowledge elements;
- validating knowledge during development and before distribution. For example a proposed lesson-learned should be subject to validation by specialists in the relating field to check its contents and verify the accuracy of the suggested solution before the lesson is made available for others to view and reuse.

5.4.3.3 Knowledge Distribution

Knowledge needs to be distributed and shared throughout the organization, before it can be applied and exploited at the organizational level. The mode of distribution depends on the type of processed knowledge. Explicit knowledge and externalized tacit knowledge are distributed through searching and retrieving, Internet, company's intranet, reading and applying, news letters, articles, training, and e-learning.

The choice of the appropriate method depends on the knowledge complexity level and the nature of the provider and seeker. Simple knowledge or easily internalized knowledge such as laws, local policies, and standards can be distributed on a company's intranet bulletin board or through a news letter. More complicated knowledge but relating to a recipient's field of work and expertise such as new developments in an engineer's area of specialization can also be delivered in a simple format such as articles. However, when the knowledge is complicated or new to the recipient then training would be a necessity, for example training an engineer to install or repair a new equipment. This can be seen as resonant with Gagne's (1968) Conditions of Learning, later extended in Merrill's (1996) Instructional Transaction Theory to facilitate computerized learning as discussed in Chapter 3. It is therefore important to choose the appropriate instruction method to ensure effective learning and knowledge internalization by recipients during knowledge distribution.

Tacit knowledge that is difficult to codify is distributed and shared through formal and informal socialization. This takes place in the forms of sharing experiences, spending time with each other, apprenticeship, mentorship, meetings, Communities of Practice (CoP), brainstorming sessions, and group-work technologies. Creating the right organizational culture and structure as well as fostering employees' willingness to share their knowledge are essential for sharing tacit knowledge, as outlined later in this chapter.

5.4.3.4 Knowledge Measurement and Review

This step includes all the activities that aim at justifying and measuring the business value of knowledge, usage and application of knowledge, and reviewing knowledge for updating and disposal. Von Krogh et al. (2000) have identified three types of knowledge justification. The first type, strategic justification, includes justifying the newly generated knowledge against the advancement and survival strategies of the company. The second type, stakeholders' justification, focuses on evaluating the stakeholders' attitudes towards the newly generated knowledge. The last type, emotional justification, concerns the aesthetic value of the newly generated knowledge. Moreover, within the first type, one can distinguish two forms of justification. The first is the justification of conceptual knowledge, and the second is the justification of materialized/operationalized knowledge, i.e. the product, service or process on which the conceptual knowledge is used.

It is widely believed that an organization is a distributed knowledge system, which comprises of knowledge clusters or components (Walsh and Ungson, 1991). If these clusters are not reviewed or modified, they usually become passive (Leonard-Barton, 1992; Spender, 1996). Therefore, one of the important tasks of management becomes to review and replenish knowledge components continuously in the organization.

The critical property of knowledge components is that they can be reviewed, revised, and reconfigured (Spender, 1996). For example, Canon has developed a variety of products, such as copiers, scanners, and cameras, based on reconfiguring and modifying its knowledge-base (Meyer and Utterback, 1993). Review of knowledge components is important to deal with environmental stimuli, solve current organizational problems, and stress the applicability and risk of knowledge in current circumstances. Review of knowledge is also important because a large part of knowledge, if not used, can be easily forgotten or ignored. This phase in the knowledge life-cycle is particularly important to engineering organizations as they operate in highly dynamic technological and global competitive environments.

5.4.4 KM Facilitators (Third Layer)

The third layer of the "SCPTS" model constitutes the facilitators that support the KM life-cycle presented in the second layer. These can be considered as the forces that drive the dynamics of managing knowledge. The facilitators are: strategy, culture, people, technology, and structure. Clear strategies to create and maintain a knowledge infrastructure consisting of culture, people, technology, and structure to support knowledge identification, acquisition, development, distribution, measurement, and review are essential for effective KM implementation. Description of the third layer elements and their role in facilitating KM are presented in the following sections.

5.4.4.1 Strategy

Engineering organizations are interested in KM to obtain some or all of the following: competitive advantage, product or service leadership, operational excellence, customer intimacy, supplier relationship, employee relations and development, and reducing time; all of which are directly linked to organizations' strategic business goals. Therefore, KM deployment initiatives taken by organizations should begin with the definition of a set of goals that an organization aims to achieve through KM deployment.

KM implementation requires the conversion of organizational goals into implementable tactics. There are various methodologies that can aid this process. The "G-spot" methodology proposed by Greenberg (2001) and later presented in a framework for engineering firms by Shankar et al. (2003) is considered. The methodology is enhanced with the performance measurement domain (Neely et al., 1997; Harbour, 1997; Crawford and Cox, 1990) as it is a widely accepted and used method to assess KM initiatives (Del-Rey-Chamorro et al., 2003; Chourides et al., 2003; Gooijer, 2000).

Strategic planning for KM, shown in Figure 5.4, should begin with a set of end goals that KM aims to achieve. These could be; sustained preservation and leverage of knowledge to develop an intelligent organization, increase profitability, or obtain greater market leadership. Long-term strategies need to be designed to achieve these goals and should be linked to a top level measurement system. The KM strategy to achieve these goals would involve investing in long-term KM for sustainable knowledge leverage and reuse. It should also strive to identify and "clearly" demarcate the organizational knowledge across various scopes of organizational working. It should then develop plans to support the acquiring, developing, distributing, measurement, and review of the required explicit and tacit knowledge within the organization. Additionally, the KM strategy should develop plans to create an organization infrastructure (culture, people, technology, and structure) that facilitates the KM life-cycle.

At the operating level, the plans should be associated with predefined objectives. These objectives should be linked with key performance indicators (KPI) to measure the contribution of KM solutions within the organization against its objectives. For each measurable objective, an implementable plan must be defined. The deployment of such plans requires implementable tactics at operating levels. This would finally result in the emergence of new objectives at the strategic level and fresh tactics at the operating level that would enable engineering firms to move up in its knowledge value chain.

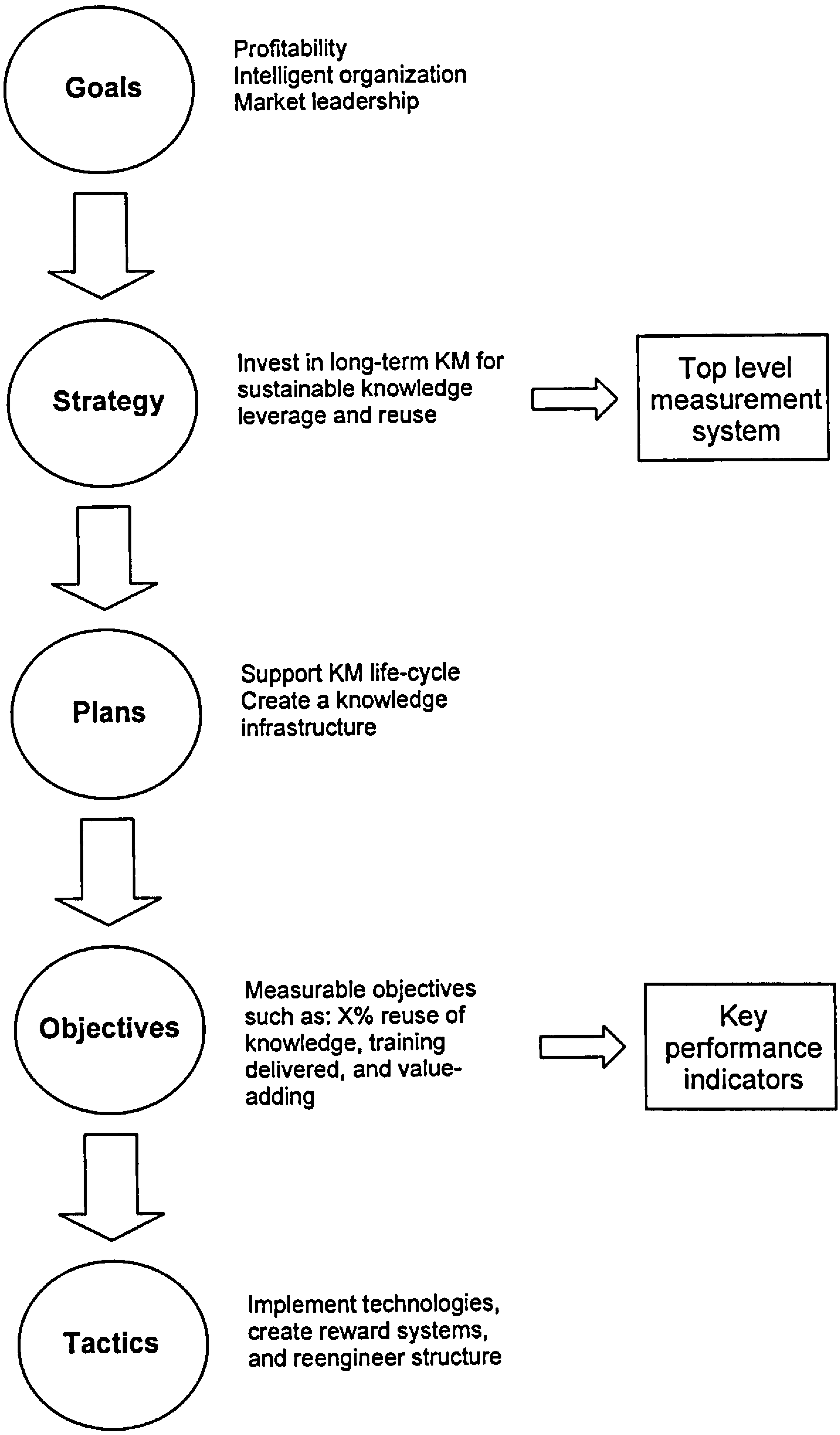


Figure 5.4: KM strategic planning

5.4.4.2 Organizational Culture

Lack of "knowledge culture" has been cited as the number one obstacle to successful KM (Agresti, 2000). Organizational culture is critical to promoting learning and development, and the sharing of skills, resources, and knowledge. The success or failure of an organization's knowledge management cycle rests heavily on the company having an accommodating culture, and its ability to manage and motivate its employees, as people are at the heart of the knowledge management philosophy. If organizations don't foster a sharing culture, employees might feel possessive about their knowledge and won't be forthcoming in sharing it.

Employees know that organizations value them because of their knowledge; they might assert that they will be considered redundant and disposable as soon as the employer has captured their knowledge. Additionally, employees might not be willing to share negative experiences and lessons learned based on failures because of their negative connotation. So although KM's purpose is to avoid similar mistakes, employees might fear that such information could be against them. Another hurdle is the "not invented here" syndrome – some believe that engineers are reluctant to reuse other people's solutions (Rus and Lindvall, 2002). Although change is hard, such beliefs must be revisited and replaced by a positive attitude that engenders and rewards sharing.

Many firms have cultures which do not support KM practices. For example, if employees are accountable for their time and the reward system and promotions are decided on the basis of value-added performance (i.e.

performance in adding value to products/services to the customer), it would be rare to find an employee who spends time on knowledge sharing projects if they are not recognized value-added activities. Similarly, if there were neither assessment nor credit given for KM activities within the firm, knowledge management would always be at the bottom of in-trays, possibly never to be seen again.

Reward systems are sometimes based on what a person knows and individual effort, and may be a source of advancement within an organization. One way to overcome this is to reward information sharing, but this can be difficult to measure. Once a reward system has been instituted, the quantity of knowledge shared is likely to increase, but the quality may decrease (Scheraga, 1998).

The creation of appropriate rewards, recognition and compensation to derive KM is essential. The reality of knowledge sharing in practice is that people must be liberated to take time out to adjust to the KM tools, learn how to use them and what KM's benefits are in the long run as well as the immediate future. And perhaps most importantly, they are able to review KM's effectiveness, including self-evaluating effective knowledge transfer. The traditional practices of recognition and reward will therefore need to be modified in a knowledge-intensive and learning environment. In particular, the encouragement of key behaviors through personal recognition is an effective management tool.

In light of the aforementioned obstacles, it is evident that organizational culture plays a primary role in the likelihood that employees will be willing to work together and share their knowledge. If the culture is not supportive, or the reward system favors only individual efforts, it may be difficult to get people to work together. People will not be willing to share their knowledge if there is a lack of trust and respect, and if they sense a lack of interest in common goals. A knowledge culture is characterized by the following:

- fostering love, care, and trust among members of the organization;
- seeing failure as an opportunity to learn rather than punishing it;
- recording and sharing of knowledge is routine and second nature;
- individuals are visibly rewarded for team work and knowledge sharing;
- actively discourages holding of knowledge and being secretive about best practices;
- encourages asking for help from expert co-workers;
- job satisfaction and security;
- constantly seeking best practices and reuse of knowledge;
- allowing time for creative thinking;
- physical space supports knowledge development and sharing, for example, working in open space and providing meeting rooms.

5.4.4.3 People

People are the core of knowledge management; this includes employees and managers. Employees are the key source of knowledge owned and managed by an organization. They are the ones who create, acquire, and are able to share knowledge. Managers, on the other hand, have the task of developing knowledgeable employees and creating the environment and infrastructure which is needed to support KM. People's role in KM is considered in three aspects: managers' role; employees' skills; and employees' willingness to share their knowledge. The first two aspects are described below, while the third one is directly linked to the organizational culture as described in the previous section.

Managers' Role

The success of KM requires the involvement of managers at various levels in an organization. Top managers have to provide a KM vision, produce a detailed KM strategy, and practice their leadership role. Leadership's primary focus should be on establishing a culture that respects knowledge, reinforces its sharing, retains its people, and builds loyalty to the organization. The loyalty and caring of a workforce organized in teams that share individualized knowledge comprise the heart of long-term competitive advantage. A second area of focus should be in ensuring that middle managers and line supervisors are well informed of the KM strategy and provide them with adequate training, empowerment, and support to promote it. Third, leadership should focus on establishing a knowledge infrastructure that enhances and facilitates the KM life-cycle. In medium and large organizations, there is a need for a knowledge officer, or similar position, at the top management level to coordinate KM activities throughout the organization.

Middle managers' role is critical as they are the link between top management and lower levels in the organization. This focus can be seen as resonant with

Nonaka and Takeuchi's "middle-up-down management" (Nonaka and Takeuchi, 1995). The role of middle managers may include the following:

(1) Identify the required knowledge within various divisions of the organization.

(2) Transfer the organization's KM strategy into specific plans, actions, processes, and defined KM roles.

(3) Communicate top management values, norms, and concerns to lower levels in the organization.

(4) Motivate, mentor, and coach their employees to share their knowledge.

(5) Facilitate learning and the acquisition of new knowledge through providing their employees with the required training as well as utilizing recruiting of knowledgeable employees as a source of acquiring external knowledge.

(6) Develop an infrastructure that supports knowledge development and sharing within divisions. For example through emphasis on team-working.

(7) Assign specific teams the responsibility of creating and maintaining the organization's knowledge management systems such as database and knowledge repositories.

Employees' Skills

Employees must possess the knowledge, skills, experience, and continuously learn and create new knowledge for organizations to benefit from sharing that knowledge. Therefore, it is particularly important for organizations to develop knowledgeable employees. One thing organizations can do is to utilize recruiting as a source of acquiring needed external knowledge. Another thing will be to facilitate learning and the acquisition of new knowledge by offering training to individuals in areas where knowledge is needed or desired. If the type of knowledge to be transferred is tacit knowledge, traditional training methods may not suffice. Tacit knowledge is difficult to codify and store, therefore active learning will be more effective (Ellerman, 1999). This can include the use of mentors, apprenticeship, imitation, and guided learning-by-doing. The active learning process outlined by Ellerman (1999) requires that the learner have an active role in acquiring the knowledge, rather than having it fed to them. Since learning is contextual and builds on prior knowledge, the new knowledge gained by learners will differ from that of the teacher. Organizations must also encourage and motivate employees to improve their skills through continuous learning.

5.4.4.4 Technology

Technology is a fundamental enabler of KM in contemporary organizations. Numerous technologies are being offered to enable KM such as the Internet, intranets, group-ware, list servers, knowledge repositories, database management, data-warehousing, data mining, expert systems, and neural networks. These technologies will not only allow organizations to store, organize, and disseminate explicit knowledge but can also aid in externalizing and socializing tacit knowledge.

Many firms are beginning to establish knowledge management systems, which include efforts to codify knowledge in repositories as well as efforts to link individuals using IT based on Internet, Intranet, and Extranet to overcome geographic and temporal barriers to accessing knowledge and expertise. Following is a description of various available technologies and their role in facilitating the KM life-cycle.

Hardware Technologies

Information and communication technologies (ICT) have transformed the ability of both individuals and organizations to augment their intelligence via accelerated learning. Personal computers coupled with local and wide area networks have expanded the connectivity and availability of computing power, which have acted as the catalyst and increased the potential of sharing knowledge between collaborating organizations. While the Internet has transformed communication between organizations and individuals, intranets and extranets have had similar effects within organizations. An intranet is a private version of the Internet making use of the same system standards and protocols to allow the sharing of information and knowledge within an organization. If such arrangements are extended to collaborating partner organizations, the system is known as extranet.

Local and wide area networks may considerably benefit engineering organizations in activities such as:

- Collaboration with clients and colleagues. Ideally, establishing communities of practice (CoP), semi-informal networks of internal employees and external individuals based on shared concerns and interests. Often such communities take the form of "virtual teams".

- Access to the existing databanks
- Access to relevant documents, multimedia files, experts, and training courses.
- Using modeling and decision support software. Examples of Web-based decision support environment were presented by Yan et al. (1999).
- Remote access to knowledge bases.

Since all of the activities mentioned are connected to accessing and exchanging knowledge, it would be reasonable to link these to the research in knowledge management. Due to globalization it might be useful for some organizations to support these activities by wide-area telecommunications networks, namely Internet. In order to simplify access to services, the easiest way to arrange these services would be through building a Web-based knowledge portal (site) providing access to specialized sites with the mentioned services (Lawton 2001).

Software Technologies

Software has been developed to support knowledge management and organizational learning on intranets and extranets, and covers database tools (e.g. data warehouses, document management systems, and capability management systems), collaboration tools (e.g. e-mail, groupware, and videoconferencing), and intelligent tools (e.g. expert systems and neural networks). Such software greatly assists in the building and sharing of explicit and tacit knowledge.

Databases or knowledge bases supported by search engines enable organizations to develop, acquire and distribute its explicit knowledge. Document Management Systems enable organizations to develop and organize explicit knowledge such as project documentation, to be stored and later retrieved for reuse. An engineering project involves a variety of document-driven activities. The work frequently focuses on authoring, reviewing, editing, and using these documents, which become the organization assets in capturing explicit knowledge. Therefore, document management (DM) is a basic activity toward supporting an organization's implementation of a KM system. DM systems enable employees throughout the organization to share documented knowledge. Many commercial tools support DM, such as Hyperwave, Microsoft Sharepoint, Lotus Domino, and Xerox DocuShare.

Specialized and customized engineering software such as CAD and project management tools can be utilized to support KM. In engineering organizations, such tools are continuously used to create engineering knowledge. Organizations can easily organize and store this knowledge for future retrieval and reuse.

Competence Management (Expert Identification) Systems enable organizations to identify sources of tacit knowledge, experience and know-how of its employees, as a first step of acquiring and distributing this knowledge. An organization must track who knows what to fully utilize undocumented knowledge. An elaborate solution to this problem is competence management, or skills management. Competence management systems such as SkillScape and SkillView, include tools that let experts generate and edit their own profiles. Other tools, such as Knowledge Mail, automatically generate competence profiles by assuming that peoples' emails and documents reflect their expertise. These tools analyze email repositories and documents and builds keyword-based profiles that characterize each employee. A simpler expert identification system can be established using an of the shelf database. Information about employees and their line of expertise is stored in a database. Data about ways of contact such as phone numbers, emails are included. External suppliers can be included in such a database, e.g. suppliers, consultants, vendors, etc.

E-learning or electronic learning is instruction that is delivered electronically via web browsers such as IE or Netscape, Internet, Intranet, CD, DVD, etc. E-learning utilizes computer technologies to create, foster, deliver, and facilitate education, training, and learning. It provides organizations with practical and cost-effective means of enhancing employees' skills and expertise and distributing explicit knowledge.

Documented procedures and lessons-learned systems enable organizations to externalize its tacit knowledge. Thereby, allowing organizations to capitalize on their experiences. The resulting explicit knowledge is easier to develop and distribute. Such systems are particularly important to engineering organizations as they rely heavily on work processes and project settings.

Artificial intelligence tools based around expert systems and neural networks also contribute to knowledge management. Although still developing, neural networks feature computers that "learn" through experience, thereby mimicking human learning.

Collaboration tools such as group-ware, video-conferencing, virtual meetings, and CoP enable organization to share tacit knowledge that is hard to externalize. Such technologies will allow socializing, discussions, and exchanging ideas, particularly when project teams are composed of participants from various locations.

The storage and communication of knowledge is central to the way in which an organization capitalizes on its knowledge base. The nature of the knowledge to be considered determines the media to be deployed. Engineering organizations need to capitalize on the staring advances in information and communication technologies (ICT) and utilize it to manage their knowledge. Only those businesses reacting to new technologies and establishing an ICT infrastructure that supports their knowledge needs will be able to manage knowledge effectively. It should be noted that organizations need only to deploy technologies that facilitate their needs.

5.4.4.5 Organizational Structure

Organizational structure can support or hinder the KM life-cycle within organizations. A facilitating structure is mainly important for the development, acquisition, and the distribution of knowledge. Such a structure is generally flexible, flat, and decentralized. A flat structure shortens the communication lines between employees mutually and between employees and their management. Functional groupings allow the interchange and development of ideas between specialists in the same field. One the other hand, the use of project teams and groups within functional departments or divisions enhances knowledge development and sharing.

Cross-functional teams, matrix structures, and network organizational structures proofed to be effective in facilitating KM. Functional barriers are low allowing for the crossover and disseminating of knowledge. Additionally, cooperation of the firm with external actors like other firms or research institutes can be a main source of acquiring external knowledge. Another way of acquiring external knowledge can be utilized through encouraging the development of informal networks such as communities of practice.

5.5 Summary

The Chapter started by setting the ground for the introduction of a new model for the successful implementation of KM in engineering organizations. It outlined the need for a KM model in engineering organizations and summarized the requirements of this model. The Chapter then introduced the "SCPTS" three-layer KM model to meet the requirements of the needed model. The various layers and elements of the model where then described indicating the interactions between them. The model aims to provide a framework to assess engineering organizations in successfully implementing KM. This chapter provides management with guidance that contributes to meeting their business objectives.

CHAPTER 6

CASE STUDIES

6.1 Introduction

The use of case studies in this research aims to test and validate the model produced in the previous chapter in as close to a "real life" situation as possible. While the elements and issues described by the model are "logical" and supported by the literature, it was important to experience the actual implementation of the model in a real organizational setting as much as possible. In addition, to solicit the opinions of the people involved with knowledge management in organizations regarding the usefulness and practicality of the model in these real situations. It is worthwhile to state that when using the model in the case studies the focus is to compare current practices against the critical factors identified by the model in order to determine strengths and weaknesses, and identify any performance gaps.

In this research, organizations selected as case studies were based in the Middle East. The organizations are characterised under different sizes, sectors, and levels of knowledge management implementation, applications, and initiatives. They fall under private and government sectors. Those organizations are from oil, computer, and consulting industries. They are also characterised as large, medium, and small size.

This chapter presents three case studies that were conducted in three different engineering organizations: a major joint government-private oil company (Oilco), a computer solutions and network provider (Compco), and a consulting company (Consultco).

The cases are presented in a similar structure, as shown in Table 6.1. First, an overview of the company is presented, then a review of the status of knowledge management in the company. This is then followed by a description of the company's knowledge management initiatives. The study will then present analysis and discussion on the case study addressing each attribute of the KM facilitators as presented in the "SCPTS" three-layer KM model. These are: strategy, organizational culture, people, technology (information technology infrastructure), and organizational structure. The chapter ends by presenting a summary of the cases and general concluding remarks.

Case Study
Company profile
Knowledge Management
KM Initiatives
Analysis and Discussion
Strategy
Organizational Culture
People
Information Technology Infrastructure
Organizational Structure

Table 6.1: Case study structure

6.2 Oilco Case Study

Oilco is a leading oil company in a Gulf State owned by the state's National Oil Company and a consortium of foreign oil companies. Oilco can trace its history back for more than 60 years, to the very beginnings of the oil industry in the Gulf. The search for oil in and around the Arabian Gulf dates back almost a century, to the years before the First World War, when exploration began in countries like Iraq and Iran.

Oilco Carries out the activities of exploration, production, development and export of crude oil and natural gas materials extracted from the concession area operated on behalf of its shareholders. The company operates and produces oil mainly from five fields. These fields are linked to the storage and shipping facilities where tankers load crude oil for export to markets in various parts of the world.

Over the years, Oilco has developed significantly with the increase of the company's production capacity. Oilco launched a number of gas-related projects, water distillation plants, field development projects, and continued to strengthen the company's infrastructure. Currently, Oilco has fully facilitated fields, a newly reconstructed head office, and a workforce of more than 2600 employees.

Oilco is structured into functional divisions as shown in Figure 6.1. Divisions within Oilco are: the engineering division, drilling division, product development division, planning division, human resources division, and information technology division. Each division operates and provides services in its specialized function. Within divisions teams are formed and used to achieve allocated tasks. Oilco's management emphasizes teamwork as it believes that team members wrestle with common problems, they learn form each other, and share their knowledge. Cross-functional teams are also formed when necessary, i.e. when tasks to be completed are multidisciplinary.

The company is headed by a general manager, deputy general manager (operation), and two assistant general managers (Technical and administration). Management reports to the Board of Directors which is overlooked by the Joint Management Committee consisting of two executives representing the National Oil Company and one from each of the other shareholding foreign oil companies.

Oilco operates under a management by objectives system. The company's business goals are transferred to specific objectives (targets) at the management level as well as the division, department, and team levels. Plans are then developed to meet these objectives. In late 1999, Oilco started the development of a Performance Management System designed as a strategic management tool to achieve better management of its objectives and associated work-plans. As a result of these initial efforts, a Corporate Balanced Scorecard was developed and implemented. This recorded progress in a range of performance measures towards the company goals and objectives.

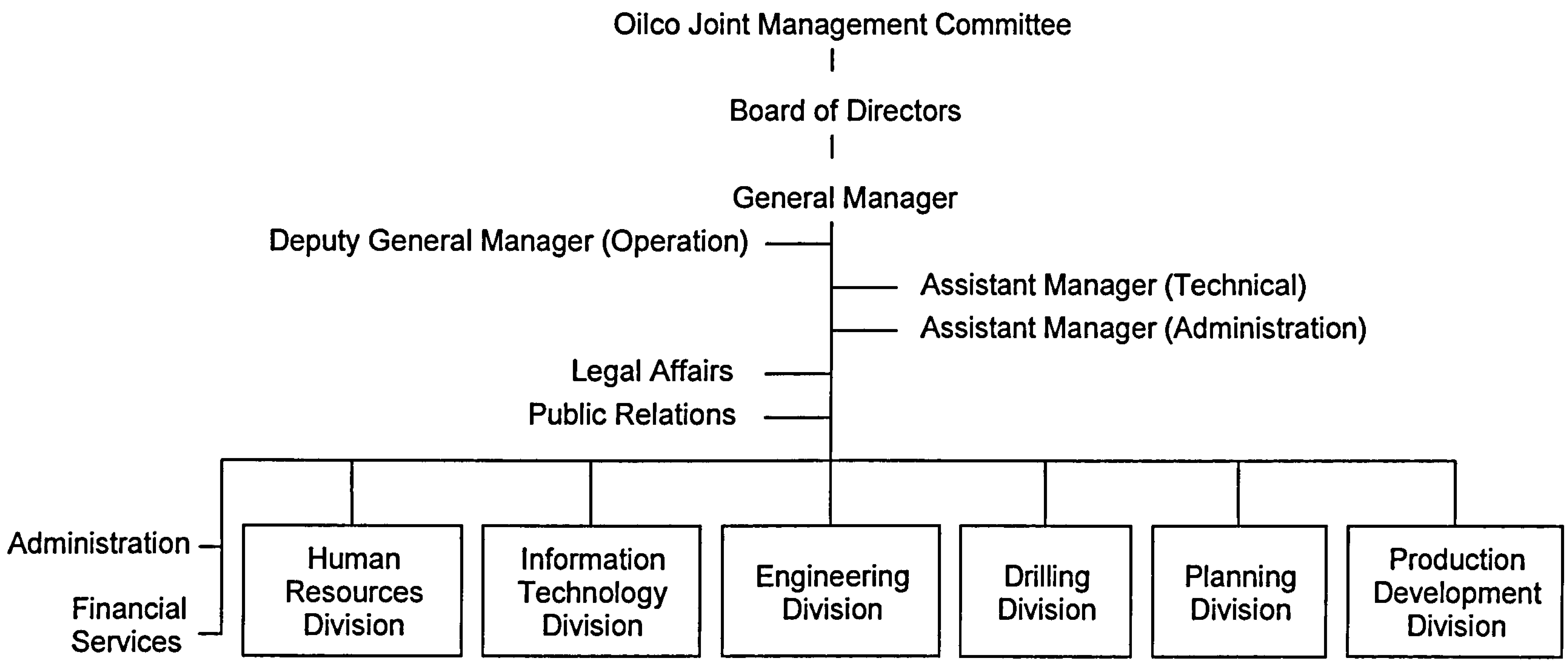


Figure 6.1: Oilco Organizational Chart

A system of contracts was then developed, with the contracts being designed to provide a basis for agreements between the company and its managing board. The core of the contracts is set of Key Performance Indicators (KPIs) grouped into various categories. The company is allocated the task of developing the necessary processes to permit them to meet the KPIs.

In June 2001, Oilco and the Oilco Board of Directors signed the first performance management contract. It included 10 key measures and laid down targets for 2001. An expanded contract signed for 2002 included KPIs related to 'value' and 'organization', in accordance with shareholders' requirements. Oilco recorded an excellent performance in terms of all areas covered under the 2002 Performance Contract, with a weighted score of 97.3 out of a possible 100 for all the KPI base targets of the year.

The Company's Performance Management System (PMS) is now firmly embedded at all levels of the organization. Managers throughout Oilco routinely make use of the PMS to help them focus their resources on key corporate objectives, to achieve the corporate KPI targets, to review their progress, and to drive the improvements in performance.

The overall progress made towards meeting the Performance Contract is assessed quarterly by the company's own management team, through Quarterly Performance Reviews (QPRs) and three times a year in a company shareholder forum. The internal QPRs review business improvements made and also discuss and agree to any corrective action required to address shortfalls and to meet the annual performance contract, with results of the meetings then being presented at the forum with shareholders.

The contract KPIs and their associated targets are continuously refined by management and through joint forums with other operating companies within the National Oil Group. The aim of such forums is to address the standardization improvement of KPI's.

6.2.1 Knowledge Management in Oilco

Despite the fact that Oilco does not have a corporate knowledge management strategy yet, the Company's Top Management have had a vision of knowledge management through its shareholders for the last few years. This vision was directly linked to the corporate performance improvements and future competitiveness strategy. Division Managers were allocated the task of developing knowledge management initiatives within their divisions. Different divisions within the corporation responded with a number of KM initiatives and this resulted in a fragmented corporate knowledge management strategy. These initiatives, described later in this chapter, include: Lessons Learnt System and Electronic Document Management System (Engineering Division); Drilling Information Management System and After Action Review System (Drilling Division).

Running parallel to this was a focus on the role of two divisions in facilitating KM; Information Technology (IT) and Human Resources (HR). Oilco's management emphasizes the role of the IT Division in facilitating the company with the newest technologies and establishing an integrated IT infrastructure. Additionally, there is a focus on the HR Division in developing employees' skills through recruiting, training, and career development programs.

Information Technology Division

Advances in Information Technology and the increasing use of IT within the company, prompted the formation during 1994 of the Information Technology Division. PC stations were being established throughout the company, as well as the Local Area Networks in two of the company's five sites each linked to Head Office by an upgraded telecommunications network.

As the production capacity and the drilling activities were rising in 1995, progress was continuing on the IT front too. Systems that permitted staff to access the Internet were introduced for the first time, and with the promise that the State's Telecommunications Company was shortly to introduce an email service, "How did the company ever operate without it", the IT manager noted.

The IT revolution was continuing in 1996, with a complete transformation during the year due to the newly created Oilco Intranet. All those who had PCs were able to communicate with each other through email and to access information through the company's Intranet. In 1999, progress continued on the IT front, with the introduction of equipment to permit all members with PCs to exchange messages with people outside the company.

The Intranet has been positioned as central in the efforts of KM in Oilco. The Intranet is used to store and support information on various knowledge areas. The capture of best practices and the facilitation of professional networks are critical elements. Explicit information such as standards, guidelines, template for formulas and other documents are part of the Intranet-facilities, not to mention email communication, bulletin boards and corporate information. Oilco Intranet is organised as the major competency structure of the company, to support administrative procedures (support) and document procedures (in projects). Use of the Intranet by Oilco employees is overwhelming.

Currently, Oilco employs a host of IT systems including office/document handling, CAD, project management tools, and a number of engineering software. Oilco has implemented several management information systems and partially integrated them with other systems, for example enterprise resource planning (ERP) systems and document handling systems. The aim is to integrate accounting, human resources data, engineering data and project management as well as building up an information database. Additionally, the company employs several engineering information management systems (EIM), two of which are DIMS (Drilling Division) and eDMS (Engineering Division). These systems are described in the next section. All the above systems play a role in managing knowledge at OIlco.

Human Resources

The two key tasks for the Human Resource Division, when introduced in 1997, were to ensure the alignment of recruitment, training and career development programmes with Oilco's long term business plan and, an issue that was to become of interesting importance in the years ahead, employee attrition, as long-serving employees reached the age of retirement, or chose to leave.

Corporate Development and Training was established with a mission to support the corporate drive for performance improvement and future competitiveness through systematically ensuring that all of Oilco's employees are equipped with the right skills, competencies and knowledge base necessary for delivering strategic objectives of short and long range term. Corporate Development and Training goals are to:

- Achieve employee growth
- Support corporate objectives
- Be the preferred supplier
- Establish a learning environment
- Exploit IT for learning enhancement
- Work in partnership with all our stakeholders (internally and externally)

Corporate development and training continues to introduce new learning and development tools and methods in an effort to provide Oilco's employees with various ways of acquiring knowledge and improving skills. In 2001, Corporate Development and training launched an e-learning program with a five-year strategy as part of knowledge management. Employees are encouraged to use the learning and training tools available to them, some of these training programs are compulsory where others will advance employee's promotion. A senior employee welcomes the way in which competency programmes have been introduced and developed, in particular the Cascade Competency Programme and the current professional and general programmes. "These are making a good contribution in terms of developing the company's employees", he says, "while the core competency programmes give all employees the skills to their jobs better".

"Oilco Family" Culture

Another important aspect of KM at Oilco is the company's culture. Although this was not directly aimed to support KM, the company has succeeded over the years in developing a positive corporate culture that has contributed significantly to its corporate success. The "Oilco family" culture, characterized by love, trust and security among employees, developed the willingness amongst employees to share their knowledge.

Management efforts to create the "Oilco Family" culture among the company employees started long before its commitment to knowledge management and are demonstrated in the following:

- Good pay package and end of job compensation
- High standard medical health care
- Job satisfaction and security
- Rewarding and recognition
- Support continuous development of employees, either though sponsoring them to continue education or providing them with the required internal and external training

- Excellent facilities, either in the main office or the fields. Those who work in the oilfields enjoy modern facilities and a safe working environment that permit them to carry out their tasks without any undue hardship
- Encourage socialization and the development of a concept of community
- Open office design within departments
- Despite the large number of employees in the main Head Office, people seem to mostly know each other

Long-serving expatriate members of staff explain their decision to stay so long with the company as a result of its secure and stable environment. One member of staff with more than 30 years service commented: "For me, Oilco is the best possible company. It looks after its employees with real concern, offers a good pay package and provides a variety of other excellent fringe benefits".

His remarks are echoed by another employee, who says, "I have stayed with Oilco, because the company has provided me with security, job satisfaction, a good working atmosphere and excellent facilities".

Part of the way in which the Company has been able to create, and to maintain, such a good feeling of being the 'Oilco Family' over the years is the competitiveness between fields and terminals, not just in work, but in a host of sporting activities. That, after all, helps to maintain a good work ethic and is why, right from early days, Management has consistently provided funds and facilities to the leisure interests of employees.

In his farewell message, a retiring senior employee recalled that the company had sent him to Britain for education, culminating in a Higher National Diploma, adding that he "was very grateful to Oilco for its total support and commitment towards my development in the company. I only hope that I have contributed enough to Oilco in my many years of employment to repay this commitment".

"The most interesting thing", a senior manger recalls, "is the pronounced company culture a newcomer finds in Oilco. It is amazing how the older generation combines with new members of the workforce and the new recruits soon discover that they have joined a high-class company, where there is a common commitment, a common attitude, and a shared dedication to hard work...the professionalism and support was tremendous".

6.2.2 KM Initiatives

6.2.2.1 Lessons Learnt System (Engineering Division)

The Engineering Division first implemented the Lessons Learnt System in 1999, realizing Oilco's top management KM vision and as part of the company's continuous improvement strategy. The engineering division identified the need to share knowledge gained through employees' experiences and considered managing this knowledge to be valuable to improving their performance. The lessons learnt system was created as a tool that helps engineers to learn from what they are doing now for better performance in the future. The system aims were to:

- Enhance communication
- Exchange experience

- Share knowledge among Engineering Division staff
- Ensure continuous improvement to the specifications, procedures, and work practices.

Every employee can report a lesson learnt that is factual, simple, positive, and specific. There are no special requirements for approval prior to publication. Sound recommendations are taken on board by modifying procedures, revising specifications or issuing work instructions.

a) Searching for a Lesson Learnt

The company's intranet was utilized to support the system. All Oilco staff members can access the lessons learnt system through the company's intranet. Search is available either by category (e.g. engineering, operations, construction, etc.) or topic. All the relevant lessons learnt will appear. Choosing any lesson will allow the user to view the lesson learnt report. The lesson learnt report includes the following details:

- Lesson learnt number and date
- Category
- Area (Location)
- Topic
- Submitted by
- Problem definition
- Action taken
- Lesson learnt
- Line supervisor comments

- The final recommendations.

b) Adding a Lesson Learnt

The process of adding a lesson learnt, outlined in Figure 6.2, is as follows:

- Engineers access the system through the Intranet.
- They will then choose to add a new lesson. At this time, they are asked for their company number that authorizes them access to write a new lesson.
- The lessons learnt report appears, with the employee's name and position in the organization. The lesson learnt is given a unique identification number.
- The engineer will choose a category, an area, and a topic.
- The engineer will be asked to input the problem definition, action taken, lesson learnt, and recommendations (e.g. modification of specifications, modification of a procedures or issue of work instruction).
- When the engineer saves the report, a message will appear confirming that lesson learnt report #000 has been emailed for approval.
- An email is automatically generated to the line supervisor requesting him to review lesson-learnt report #000, submitted by (X). The email also provides the line supervisor with a password to access the report.
- The system is designed in a transparent manner. Everyone in the division has the right to report on a lesson learnt. The line supervisors only have the right to comment. The engineering managers can approve or disapprove publication.

- The line supervisor adds his/her comments about the lesson learnt (e.g. supported) and saves the report to get a message that the report has been emailed for approval.
- A similar email, to the one sent to the line supervisor, is now generated to the manger requesting him/her to review the report and providing him/her with a password.
- The manager either approves or disapproves the lesson-learnt report. Upon approval the lesson learnt will be published and is available for viewing.
- Automatic reminder emails are sent to the line supervisors, and managers if no action is been taken towards pending lessons learnt within one week.
- All engineering division staff receive weekly emails indicating the status of lessons learnt; i.e. lessons approved, lessons not approved, lessons pending, total issued, lessons pending/closeout percentage, and contributors of the week.
- When the lessons learnt are published, Discipline Forums take over as key instruments in the close out process as shown in Figure 6.3.

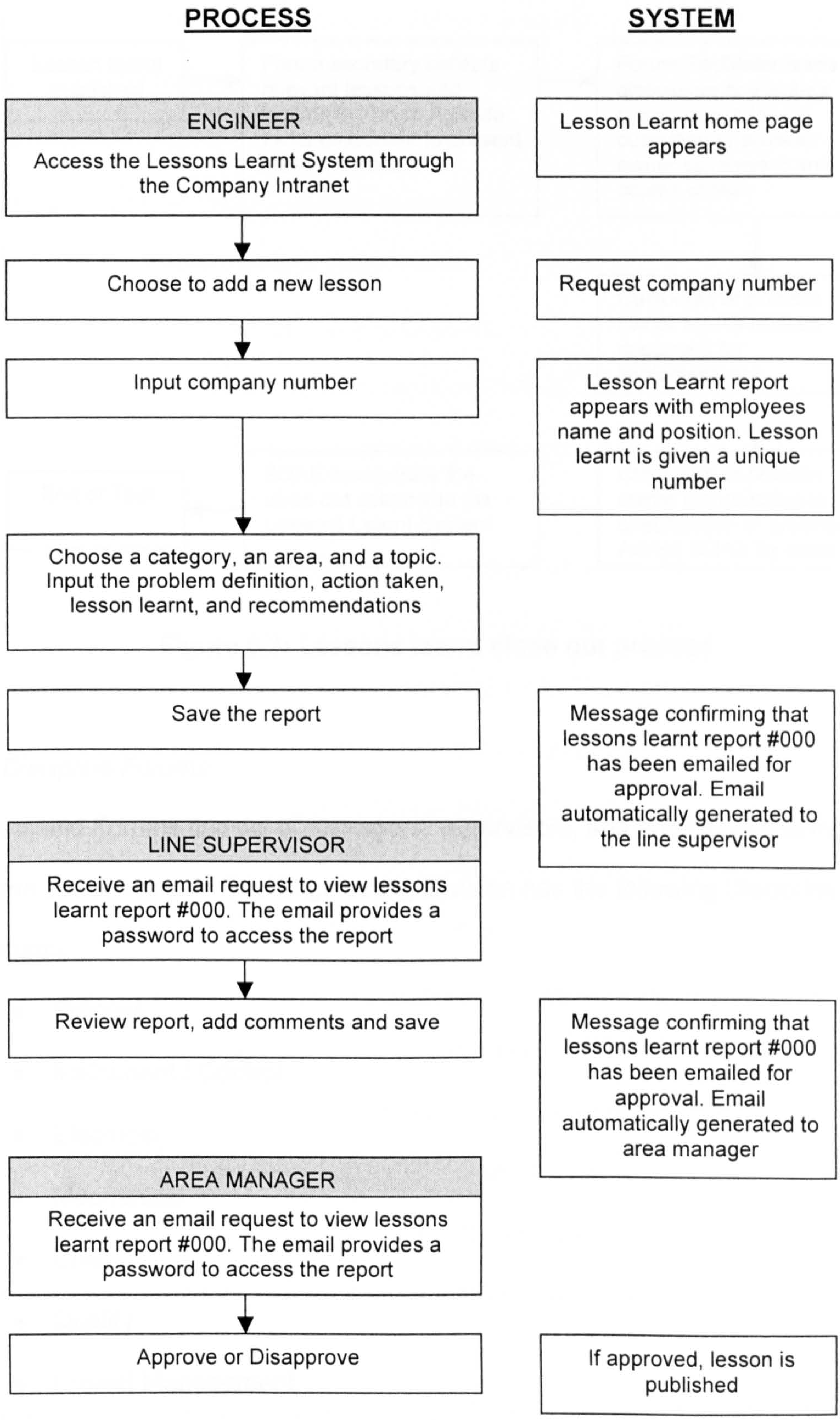


Figure 6.2: Adding a lesson learnt process and system interface

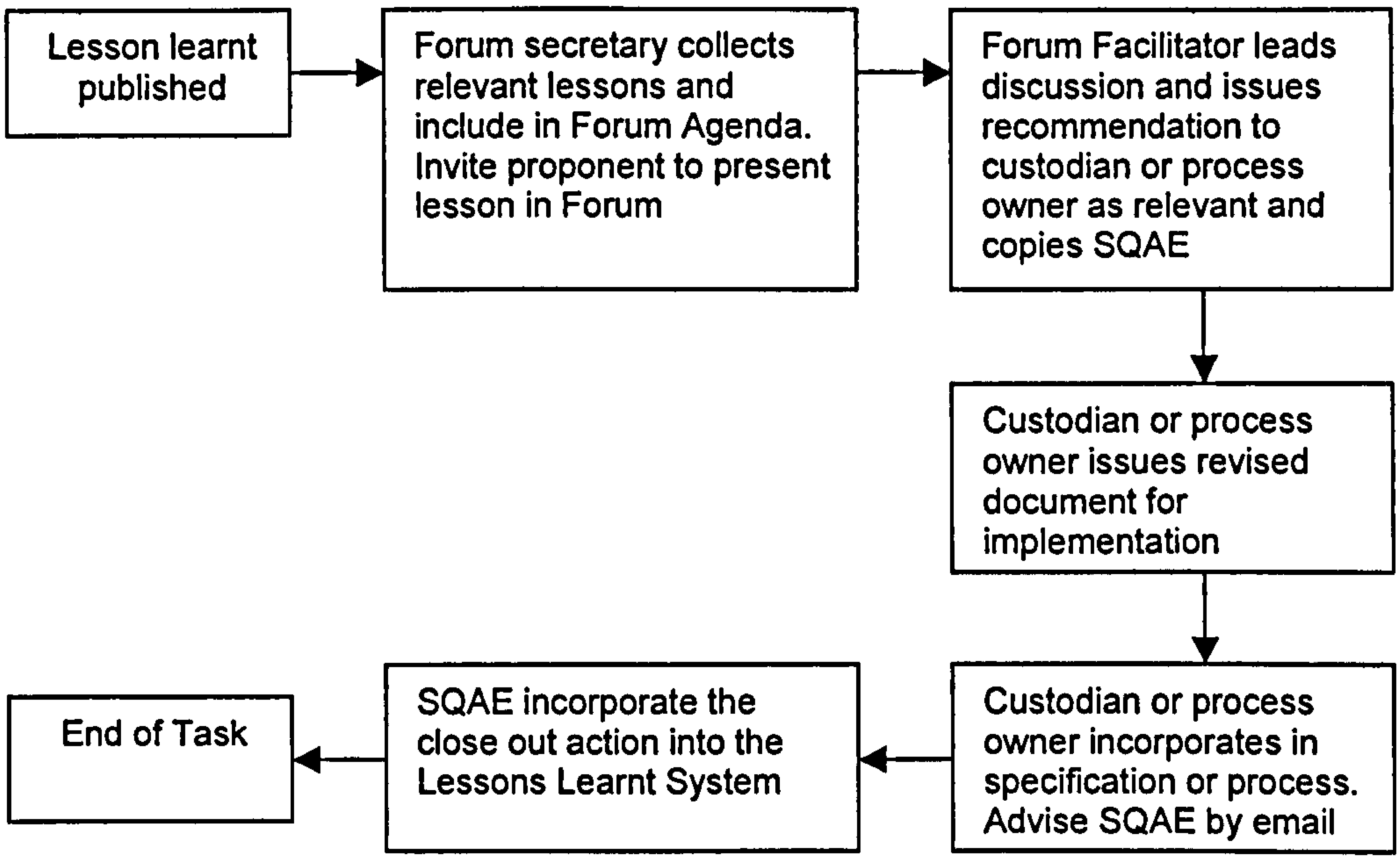


Figure 6.3: Lessons learnt close out process

c) Discipline Forums

Discipline Forums consist of managers, supervisors, and engineers sharing the same specialization. The Engineering Division has the following Discipline Forums:

- Process
- Instrument / Control
- Electrical
- Mechanical
- Civil
- Quality
- Project Management
- Corrosion

The Forums objectives are:

- Develop common understanding and improve practices
- Identify problems during design and execution
- Share solutions and lessons learned
- Share experiences and innovations
- Implement new ideas and experiences
- Encourage continuous learning through visits, lecture, reviews, etc.
- Seek and acquire applicable new technology

Discipline Forums meetings take the form of brainstorming sessions. Participants discuss the lessons learnt, included on their agenda, in their regular meetings and issue the needed recommendations. It is only then that the lesson learnt will be posted as closed. It is important to note that discipline forums play a key role in managing knowledge at Oilco. Their meetings allow for the development and sharing of knowledge among professionals within the same specialization. These meetings have often resulted in amendments to procedures, identifying problems and sharing solutions as well as identifying the need to acquire external knowledge through employees training. A senior engineer commented, "Our discipline forum meetings are critical to our operation. These Saturday morning meetings allow us to review our previous work to learn from what we are doing and share experiences. We can then plan better for the future and ensure that we continuously improve our performance".

The engineering division management regularly, in their meetings, encourage employees to share their knowledge and contribute to the system by adding new lessons. Discipline forums also recognize engineers who add a significant lesson to the system by publishing their names on the division's bulletin board on monthly basis. One the other hand, engineers are reminded to view the lessons-learnt weekly through the automatically generated emails.

The number of published lessons learnt has increased from 41 lessons in 1999 to 206 lessons in 2003 as shown in Table 6.2. Engineers find the system to be a useful tool that allows the sharing of relevant knowledge in their field of expertise. This is evident by the engineers' feedback to the documented lessons-learnt; engineers are not only reading the lessons to learn from it, but they often send feedback of their opinions on certain posted problems to the discipline forums and the system administrator. An engineer who has been with the company for three years said," I continuously use the system to read about new lessons learnt. It has, more than once, provided me with information that I needed to perform new tasks. I hope that we can share more of this knowledge".

Year	1999	2000	2001	2002	2003
Number of Published lessons	41	63	80	120	206

Table 6.2: The number of published lessons learnt per year at Oilco

A senior supervisor and member of the instrument/control discipline forum commented," The lessons learnt system has added significant value to the division not only by allowing our engineers to learn from each other, but also though improving our performance. In the last four years the various discipline forums had taken critical actions that include changing specifications, amending procedures, stopping the usage of certain components and devices or replacing them by others, based on published lessons learnt", he added," After using the system four more than four years, we have identified certain shortcomings that we are planning to adjust to help us improve the usage and benefits of the system

d) System Enhancements

In March 2004, four years after implementing the system, it was apparent that several enhancements were needed to make use and management of the system easier. These enhancements were a result of delays in the close out process due to approval bureaucracy and feedback from managers, supervisors and engineers to the system administrator. The requirements that were recommended, and are still subject to approval, are:

- Adding 'Information' category to the lessons learnt system. The Information category will allow the sharing of any information, not only lessons learnt, which might be useful to other employees. Items for information sharing are not sent for comments or approval. This is intended to support knowledge sharing among engineers on issues that are not necessarily problems encountered and their proposed solutions, i.e. lessons learnt.
- Allowing the system to become user friendly and thereby improving the usage of the system by adding the following features:

- Spell-check feature
- Help menu
- Print facility before submission
- Increase the field size in lesson learnt issue screen
- Attachments of file to the lesson
- Employee data should be taken from exchange server

- Authorize Read / Write access to some users in other divisions to be identified by the engineering division. This is a result of engineers in other divisions requesting authorization to view the lessons learnt and contribute to the system due to the common interest resulting from cross-functional teams.
- Search facility should be more flexible allowing field based and free text search
- Facility to generate custom reports by field and the ability to export reports to Microsoft Excel and PowerPoint
- Adjustments are needed on the weekly automatic email. The system should generate automatic email notification and have automatically extracted data and links for the following:
  - New lessons since last email
  - New lessons in discussion board
  - Pending lessons for close out
  - Closed out lessons
  - Champion (champions of the month, the top five, and reset at the end of the month)
- Lesson approval cycle is to be modified as follows:

- Employee will select line supervisor from the exchange server and route the lesson
- Automatic email should be generated to the selected line supervisor
- Line supervisor comments on the lesson
- If one week passes without action from the line supervisor lesson will be posted with "no comment" in supervisor comment field
- Upon lesson posting automatic email should be sent to discipline forum facilitator responsible for closing out the lesson
- Any lesson can be subject to discussion by engineering division staff, discussion form linked to each lesson.

The new cycle aims at reducing the time needed for the lesson learnt to be published by introducing time constraints. The cycle also allows engineers to discuss the posted lesson and input their opinions before the lesson is forwarded to the appropriate discipline forum. These enhancements would overcome the shortcomings identified in the system and allow for improved usage and benefits. Figure 6.4 shows the lessons learnt process and system interface after enhancements.

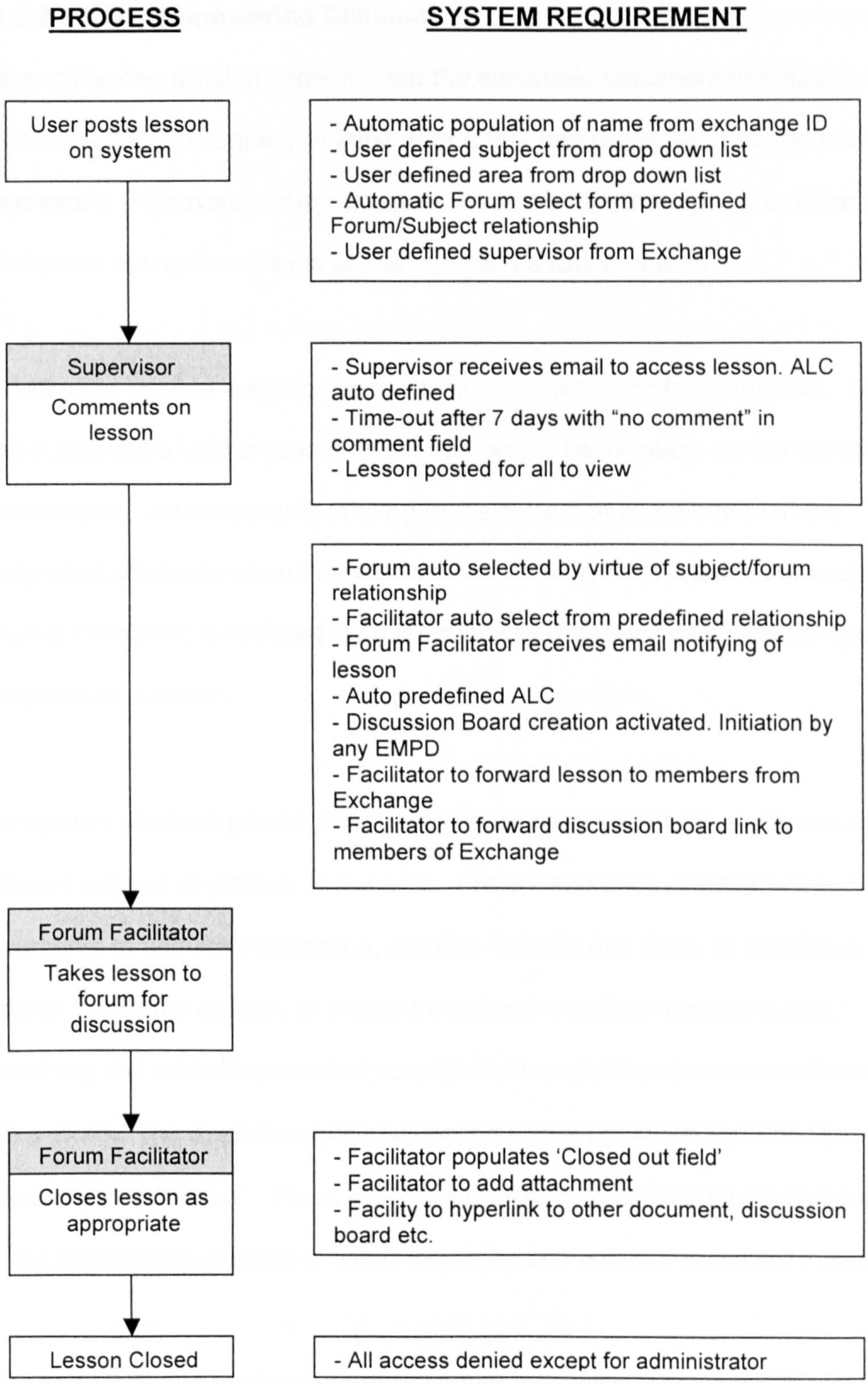


Figure 6.4: Lessons Learnt Process and System Interface (after enhancements)

6.2.2.2 e-DMS (Engineering Division)

The engineering division implemented the electronic document management system (e-DMS) in January of 2004 after a trial and preparation period that took three years. The system supplier spent the last of the three years at Oilco to ensure that the system meets all the company's requirements.

e-DMS aims to store and organize project documentation for future use. Each project is given a unique identification number, at its initiation, by the system administrator. All documents relating to the project must be stored in the designated database when processed. Any document, of a particular project, needed thereafter, is restored form the project's database using the designated identification number.

The system provides project members with an easy electronic access to a software copy of all project documents. Project members retrieve needed documents to acquire information, prepare reports, use them as templates, refer to them in a future project, or simply to review them. An engineer noted," Searching and retrieving needed documents from past projects is much easier with e-DMS. The system helps in saving time when trying to find and reuse project documentation". Thus, e-DMS is a technological tool that is being used by the engineering division to assist in storing and organizing explicit knowledge

Prior to e-DMS, the engineering division had a drawing management system where all the drawings relating to any single project were stored individually. It was a result of the success of the drawing management system in saving time and effort that the engineering division decided to add more value by extending this to a system that covers all the project documentation. A project manager said," We spend considerable time in retrieving documentation from past projects and preparing documents that we already have. By introducing e-DMS we intend to store and organize all projects' documentation electronically and make them easily accessible to our engineers. In the future we intend to expand the usage of e-DMS to include not only documents but also information about projects' business processes".

6.2.2.3 DIMS (Drilling Division)

Oilco's Drilling Division implemented DIMS (Drilling Information Management System) in 1999. DIMS is a completely integrated drilling, completions and well servicing database, communications and engineering software. DIMS facilitates the operation of reporting and query needs for operating oil and gas exploration and production companies.

Drilling operations are critical to the business performance at Oilco. The operation involves spending large amounts of money on constructing new well sites, relocating oil rigs, in addition to the high operating running costs per day. A stoppage in the operation at a drilling well site for a short time may mean loosing millions of dollars. Therefore, it is crucial for Oilco and more specifically the drilling division to run a highly efficient operation. This relies heavily on the handling of knowledge; it requires that the data generated at the well site must be very accurate. It also requires that this generated data is efficiently and effectively transferred into analyzed information in the desired format and communicated to the right people where it is internalized into valuable knowledge. Drilling information generated at the well site is valuable not only to technicians and engineers running the operation but also to personnel in the drilling main office as well as Oilco's top management. However, each individual is interested in different aspects of that knowledge, for example engineers at the well site are interested in drilling measurements which they are able to internalize into valuable knowledge, whereas top management are interested in duration and cost. Additionally, knowledge about the drilling operation at a well site is considered very valuable, to the company, in future drilling operations, particularly in the case of an offset well site project, i.e. a new site within a close distance from an old one.

A senior supervisor in the drilling division notes," Information generated at drilling well sites is crucial to our operation and constitutes valuable knowledge to our engineers and management. Site engineers need to receive accurate 'up to the minute' data and analysis to successfully perform their tasks. This information then needs to be forwarded to the drilling division main office every twelve hours for further analysis, review, and report preparation. Top management must receive a drilling report every morning based on which they decide on subsequent actions", he adds" we also rely on this information in future projects as an important source of reference information, specially in offset well sites".

Cost benefits can be realized when utilizing DIMS to plan upcoming projects. Procure detailed statistics on previous work from offset wells stored within the database to identify procedures requiring improvement. There is also a facility to assist in the preparation of drilling programs. Furthermore, as a result of utilizing DIMS, the drilling completion report is now done in an average of 1.7 days compared to the 45 days it used to take. A senior engineer commented," reducing the completion report time to an average of 1.7 days is a tremendous achievement. It had significantly improved our performance and reduced our costs".

The various features DIMS provide, promised to improve the division's performance through providing a reusable database of information, enhancing communication and knowledge sharing, reducing time, saving money, and improving engineering performance. DIMS captures and stores the complete well history within a relational database system consisting of over 130 tables and over 3400 data elements. The system is designed to allow data input and query capabilities for virtually any operation carried out.

The system is designed to be the data input facility at the well site. Data collection at the source is important to the accurate population of any as quick viewing, editing or browsing of the database. Morning report entry is made even more efficient by carrying forward the majority of the previous day's information. In addition to providing data and measurements at the drilling site, a report with the required information is sent to the drilling division main office every 24 hours. This report is then published in Oilco's Intranet.

The reports contained within DIMS include:

- Well Summary
- Well Planning
- Cost Estimate and AFE
- Daily Drilling Completion / Work-over
- Casting
- Cementing
- Pipe Tally
- Drill Stem Test
- Geological Summary
- Coring / Sidewall Coring
- Conventional Pump
- Electric Submersible Pump
- Fluid Hauling
- Gas Lift
- Gravel Pack
- Incident Report
- Open/Cased Hole Logging
- Perforate
- Pressure Survey
- Stimulation
- Well Tests
- Well bore Equipment
- Well Head Report
- General Work

In addition to these reports, numerous engineering and summary reports are available for on-screen viewing or hard copy printout. Oilco's management receives daily and weekly reports providing them with the managerial information they need (e.g. duration and cost).

a) Data Analyzer:

The Data Analyzer allows DIMS users to get maximum benefit from their data. Data Analyzer Ad-Hoc reporting tool allows engineers to easily interrogate the database information not readily available in standards reports. Output can be generated to text, spreadsheets or a graphic editor, with its own Wizard driven formatting. Complex queries can be undertaken, including user defined variables and filtering parameter prompts.

One of the most powerful features of Data Analyzer is the ability to group multiple queries in a Template. The Template itself can be a query, for instance grouping all of the wells in the database by Operating Region. All of the queries contained in the template can then be filtered by the Operating Region without having to be imbedded in the regional filter in all of the queries. Once the result set of the initial query is generated, the user can select only those regions that are of interest. Any and all queries can be grouped into a Template.

b) Other Features

- *Integration with other software*. Oilco's Drilling Division added value to their DIMS by integrating it with the following engineering applications software: COMPASS for Windows (Computerized planning analysis and survey system); CASINGSEAT (Graphics-based tool for casing scheme and setting-depth determination); STRESSCHECK (Interactive graphics-based tool for casing design); WELLCAT (Integrated software for design and analysis of well bore tubular); HYDRAULICS (Complete analysis of the circulation system: Bit jet optimization, pressure losses, and swab surge); CEMENTING (Simulates the pumping of multiple fluids with different properties. Calculates pressure at critical point); TORQUE / DRAG (Torque and drag prediction for drill strings and casing / liner strings); and WELL CONTROL (Predict maximum size of an influx; design casing steam to withstand maximum pressures; perform sensitivity analysis; provide actual kick support)

- *Data Validation.* DIMS can be configured to allow as much or as little data input validation as required through the use of pick lists, input masks and value ranges.

- *Data Access and Security.* The system administrator can set up the complete system access based on the user's login password. Create, delete, view, edit and printing access may be granted or revoked to virtually any information in the system.

- *Internal Communications Package.* DIMS includes an integrated communications package that operates under virtually any condition from almost any location using land lines, satellites or cellular networks. The data is completely compressed for confidentiality.

6.2.2.4 After Action Review System (Drilling Division)

Previous efforts have been made by the Drilling Division to store and access textual reports of important lessons using standard word document and posted on Drilling Exchange Public folder. However, even when textual design records have been captured they were not used. Therefore, drilling management has envisioned the need to have a real-time After Action Review System in place to document and share problems, achievements and experiences gained while performing drilling job related duties that would ultimately help in the process of decision-making.

The after action review system was launched by the drilling division last year. The idea is very similar to that of the lessons learnt system implemented by the engineering division. The system aims to:

- Allow engineers to exchange experience
- Enhance knowledge sharing
- Enhance communication
- Improve performance

Engineers can access the system, document difficulties they faced, how did they solve them, and what are the recommendations and achievements. The review is then forwarded to the senior engineer and the leader for review. Upon approval the review will be closed, published, and available for others to view.

The division recognizes employees contributing most to the system each month by publishing their names on the after action review homepage and the division's bulletin board. Rewarding outstanding contributors is currently under consideration.

6.2.2.5 E-learning in Oilco (Corporate Development and Training)

Oilco's e-learning program was launched in 2001, with the mission of transforming Oilco into a true learning organization where employees take responsibility for their learning and development, share their knowledge as well as the lessons learned from their experiences with others. The program provides new means of delivering needed training and instruction to Oilco's employees to add to the existing methods such as class roam training.

a) E-learning Goals:

- To utilize technology to support competency development, assessment and assurance process in Oilco.
- To make the best learning technology available to Oilco employees, thereby giving them a flexible and instantly accessible training in addition to their current menu of learning approaches.
- To encourage a culture of self-development and self-learning and move the company even closer to being a true learning organization.
- To provide employees with an integrated learning experience by ensuring proper blending and linkage between the various learning and development tools and methods by using the power of modern learning technologies.

b) Strategy

Corporate Development and Training at Oilco realized top management's KM vision and produced a five year e-learning strategy aimed at improving employees' development and training through providing additional means of learning, enhancing knowledge sharing among employees, and strive to become a learning organization. The strategy was detailed into clear objectives for each of the five years and these objectives were linked to performance indicators to review and monitor the development and progress of the program. The e-learning strategy is structured into the following four stages:

Stage 1 Infrastructure 2001 (Build infrastructure)

- Establish 5 centers
- Full time staff
- English language courses
- PC skills courses
- Permit to work courses

Stage 2 Evaluation 2002 (Evaluate & Explore)

- Evaluation & Audit
- Customer Survey
- Just-in-time Courses
- Marketing events conducted
- Detailed Strategy
- LMS Business Case
- Soft Skills Courses

Stage 3 Growth & Alignment 2003-2004 (Do it better)

- Strategy in action
- Policy structure & job
- Blended learning
- Marketing & recognition
- KM & LM integration
- MOS / CDL certification
- Learning Resources Center (LRC & VLRC)

Stage 4 Integration & Institutionalization 2005+ (Institutionalize)

- Integrated learning & knowledge management
- Content strategy
- Certifications
- Formal rewards
- Integrated with CAMS
- Learning organization

c) E-learning

Oilco continuously emphasizes the development and training of its employees. Some of the training is made compulsory to all the company's employees by the management whereas other courses and programs are decided by individual divisions. The training delivered varies from corporate health and safety courses through computer, office, and managerial skills courses to technical engineering programs. Prior to e-learning, training was delivered either by external consultants or through internal instructor led training which in both cases was incurring high costs. Additionally, a large number of Oilco's employees are based on the fields, which meant that they had to leave their jobs and travel to attend training which added more cost to the company in traveling expenses and having to substitute for their absentee. Corporate Development and Training realized that not all knowledge needs to be delivered through an instructor. Some of the courses can be effectively delivered to learners through e-learning, whereas others could be successful through integrating e-learning with class roam training. This would be significantly be more cost effective and will allow employees to learn at their own time and base in the fields.

In Oilco, e-learning is defined as the use of computer technologies to create, foster, deliver, and facilitate education, training, and information anytime and anywhere. Employees are continuously encouraged to use the system. This is done through Oilco Intranet, seminars, and handout materials provided by Corporate Development and Training. Employees are clearly informed of the following reasons why they should use it:

- In Oilco many courses are available on the desktop and employees can access them anytime at their convenience
- Employees learn at their own space
- Oilco's e-Courses are aligned to international standards and therefore help employees earn international certificates easily
- Employees do not need any approvals if they are learning during their free time

- Employees can use e-learning courses "just-in-time", when they want to clear a doubt or when they want to refresh their memory just before their presentation
- E-Courses are highly easy to navigate compared to a book or a document
- E-learning saves time for the learners as well as the coaches, mentors and trainers
- E-learning provides an objective and reliable method of assessing and giving feedback to oneself and others
- E-learning can be tracked and monitored for self development as well as for the development of others
- E-Courses can be used effectively as pre-course and post-course reference material to supplement Instructor Led Training (ILT)
- E-learning provides reliable reports to justify the progress of self and subordinates on personal development targets

Managers share their responsibility by encouraging their employees to use the system. A field manager delivered the following message to his employees "E-learning is a tool where technology is used for education. You may call it self-learning with the aid of technology. You are in full control as you are the student and teacher at the same time. The beauty of this tool is that you can teach yourself anytime at your own base. In the fields this tool helps many of our employees and trainees to enhance their skills and knowledge. I urge you to take full advantage of this tool as it is for you."

A rewards system is enforced for the e-learner of the year. Three to four employees are selected from each field and rewarded every year. The selection is based on the number of hours spent, certifications obtained, and the level of expertise. Motivation and rewarding has encouraged more employees to use e-learning.

E-learning usage in Oilco has been steadily growing since its implementation in 2001. Compared to year 2002 Oilco has doubled its utilization of e-Courses during the year 2003 delivering 25442 hours of training.

d) Learning Resources Centers:

Oilco has fully established five Learning Resources Centers (LRC), previously known as e-learning centers (ELC) located at five different sites since 2001. These dedicated centers are very useful for supervised e-learning, for conducting electronic assessment or even when employees would like to learn without any reference.

LRCs are fully equipped with multimedia computers and physical lay out suitable for learning environment. An e-learning coordinator is available in each center to assist users. A senior development and training advisor commented, "There is no socializing when everybody is trained in their office. LRCs allow people to meet each other, communicate, and share experiences in addition to its other benefits", he added "people in the fields away from their families seem to benefit greatly from the program as they have free time after work and they are utilizing it in e-learning and developing skills".

e) Available Courses:

- Language Courses: Several English language courses covering topics such as grammar, pronunciation, effective writing, conservation skills and so forth are available. Fully interactive Arabic language courses are also available for non-Arabic speakers on request. These courses are at par with international standards prescribed by the leading testing and certifying agencies. One of the beneficiaries of these courses is the Company General Manager as he was able to deliver a 15 minutes speech in Arabic only six months after taking the Arabic e-learning course. An operation foreman said, "I have used English e-learning course. It has improved my speech, grammar, and writing skills. Personally, I feel that e-learning is a great tool since its available at all times".
- Administrative Skills: Several courses covering various administrative skills such as office administration, typing skills and writing skills are available. The writing skills courses help employees write logical, well-written, and effective e-mails, memos and reports. New employees expressed their satisfaction with the writing skills course. Using examples from Oilco's paperwork benefited employees not only in writing skills but also in geting familiar with the company's administrative paperwork.
- Technical Topics: Several courses covering the various oil and gas disciplines are being evaluated for implementation.
- HSE (Health, Safety, Environment): Apart from the Permit To Work (PTW) course which is used widely by the Oilco employees for PTE training and

assessment, many other courses such as gas testing, safety Induction and so forth are in the pipe line.

- Information Technology: Fully interactive courses are available covering widely used office applications, operating systems and Internet. Courses range from basic to advance and are aligned to international testing standards prescribed by certifying agencies such as Microsoft, CISCO and ICDL. An administrative assistant said, "E-learning PC skills course helped me achieve my Microsoft Office Specialist Certificate. E-learning is fast, easy, and reliable".
- Behavioral Skills: Fully interactive courses that provide employees with the soft skills needed in today's dynamic work environment are available to all employees online. The topics covered include presentation skills, decision-making and problem solving, managing meetings, emotional intelligence, performance management and interpersonal communication. Some of these courses are accredited by universities and certification agencies.

f) Virtual Learning Resources Centre (VLRC):

Virtual Learning Resource Centre integrates the various learning resources, knowledge objects, feedback tests, collaboration tools and e-learning courses so that employees can access them easily. VLRC has got features to support discipline specific knowledge sharing, collaboration, and assessments.

The Virtual Learning Resource Centre website on Oilconet is the employee's point of access to all the available e-learning courses and learning resources.

The website visitors can benefit from several services that enrich their e-learning experience, and link them to information and experts.

The VLRC website consists of two major sections:

1. The course catalogue: In the course catalogue, users can access and take e-learning courses on-line. They will also find information about the courses such as the course learning objectives, duration...etc., and they can see and track their progress in courses they have accessed. The e-learning courses are listed on the catalogue by topic.

2. The information resources disciplines: This section consists of a searchable database that stores a variety of business related information or what is called learning resources. A learning resource can be defined as any document, presentations, templates, schematic, drawing, job aid, or guide that improves employees' knowledge and helps them do their work.

In this section, users can search and access the stored learning resources, which are organized by discipline. Website visitors can also submit a nugget of knowledge they feel of value such as a safety tip or a report. Once the submitted learning resource is approved for publishing it will become part of the searchable knowledge database.

The Website offers its visitors many utilities aiming at making their learning experience more enjoyable and to provide support as well as keep them updated with the latest news on e-learning. These utilities include:

- News and events: show the latest e-learning news
- What's new: users can check for new published learning resources
- Success stories: here users are welcomed to share their experience and tell how the Website benefited them
- Test your knowledge: users can enjoy taking different online quizzes
- Poll: online poll question on various aspects of learning
- E-learning discussion forum: here website users have a place in which to share their problems and solutions
- Feedback: to listen to website visitors and find out what they want from the website
- Survey: visitors can fill in the survey and say what they think of e-learning

On the day VLRC was launched the petroleum development manager delivered the following speech to Oilco's employees "My dear colleagues, training is part of our lives. On-the-job training is the fastest way we can become competent employee at the work place. Nevertheless, on top of the on-job training, we have always focused on training courses. Over the years, we have come to this realization that there are certain elements that we cannot learn from training courses. Today I am proud to announce the creation of the virtual learning resources center in Oilco, which tries to reduce the gap between the training courses that we normally take and the on-the-job training at work. The center will try to reduce the gap by focusing on e-learning, on interactions, and on digital knowledge sharing. Try to use it."

g) Testing and Assessments:

E-learning provides employees with fast, effective and reliable assessment for personal and formal purposes. These assessments will help employees and managers at the same time. Managers can monitor the progress and achievements of the employee for development purposes. Employees can set learning objectives and spot weak areas that need improvements. Most of e-learning assessments are comparable with international standards. Types of assessments are:

- Assessment for Placement and Personal Development
  - ➢ These tests help to identify the level of the person and accordingly set the learning goals and path
  - ➢ Results of these assessments will not be shared or reported and it can help the employee spot his/here improvements areas
  - ➢ Assessments covering a variety of topics such as IT, language, and administrative skills are available

- Assessments for Formal Purposes and Recruiting
  - ➢ These types of assessments are coordinated with qualified subject matter experts, instructors and trainers
  - ➢ They cover topics like English language, computer skills and typing skills

- Internal Certifications
  - E-Assessment can be used for awarding internal certifications that are mandatory.
  - Currently, Permit to Work (PTW), assessment and certification are available in the LRCs. More internal certifications are being added

- External Certifications and Accreditation
  - The demand for external internationally recognized certificates and accreditation has been in the rise to ensure universal standards. Oilco LRCs have been moving towards meeting this need for global standards.
  - Oilco LRCs are accredited by ICDL Middle East, the local accreditation agent for the ICDL with the support of the USNESCO – Cairo office, to conduct training and testing for awarding the globally recognized international Computer Driving License (ICDL). The ICDL program was created by the ECDL Foundation, a non-profit organization in Ireland. Oilco e-learning coordinators are qualified and certified ICDL testers and trainers
  - Some of Oilco's e-learning courses are recognized and approved by the international certification agencies such as Microsoft, Project Management Institute, ICDL, CISCO and so forth
  - Some of Oilco's e-learning courses are approved by some universities as recognized course material

6.2.2.6 Skills Transfer Box (Oilco)

Oilco established the skills transfer box to acquire knowledge from experienced employees, who are about to retire or leave the organization, and transfer it to new employees. The idea is that whenever an employee with a significant position (has valuable tacit knowledge) is about to retire or leave the company, a position (skills transfer box) is created. This position allows the hiring of a new employee to be trained by the experienced one to develop the required skills. Both employees share the same position during this time, and they can stay with each other as long as needed, not exceeding two years, to transfer the required knowledge. Management approval is required to create a skills transfer box. The approval is based on the job description and significance. A senior human resource advisor notes," We recognize the value of knowledge accumulated through our senior employees' experiences. We believe that the skills transfer box is worth its value as it allows us to transfer this experience to new employees".

6.2.3 Analysis and Discussion

Oilco possess vast amounts of knowledge in various areas that is considered valuable to the organization. This knowledge includes explicit knowledge, externalized tacit knowledge, and tacit knowledge in the form of engineers' experiences. The company's efforts to manage knowledge targeted the three types. For example, e-DMS aims at managing explicit knowledge in the form of project documentation; the lessons learnt system aims at externalizing tacit knowledge; and the discipline forum meetings aim at developing and sharing tacit knowledge.

With respect to managing this knowledge, Oilco's management identifies knowledge that is critical to the whole organization such as the safety training programs delivered through e-learning, whereas individual divisions identify knowledge that is critical to their operation, for example the engineering division identified their need to share employees' experiences. The knowledge is then acquired, developed, and made ready for distribution. At Oilco it is recognized that different knowledge needs to be delivered in different ways. Therefore, the company provides various training techniques. On the other hand, meetings, discipline forums, teamwork, and the skills transfer box initiative are employed to handle tacit knowledge that is hard to externalize. Although the company does not have a common unified plan for reviewing and measuring this knowledge, this had been done on some cases such as the lessons learnt system.

The following sections address each attribute of the five KM facilitators described in the "SCPTS" model within the context of Oilco

6.2.3.1 Strategy

- There is no corporate KM strategy at Oilco. However, top management's vision of KM was linked to the company's corporate performance improvements and future competitiveness strategy.
- The absence of a corporate KM strategy resulted in fragmented KM efforts where individual divisions developed their own objectives of performance improvement within a KM vision. For example, the human resources division focused on improving employees' development and

training and manage knowledge in a more effective way. The division developed a five year e-learning strategy by which they provide additional and cost effective means of distributing knowledge to their employees. Similarly, the engineering division realized the importance of sharing employees' experiences through developing the lessons learnt system.

- Although certain divisions such as the drilling and engineering divisions had KM initiatives, other divisions did not have such initiatives. Additionally, KM initiatives were not being developed on organizational level despite the need for that, for example four yeas after implementing the lessons learnt system by the engineering division; the drilling division launched a similar initiative, after action review system, without benefiting form the experience gained from using the lessons learnt system.
- Management by objectives at Oilco and the use of the performance measurement system ensured that plans are developed, monitored, and reviewed to achieve desired target. This is evident in the progress of the e-learning program.
- The IT manager stated that the company is currently in the process of developing a corporate KM strategy to extend the success of KM initiatives in individual divisions to the whole organization.

6.2.3.2 Organizational Culture

- Although it was not intended to directly support KM, the organizational culture at Oilco has a key role in facilitating KM.

- Upon the commencement of the KM initiatives, the "Oilco Family" culture seemed to be tailored to support knowledge sharing. The culture is characterized by its openness, flexibility, and empowerment of employees. Management efforts in creating the "Oilco Family" culture resulted in an atmosphere of love and trust among employees. In this culture, Oilco's employees do not only have the required setting to support the sharing of their knowledge but more importantly they are willing to share it. This is reflected by the contributions made to the KM initiatives targeting tacit knowledge such as the lessons learnt system.
- Rewarding systems are also in place to motivate employees to contribute to knowledge sharing as well as team working.
- Developing the employees' willingness to share their knowledge is critical to the success of initiatives that target tacit knowledge such as the lessons learnt system and the after action review system.

6.2.3.3 People

- There is no knowledge officer or similar position in Oilco.
- According to a senior human resources advisor, the company is currently considering creating a knowledge officer position at the management level to coordinate KM practice in Oilco.
- Division Managers in Oilco have a critical role towards knowledge management in the Company. Division Managers have the responsibility of communicating top management's vision of KM to their individual divisions. The Division Manager exercises leadership by defining KM

roles, assigning staff for the implementation of KM tools, and by enabling cross-departmental cooperation.

- Division Managers' leadership role extends to motivating employees into contributing to KM and sharing their knowledge. Oilco's IT manager commented, "Regular meetings are continuously held with employees to discuss knowledge sharing issues". The Head of Corporate Development and Training delivered this message to The Company's employees encouraging them to utilize Oilco's e-learning program "e-learning facilitates individual learning, as such Oilco is moving from conventional class room type training concept to blended learning and subsequently we aim to move to integrated learning. In order to achieve this we need to create an environment of self-learning and knowledge sharing for our staff. We hope that by integrating self-learning, classroom training as well as knowledge sharing we will be able to transform Oilco to a true learning organization. We also understand that we need to fully utilize technology to support our strategy. We expect and urge individuals in Oilco to utilize this facility to derive their own learning and development. It will undoubtedly enable them to learn at their own time and base".
- Oilco encompass a strong element of human resource management in its understanding of KM. Recruiting and training are important ways of developing knowledge resources. Moreover, an emphasis is adopted on making it attractive to stay with the Company as part of the "Oilco Family" culture, making the people loyal and willing to share their knowledge.

- Oilco supports employees' development through sponsoring their education as well as providing them with various training methods such as external training, internal instructor led training, and e-learning.

6.2.3.4 Information Technology Infrastructure

- Oilco is committed to establishing a strong IT infrastructure.
- The company emphasizes the application of new technologies to facilitate KM activities.
- The company's intranet is utilized to support the development and storage of knowledge. It also supports the company's email system and enhances communication among employees. Additionally the company's intranet is used to support a variety of software that facilitate KM such as e-learning, a number of management information systems, KM tools (lessons learnt systems, after action review system, etc), and a wide range of software.
- Oilco employs various software that support the management of explicit knowledge such as data bases, e-DMS, and DMIS. In addition, other software is employed to support the externalization of tacit knowledge such as the lessons learnt system.
- The company continuously provides and updates their technologies to meet their needs.

6.2.3.5 Organizational Structure

- Oilco is structured into functional divisions. The structure within each division is designed to promote knowledge development and sharing through emphasis on teamwork.
- Discipline Forums in Oilco are key factors in developing and sharing knowledge and experiences among professionals sharing the same specialization. The Forums meet regularly to discuss related issues, identify problems, share solutions and lessons-learned, develop common understanding, and seek continuous improvements.
- Cross-functional teams are also formed when needed and that adds value by transferring knowledge between different departments and divisions.
- Looking back over his many years with the company, a senior employee singles out the way in which Oilco's organizational structure is now aligned to business needs as being one of the major changes during the last 40 years. Now, he notes, the divisions are aligned to specific teams wherever possible, "and this is yielding better results in terms of achieving goals and objectives".
- Cooperation with other organizations within the National Oil Group of companies exists at the management level. This aids in acquiring needed external knowledge, in addition to sharing knowledge and best practices. During 2003, for example, joint forums were held by operating companies within the National Oil Group to address issues related to the standardization and improvement of KPIs, which form the basis of the Performance Contracts.

- Another source of acquiring external knowledge for Oilco and its employees are the external contractors. Oilco uses a number of external contractors; suppliers, vendors, and subcontractors to accomplish certain jobs. The company deals with, manages, controls, and maintains relationships with these external companies.
- One form of establishing good work relations, socializing and sharing knowledge with external partners in Oilco is the well drilling workshop. Before any new well drilling job is commenced, a well drilling workshop is conducted where all partners, supply providers, and supporting companies are invited to join the Oilco project team to discuss the upcoming project and estimate its duration. The gathering takes place in an air-conditioned tint in the field allowing office workers to get a real feeling of fieldwork and enjoy a served launch and the day out.
- In 2003, Oilco re-established its General Management Committee for Technology (GMCT). The objective of the committee is to ensure that an integrated and structured approach is taken to the task of adopting new technologies that would bring added value to the Company's operations as quickly as possible. The Committee's underlying philosophy is not that the Company should itself undertake research and development but, rather, that it should adopt advanced and proven technological innovations that have been introduced by its shareholders. It provides Oilco, therefore, with a proven and effective process that makes it possible to apply new technology solutions that will improve the way it carries out all of its activities and will ensure that it continues to be a leader in the introduction of the latest technology in the region. The

GMCT is, therefore, identifying needed external knowledge and providing a process for acquiring it from the shareholders and deploying it in Oilco.

6.3 Compco Case Study

Compco is a private computer company founded in 1987 and currently has three headquarters in the main cities of the country. The company is structured into six business units (Figure 6.5); each consists and holds services and products, those units team up together to provide total IT solutions to clients. Compco six business units are:

- *Storage and Services* business unit provides quality design and implementation of critical mission enterprise servers and storage configuration, as well as on-site and/or telephonic support. The company offers a set of scalable solutions that meet a variety of companies' needs, from large global to small businesses. Compco offers comprehensive storage and back-up services that include IT consulting, system integration, installation and startup services, migration support, maintenance, outsourcing services. The company has configured, implemented, and is currently supporting a good number of compound, distributed heterogeneous storage area networks (SANs) and back-up solutions across multiple operating systems such as Unix, NT and platform such as HP, Sun, Compaq.
- *Network Solutions* business unit provides efficient network operations. Network Solutions is certified by Cisco for the following applications: security specialization, voice access specialization, and wireless LAN specialization. The business unit also provides consulting, optimization,

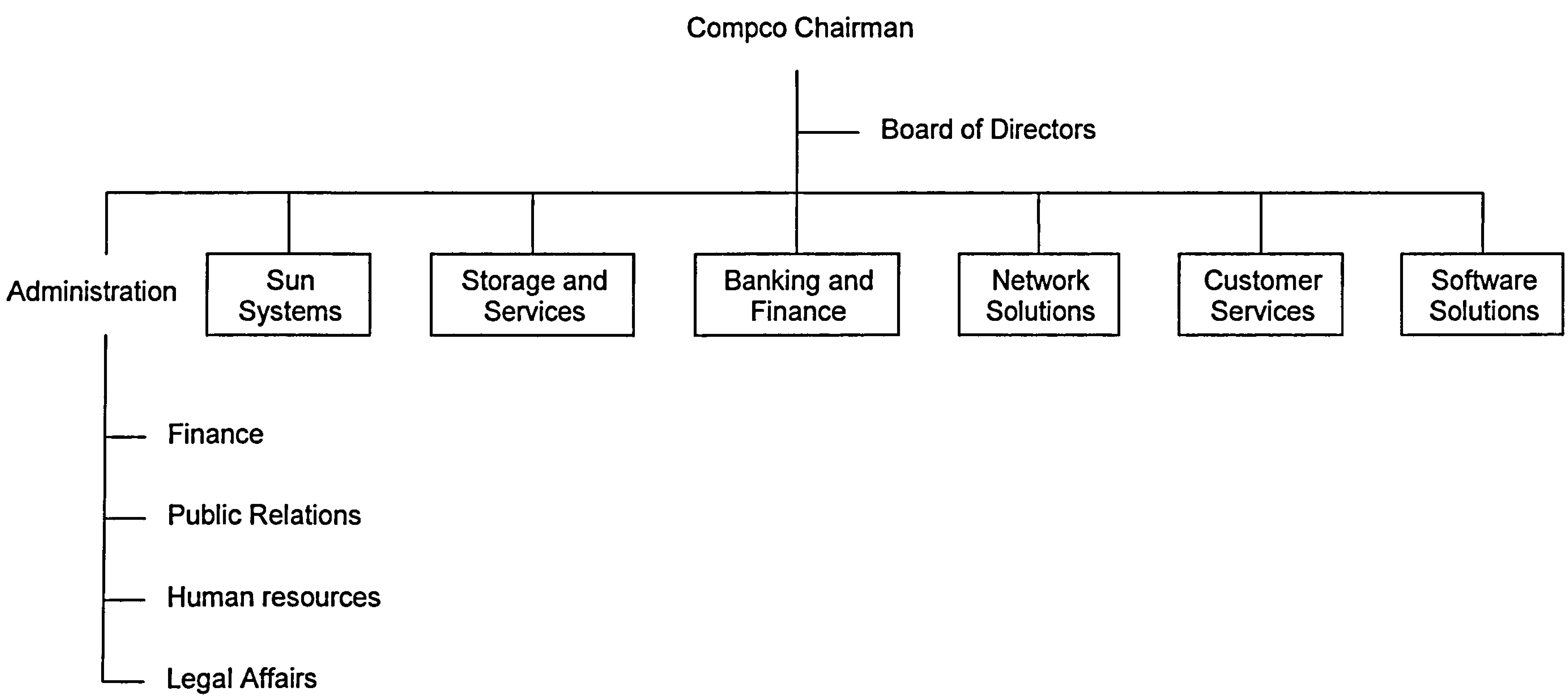


Figure 6.5: Compco Organizational Chart

operational abilities, network design, project management, premise cabling, and staging.

- *Sun Systems* Business unit provides a comprehensive portfolio of products and professional services to help customers plan, design, implement, manage, maintain and support their information technology resources and solutions. The unit helps customers in planning, implementing and supporting their e-business infrastructure in the following domains: SUN desktops and work stations, SUN UNIX servers, enterprise storage solutions, high availability – clustering solutions, disaster recovery solutions, servers and storage consolidation, UNIX – Windows NT interoperability solutions, and iPlanet products and services (portal, messaging, applications servers, e-commerce, suite, etc).
- *Customer Services* business unit provides a comprehensive portfolio of professional and multi-vendor services that help customers plan, design, implement, manage, maintain, and support the IT resources and solutions. They form the traditional services (hardware product support, software product support, network product support, and training courses), open services (outsourcing services, always on-call services, third party services, and PC integration and desktop services), and the professional services (Internet and security services, consultation services, and e-learning solutions).
- *Software Solutions* business unit provides total system analysis, implementation and support for Peregrine applications such as Fleet Management, ServiceCenter, AssetCenter, Infratools Remote Control, Infratools Network Discovery, and Infratools Desktop Discovery.

- Banking and Finance Business unit provides banks with the latest products and technology of hardware and software solutions.

Compco has a workforce of about 150 employees, of which 100 are dedicated professionals and expérts focused to provide customers with state-of-the-art IT solutions. The company has business alliances and partnerships with leading IT vendors and system integrators in the region and in the world such as Compaq, SUN Microsystems, Cisco, Avaya, Peregine, Oracle, Microsoft, Hypercom, and Wincor-Nixdrof.

Compco operates as an integrated management system, combining quality, commercial, and technical disciplines into a coherent approach. The company maintains a consistent approach to the way work is conducted. This is achieved by a single set of principles at the highest level, adhered by all of the operation units, to provide customers with a consistent service and access to world wide resources. Compco recognizes that everyone in the organization contributes to customer satisfaction through:

- Understanding customer needs and requirements.
- Meeting or exceeding customers' expectations.
- Use of a practical mix of new and proven techniques and technologies.
- Constant development of Compco's staff and management expertise.
- Commitment to the continual improvement of the company's processes.

Compco's management recognizes the right of its customers to not only expect but to demand quality. To ensure that its customers receive both products and services of the highest standards available, Compco has adopted a fully documented quality management system based on the internationally recognized standard ISO9001. Compco is committed to forging a partnership with both its customers and suppliers. It continuously strives to strengthen this strategic alliance using the standard as its baseline for measurement and improvement of quality to the benefit of both the customers and the business.

Compco has been successfully maintaining an independent and profitable organization. The company's clients cover all commercial and industrial sectors from energy, telecom, defense, education, banking and finance, transportation, public utilities to governmental departments.

6.3.1 Knowledge Management In Compco

The thought of KM at Compco started when the company realized that critical organizational knowledge exists in the form of tacit knowledge accumulated through its engineers' experiences. The company was faced with the difficulty of finding a replacement engineer with similar qualifications, or having to train a new engineer, when one leaves the company. Compco's management, therefore, identified the need to manage its knowledge with the aim of saving time and money and maintaining competitive advantage.

A KM strategy was developed and directly linked to the company's quality management and performance improvement. The strategy focused on two issues: (1) developing knowledgeable employees through recruiting and continuous training; (2) externalizing tacit knowledge with emphases on technology as a main enabler. The strategy is designed to keep the company's knowledge and core competencies above market standards thereby serving customers beyond their expectations and maintaining a competitive advantage. The company has ongoing activities to realize this strategy with emphasis on employees' skills, whether through recruiting or training, and management of tacit knowledge.

KM initiatives started with trying to manage knowledge stored in databases. This was followed with efforts to document tacit knowledge and make it available for reuse. Efforts included introducing the helpdesk, creating knowledge bases of lessons learned, and documenting standard operating procedures.

Training and Development

KM at Compco is strongly oriented towards developing knowledgeable employees. The company's KM strategy resulted in plans to utilize recruiting and training to facilitate KM through employees' development. A formalized multi-stage recruitment and selection process is implemented to replace the old highly informal interviewing process. At the preliminary selection stage, the candidates must posses and present the qualifications and expertise required for the considered position. Shortlisted candidates have to pass various tests to demonstrate their technical and language skills. Successful candidates proceed to an interview were they are expected to demonstrate a strong understanding of their own and related disciplines. The company's human resources advisor said," We have redesigned our recruitment and selection process to meet our business needs. It helped us ensure that we recruit employees who have the required skills and experiences".

Professional development is considered to be particularly important to employees. In order to stay at the top of their professional fields they must be constantly aware of the developments in their disciplines and they need to acquire the training required to master new technologies. Through its various business units and in collaboration with its external partners, Compco ensures that engineers receive adequate training continuously and obtain the appropriate certifications. Compco's operation manager stated "In this environment where technology is changing rapidly we must ensure that our engineers' technical skills are continually enhanced to ensure high quality design and implementation of all services and solutions provided by Compco".

Information Technology

Unsurprisingly, as a provider of the latest technologies and solutions in information technology, Compco KM strategy focuses on IT as a main KM enabler. The company has a well established IT infrastructure composed of up-to-date hardware and software technologies. These include a local intranet, knowledge bases, ERP, technical software, and collaboration tools. All of which play a key role in KM at Compco. The product manager commented," Today, many technologies are available that can significantly facilitate knowledge management. In our approach to knowledge management, we utilize these technologies to facilitate our needs".

Compco's intranet is used to store and support information on various knowledge areas. The storage of explicit knowledge and the capture and externalization of tacit knowledge are critical elements. The intranet is also used to support the various software tools and technologies employed by the company such as database, lessons-learned knowledge base, helpdesk, management information systems, and project management tools. Additionally, it is utilized to enhance communication through supporting the company's email system and providing bulletin boards.

As Compco operates in various geographic parts of the country and sometimes even in neighboring countries, the company's intranet and email did not provide sufficient means of communication. Therefore, Compco extended its network by utilizing the Internet. A private web site was constructed containing general information for customers and allowing Compco's engineers, with the use of a password, to access certain company's databases and documented information. Additionally, the web site contains collaboration tools that enable engineers to communicate across distance and hold meetings and discussions. An engineer commented," While performing our jobs, we often need to communicate with the main office and the helpdesk. We also need to refer to our standard operating procedures available on the company's intranet", he adds," when working in the field and in other countries we communicate and access needed data through the company's website available on the Internet. It has been very useful and practical".

Compco's Culture

The primary emphasis on all KM initiatives at Compco is on developing skilled employees and the technology to support KM. The issues of how to change the culture in order to encourage individuals to share their knowledge and create a knowledge friendly culture were not really considered. The need to change the organizational culture and people's attitude was recognized. However, this was not translated into any organization wide initiatives to actually change people's attitudes and behaviors. Thus, in the past, it was very clear that knowledge had typically translated into organizational power – if one had critical knowledge then it would be in his/her interest to keep that knowledge to themselves so that he/she would be indispensable to the company, sharing that information with others would reduce that power. There were no attempts made to introduce initiatives to try and change this embedded culture. The product manager acknowledges," We have worked hard on developing a workforce of highly skilled employees, now we have turn our attention to making it attractive for them to stay with the company, discourage them from leaving, and encourage them to share their knowledge".

There was a wide spread recognition across teams that the current reward system did not encourage knowledge sharing and probably even prohibited it by rewarding people for their personal expertise rather than their sharing of this expertise. Yet there was no attempt to change the reward system to support knowledge sharing.

While the impact of the reward system on knowledge sharing can be considered at the individual level, it is also possible to look at how the reward system, or at least the monitoring system, impacted on knowledge sharing at the organizational level. At the organizational level each business unit was held accountable of its individual business performance. Targets were set and the units were measured against these targets. Only those departments who achieved or surpassed their target were rewarded. This meant that there was more incentive to protect knowledge within a group rather than share it with others outside the group.

On the other hand, Compco has some strong elements in its culture that support knowledge creation and informal sharing of knowledge. The dual notions of autonomy and the empowerment of employees are strongly reinforced as part of the total quality management system. These allow for engineers to be creative and continuously generate knowledge. Additionally, the open office design at Compco enhances informal sharing of knowledge between colleagues.

6.3.2 KM Initiatives

Compco's plans aiming at utilizing technology to enable KM as part of the company's KM strategy yielded the following three initiatives: helpdesk, lessons-learned knowledge base, and standard operating procedures,

6.3.2.1 Helpdesk

Management at Compco realized the importance of documenting experiential knowledge represented by the satisfactory solutions applied during service support and to reuse it in future situations. Compco employs the helpdesk technology to respond to external and internal requests for products and service support. Calls (jobs) are dispatched to technicians and engineers through email indicating full details of the customer contacts and the required job description or problems encountered. A helpdesk operator monitors the status of each job and maintains continuous contact with technicians and engineers through phone calls and email until the job is completed. Calls will be marked closed on the system only when the technician or engineer enters the actions taken to complete the job. If there is a delay in completing a particular job, emails will be sent to the appropriate supervisor.

To tap this potentially valuable information and make it available for reuse, Compco has integrated its helpdesk technology with a knowledge base. Upon the closure of a particular job, the helpdesk personnel will review the call and if there is any non-routine problems encountered and solved the call will be marked and sent to the lessons-learned knowledge base. This requires that the helpdesk personnel be familiar with the jobs performed. At Compco, senior engineers are allocated for this task.

It is important to note that the helpdesk personnel has a key role in ensuring that jobs are completed as well as transferring the appropriate problems and solutions to the lessons-learned knowledge base in the right form. Lessons transferred to the knowledge base usually require the helpdesk personnel to physically meet with engineers submitting the solution to clearly document the lesson.

Despite the fact that all completed service support jobs at Compco result in documented solutions, the system has some problems. One problem encountered with the helpdesk is that not all solutions are easily documented. For example, when a solution involves performing a technical repair that can not be represented by a procedure, it could be difficult to express this in writing. Another problem is that engineers do not have the extra time to spend in long documentation as they are busy performing their assigned jobs; there main concern is to get the job done. An engineer noted," It is more important for me to deal with the customers and get the job done than to document the solution. Sometimes jobs consume long times and involve technical repairs that are hard to document". A helpdesk operator commented," We spend considerable time following up engineers to get them to close their jobs", he added," Often engineers' documented solutions are not explicit, they write a very brief summary of what was accomplished which does not really constitute a clear solution".

6.3.2.2 Lessons-Learned Knowledge Base

Compco's lessons-learned knowledge base was developed as part of the company's KM strategy in an effort to externalize tacit knowledge. The aim was to capture knowledge gained form engineers' experiences and make it available for future use. Lessons-learned stored in the knowledge base constitute problems encountered by engineers or technicians while performing jobs and the successful applied solution. These lessons are directed to the knowledge base by the helpdesk personnel.

Engineers can access the lessons learned knowledge base through the company's intranet and its website. Search is available by category; the lessons are organized into categories according to the business units. Upon selecting a category all relating lessons learned will appear. Choosing one will allow the user to view the details of the lesson. These include number and date, category, topic, engineers name, job description, problem definition, the actions taken, and any comments. Each business unit reviews their lessons learned weekly for discussion and approval or removal.

The use of the lessons-learned knowledge base by engineers and technicians at Compco is overwhelming. They believe that it saves them time and allows them to do a better job. An engineer said," we regularly get calls concerning the same problem by different customers; the lessons-learned system allows us to learn from our experiences and provides us with successful applied solutions to these problems". However, due to the problems mentioned previously only around 10% of the documented solutions are developed into a reusable lesson-learned.

6.3.2.3 Standard Operating Procedures (SOP)

As a provider of software and network solutions, Compco relies heavily on procedures to accomplish tasks in its operation. Compco's management realized that managing knowledge of and about procedures carries the most promising potential for improving the company's performance and the quality of service provided to customers. This knowledge comprises not only procedures but also knowledge about the construction of such procedures. However, major parts of this knowledge reside in tacit working practice.

Compco developed the Standard Operating Procedures system to allow the storage and reuse of the various operating procedures performed by engineers. The system is available through the company's intranet. Management considered SOP to be very important and a key tool in KM. Engineers are continuously encouraged by their managers to document procedures and provide the necessary amendments to the existing ones.

A standard operating procedure provides engineers with a set of temporally or logically ordered activities to reach a goal or complete a certain task. The procedures are represented in a semi-formal computational symbolic notation, i.e. general activities and their relations are represented by formal symbols (boxes and vectors). Additional information is also attached informally.

The use of SOP by engineers to accomplish their work at Compco is overwhelming. However, the feedback in documenting new procedures and providing amendments is not as good. Although management continuously encourages engineers to document new procedures, no rewards system exists to motivate them. The production manager commented," we rely heavily on procedures to accomplish tasks. These procedures often, in practice, require amendments. In other words, while performing a procedure an engineer might discover that on of the steps could be done in a better way. In other cases our engineers perform new tasks were no documented procedure exists. In both cases this knowledge is very valuable to us and with the SOP we aim to document this knowledge and make it available for future use. What we would ultimately like to have is not only a step procedure but detailed information about each step". He also acknowledges," Currently the contribution to the system is limited. We understand that our engineers are busy and this is an additional task for them, but we plan to encourage more contributions and currently we are considering a reward system to aid in this".

6.3.3 Analysis and Discussion

The following sections address each attribute of the five KM facilitators described in the "SCPTS" model within the context of Compco

6.3.3.1 Strategy

- Compco developed its KM strategy to help in achieving the company's business objectives of total quality and performance improvements.
- The KM strategy focused on employees' skills through recruiting as well as development and training. It also focused on utilizing technology to enable the management of tacit knowledge in addition to explicit knowledge.
- The KM strategy resulted in plans to achieve these objectives. These included developing and enforcing a new recruitment and selection process, emphasizing training programs, and developing technological

tools to aid in managing knowledge such as the lesson-learned knowledge base.

- Progress on the various initiatives was continuously being reviewed by management. However, no performance measurement system was linked to the strategy.

6.3.3.2 Organizational Culture

- Compco's organizational culture supports knowledge creation through the empowerment of employees.
- The organization culture at Compco does not support knowledge sharing. Employees are reluctant in giving up their knowledge. This is evident in the contribution to the SOP system.
- Changing the organization culture to support KM is not yet part of the KM strategy.
- No reward systems are in place yet to support knowledge sharing.
- No efforts are made to change employees' attitude towards knowledge sharing, or to make it attractive for them to stay with the company.
- Management are now realizing the importance of changing the company's culture to facilitate KM. They are reevaluating there KM strategy and are considering employing reward systems to encourage knowledge sharing.

6.3.3.3 People

- There is no knowledge manager at Compco. The KM strategy is transferred into KM plans and initiative by top management.

- The KM initiatives are directly related to the various operation units through the various managers.
- Unit managers practice their leadership in motivating and encouraging their employees to contribute to the KM initiatives.
- Unit managers also have a key role in developing employees' skills through providing them with the required training continuously.
- Developing employees' skills is emphasized in Compco's KM strategy. This facilitated by acquiring external knowledge through providing the needed training programs.
- Recruiting is also emphasized as a key source of acquiring needed external knowledge.
- Developing employees' willingness to share their knowledge is not yet part of the company's KM strategy.

6.3.3.4 Information Technology Infrastructure

- Compco's KM strategy emphasizes the use of technology to facilitate KM.
- Through its emphasis on information technology, Compco has a solid IT infrastructure that includes the company's intranet, various software tools, and collaboration tools.
- Technology employed at Compco support the storage and dissemination of explicit knowledge through database and documents provided on the company's intranet. It also supports the externalization of tacit knowledge through tools such as the lessons-learned knowledge base and the SOP. Additionally, it enhances communication within the company through the use of various collaboration tools.

- Although the technologies are deployed to externalize tacit knowledge such as the lessons learned knowledge base and the SOP system, no efforts were made to motivate employees to contribute to these systems and give up their tacit knowledge, for example rewarding engineers for adding a new procedure to the SOP.

6.3.3.5 Organizational Structure

- Compco is structured into functional business units directly overlooked by management. Within each unit, project teams are formed to accomplish allocated tasks. This organization supports knowledge generation by team members as they share the same specialization and face the task of handling common situations. Group members have regular meetings and brainstorming sessions were tacit knowledge is developed and shared.
- Cross functional teams are only formed when an approached project is multi-disciplined. This limits the transfer of knowledge between various units as the only other links available are through unit managers and informal sharing of knowledge.
- Compco has a strong structural element to support KM in its formal networks. The company has external business alliances and partnership with a number of organizations whom they represent in the country or are affiliated with, such as Compaq, SUN, Microsystems, and Cisco. These external firms provide Compco with a critical source of needed external knowledge. The company acquires explicit documented knowledge as

well as tacit knowledge that is acquired though the training of its employees.

6.4 Consultco Case Study

Consutlco is one of the leading, independent and multi-disciplinary engineering consulting companies in the country. The company was established in 1968 and has a head office and two branches in the largest three cities of the country. With a workforce of 90 multi-disciplined skilled engineers the company provides a comprehensive range of engineering, architectural, and construction management services, from concept and feasibility studies through all stages of design, to site supervision, project management, cost control and commissioning. The company clients cover both governmental and private sectors.

Over the years, Consultco has successfully designed and supervised major projects in the country such as roads, towers, building facilities, and bridges. The company draws upon a vast bank of skills from among its expert staff including architecture, structural engineering, building services engineering, water and public health engineering, environmental consulting, building and land surveying, electrical and mechanical engineering, and auditing and quantity surveying.

Consultco has a flat organizational structure, consisting of the founder (now Executive Chairman), Chairman and Managing Director, overseeing the rest of the workforce. The company is organized into small functional departments

(Figure 6.6) with one level of management represented by the management team. Members of the management team are the heads of the departments and are all also active engineers contributing to project teams working within the firm. Consultco is characterized by emphasis on project teams in its operation. Single or multidisciplinary, cross-functional, teams are assigned to meet client and project requirements.

Consultco takes seriously its commitments to all of the company's stakeholders. This is reflected in Consutlco's robust policies for the environment, quality, and health and safety issues. The company's commitment to acting responsibly in each of these areas is reflected in the accreditations it holds across the company for ISO 9001 and ISO 14001.

The company's quality policy strives to take all reasonable actions to satisfy customers by meeting and where possible exceeding their specified requirements. This is achieved by developing and implementing processes which enable the company to design, develop and construct solutions that meet customers' needs. Through improved levels of customer satisfaction and increased employee involvement in the quality programme, Consultco seeks to achieve business excellence. To achieve this policy the company has adopted the following approaches:

<u>People</u>

1. The company recognises that its people are its greatest asset and has achieved 'Investors in People' accreditation. Consultco ensures that its

employees have received relevant training to enable them to be competent in their areas of work. Quality responsibilities are defined for all employees and suitable training is given to ensure that they fully understand and can meet them.

2. Employees are actively encouraged to seek customer feedback on levels of satisfaction, both from internal and external customers. This feedback is used to assist with continual improvement.

3. Employees are actively involved in quality improvement programmes within the company to help it achieve its quality objectives.

4. As part of the employee appraisal programme the company includes a review of quality related competencies and set SMART objectives.

Process

6. The company is currently certified to BS EN ISO 9001:2000 and actively seeks to maintain certification to this standard

7. The company has identified and defined the processes within the business and its importance in delivering customer satisfaction. Through process improvement and continual review the company seeks to keep pace with changing customer needs and changing market requirements.

8. The company has defined quality objectives that are aligned to the business objectives and values. Progress is measured and reported against these objectives on a regular basis and communicated to all employees.

9. The company has developed systems to identify non-conformance events and customer feedback and to define and develop effective corrective action where required. All such events are analysed to identify trends and to assist in the program of continual improvement.

10. The company has established an internal audit and surveillance system to monitor all activities and processes with a view to ensuring compliance and to ensure that best practice is identified. Results of audits and surveillance are communicated to management to ensure that appropriate action is taken where required.

11. The company regularly consults with and monitors the performance of its supply chain partners to ensure that the quality of its service is not affected by the unacceptable quality of others.

Performance

12. The company carries out regular reviews of its quality system to ensure that it remains effective in terms of current business activity and future objectives. The review takes into account information relating to customer satisfaction and feedback. The review monitors progress against the quality objectives and identify new objectives and targets.

13. The company has developed a number of key performance indicators to enable it to benchmark itself both internally and externally with other similar organisations within its field of operations.

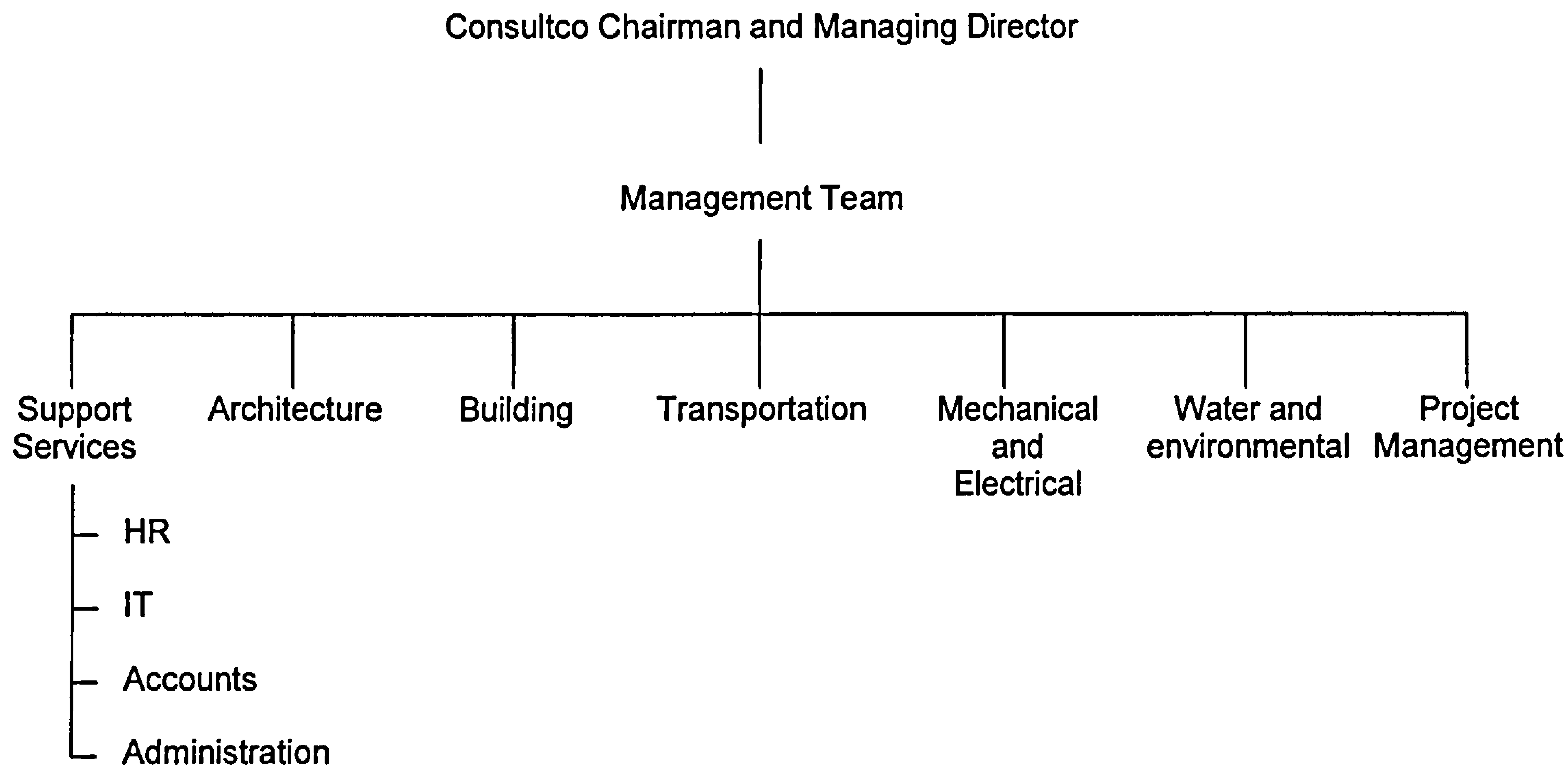


Figure 6.6: Consultco Organizational Chart

6.4.1 Knowledge Management in Consultco

The vision of KM at Consultco was initiated through the company's quality policy. The quality policy emphasizes the need to focus on people as the company's greatest asset. Consultco's management recognized this policy and decided to invest on its employees and create the environment to support knowledge creation and sharing. Thus, KM practices at Consutlco are focused on people, organizational culture, and structure.

Appreciating the significant level of expertise that needed to be maintained and nurtured for the company to be creative, innovative, and successful over time. It was of crucial importance to the company to attract and retain highly skilled engineers. Consultco focuses on recruiting and continuous training and development to establish a skilled workforce. Additionally, the company strives to create and foster a knowledge friendly culture and structure where employees are willing to share their knowledge, have direct communication channels, and are encouraged to stay with the company.

More recently, the company realized the need to capture project knowledge, store it in easily retrievable format, and make it available for future reuse. Project team members gain experiences and valuable knowledge that the company can reuse in future projects. A project manager noted," Experiences gained in projects are valuable to us as we will likely encounter similar scenarios and problems in future projects. At the completion of a project, our team members are spread all over the company and the knowledge remains only with them. We want this knowledge to extend outside the project team and be shared by other members in the organization".

<u>Culture</u>

The organizational culture at Consultco contributes significantly to the process of knowledge creation and the management of knowledge workers. The company's engineers enjoy a highly informal, open working environment, in which they are afforded significant autonomy, trust, and ample resources both tangible (financial) and intangible (time), to facilitate knowledge development.

Not only does the organizational culture at Consultco facilitate knowledge development, but equally important employees are welling to share their knowledge. The company fosters love and trust among employees through encouraging socializing, creating job security and satisfaction, and ensuring that failure is not punished but rather it is seen as a learning process. The friendly relationships amongst employees extend outside the office. The company's employees are happily welling to help and assist each other.

The chairman of Consutco commented, "We take pride in our friendly culture and always strive to maintain it...there is no boss in our company...we are all professionals learning together and working with each other to achieve a common goal". A civil engineer who joined the company three years ago said, "The first thing that impressed me when I first joined the company was the friendly environment...everybody was offering me assistance and that was very comforting".

Consultco has a regular reward system through the operation of quarterly bonus system dependant upon departmental and project performance in terms of timeliness, quality, and achievement. Knowledge-sharing across departments was not explicitly recognised but it was clear that much information transfer of this kind had occurred on projects, through both formal requests and through more voluntary activities.

In order to complete high profile and complex engineering projects, team members, generally, recognize the importance of sharing knowledge. They are keen to pool ideas, seek commonality in design and co-operate in moving the project forward.

Employees' skills

Through its quality policy, Consultco has strong emphasis on developing a highly skilled workforce as the company considers people to be its greatest asset. This is realized through the company's recruitment and selection process together with its training and development programs.

During the recruitment selection process, short-listed candidates, based on qualifications and expertise, are requested to attend an interview. The aim of this interview is not only to test and evaluate the candidate's level of expertise in the relevant field, but also to ensure that they possess the personality that fits well with the company's friendly culture.

Consultco's focus on training and development is clearly noticed in the company's objectives. Some of the management system objectives adopted at Consultco, as part of its management programme, are:

- *Project Management:* To introduce the Project Managers Development Programme for the development and improvement of Project Management in the Organisation.
- *Training:* To determine and implement a training strategy for all employees to develop both individual and company wide skills competence.
- *Safety Awareness:* The improvement of Health & Safety awareness of Consultco employees and the proactive development and promotion of safety culture throughout the organisation.

6.4.2 KM Initiatives

KM practice at Consultco is focused on investing in people as a critical strategic asset and developing a knowledge friendly organizational culture and structure to support knowledge development and distribution. It is only now that the company is considering implementing technologies to aid in externalizing and storing project knowledge to make it available for future reuse. Systems being considered are aimed to manage procedures and lessons learned.

6.4.3 Analysis and Discussion

The following sections address each attribute of the five KM facilitators described in the "SCPTS" model within the context of Consultco.

6.4.3.1 Strategy

- Although, there is no KM strategy at Consultco, management has a KM vision that is realized through the company's quality policy and integrated with its management by objectives system.
- Developing and retaining skilled employees together with creating a knowledge friendly environment are recognized in the company's objectives and are central in developing and maintaining high quality at Consultco.
- The company has ongoing plans to achieve the development of its employees through the recruitment policies and long term training programs.
- The company's objectives are linked to a performance measurement system to monitor progress and ensure the achievement of its objectives.

6.4.3.2 Organizational Culture

- Compco's culture plays a key role in facilitating the development and sharing of knowledge.
- The company's culture is highly informal and characterized by love, trust, and employees' willingness to share their knowledge.
- Reward systems are in place to encourage the development and sharing of knowledge among project team members.
- The open office space supports the informal sharing of knowledge.

6.4.3.3 People

- The focus on middle management is not exercised to a large extent at Consultco due to the flat organizational structure with only one management level. However, department heads relay the company's values to their employees. They also have a key role in the recruitment selection process and the development and training of employees in their departments.
- Consultco considers its people's skills and experiences to be the company's knowledge base and intellectual capital.
- The development of employees' skills is recognized with Oilco's commitment to long term training and development programs such as the project management program.
- Employees' training is a main source of acquiring external knowledge at Compco.

6.4.3.4 Information Technology Infrastructure

- Consultco's information technology infrastructure includes an email system, basic desktop software, and engineering software.
- Consultco focuses on investing in engineering software technologies that facilitate project working. The company employs various engineering software packages including project management tools, CAD, software for structural design and analysis, civil engineering software, and surveying software.
- While facilitating low-level communication and supporting engineering activities, IT at Consultco does not play a role in knowledge development

or distribution. Some project documentation is stored electronically. However, the majority of projects continue to be documented in a traditional manner, as project leaders were free to provide documentation in whatever way they deemed appropriate. Client requirements needed to be fulfilled in this respect. However, if the client was satisfied with the documentation produced, no further effort was directed at producing, recording and classifying project documentation in a consistent manner across the company. The information stored is not generally reused.

6.4.3.5 Organizational Structure

- The flat organizational structure at Consultco is ideal for supporting knowledge development and sharing. With only one management level, the communication lines between employees as well as between the employees and management are short and direct.
- The development and distribution of tacit knowledge within specialized departments and across department boundaries is facilitated by the existence of functional departments and the use of project teams.
- Functional departmentalization allows for knowledge generation and distribution among engineers sharing the same specialization.
- The continuous use of project teams allows for knowledge sharing across departmental boundaries.

6.5 Discussion

This chapter presented three in-depth case studies that were conducted at three different engineering firms to test the constitute elements of the proposed

"SCPTS" three-layer KM model. The focus in the case studies is to identify the success elements for implementing KM and compare the current practices with the proposed model. In the following sections, a general discussion on the case studies is presented according to the elements of the "SCPTS" three-layer KM model.

6.5.1 Engineering Knowledge

The three engineering companies studied have vast amounts of knowledge in various areas that are critical to achieve organizations' business goals. This knowledge varies from explicit knowledge such as project documentation and drawings to tacit knowledge in the form of employees' experiences. Part of the valuable tacit knowledge which engineering companies have can be successfully externalized into explicit knowledge that is more easily transferred to other members of the organization. This is in line with Nonaka (1991) distinction of knowledge types and interaction between them. Technologies are available to aid in this transformation such as those used in the lessons learnt systems. However, a supporting culture characterized by employees' willingness to share their knowledge is necessary for the success of these tools. On the other hand, tacit knowledge that can not be easily externalized need to be recognized and therefore managed accordingly, for example through meetings and brain storming sessions as in the case of the Discipline forums at Oilco.

6.5.2 KM Life-Cycle

It is clear in the three cases that the first step in managing organizations' knowledge is to identify the needed knowledge. Organizations can then develop plans to acquire, organize, and distribute that knowledge. The acquisition and development of the needed knowledge depends on the source and form of that knowledge. For example, some knowledge might be acquired externally through a training program as in the case of Compco where engineers receive continuous training programs on new products in cooperation with the company's external partners. Other knowledge, however, could be available internally in the form of available documents or employees' experiences as in the case of Oilco where the company's intranet is utilized to support bulletin boards, e-DMS, DIMS, etc. Having developed the needed knowledge, it then needs to be distributed to those who need it. The distribution method depends on the type of knowledge handled. Some knowledge can be distributed over the company's intranet, whereas other knowledge needs to be distributed through socialization as in the case of the skills transfer box and Discipline Forums at Oilco. The ability of a company to succeed in managing its knowledge relies on its ability to facilitate the KM life-cycle. This has been recognized by a number of researchers in the literature evident by the number of KM life-cycles frameworks proposed (Nissen et al., 2000; Rubenstein-Montano, 2001a).

6.5.3 The Role of Strategy

The three companies studied are all interested in knowledge management to achieve strategic business goals. These goals include performance improvement, competitive advantage, and total quality. However, only one of the three companies, Compco, transferred its goals into a KM strategy. The other two companies, Oilco and Consultco, had a KM vision that was directly linked to the company's' performance improvement and quality strategies.

The success of the three companies in developing strong elements to facilitate KM is linked to their strategies. For example, Oilco has created a positive organizational culture, skilled workforce and supporting IT infrastructure to realize its KM vision through its performance improvement strategy. All of which significantly contribute to KM successful implementation. The use of the KPI measurement system allowed the company to measure, review and strive to improve the status of its employees' skills, IT infrastructure, and organizational culture. Having realized the importance of deploying a KM strategy, Oilco's management is currently considering establishing a KM strategy to integrate the various KM initiatives as well as identify and focus on areas that can facilitate KM in the company.

Similarly, Consutco was able to create a friendly culture and highly skilled engineers as part of its quality strategy. These again contributed significantly to KM practice in the company. Compco, on the other hand, did have a KM strategy. The strategy focused on people and technology and this was realized through the company's objectives. The company was able to develop plans to employ and maintain skilled employees as well as an IT infrastructure to support KM.

Engineering companies are interested in KM to achieve their business goals. Therefore, a successful implementation of KM requires the development of a strategy to achieve these goals. This strategy would then develop plans and objectives that address the various factors which affect KM success. A KM strategy promises not only to develop strong key factors to facilitate KM such as a friendly organizational culture, but would also utilize it to support the knowledge life-cycle. The strategy needs to be integrated with a measurement system to evaluate the level of contributions of KM to business goals and to enable the company to make continuous adjustments along the line of implementation. Recently, researchers recognized and emphasized the importance of strategic management in deriving KM initiatives (McAdam, 2000; Meso et al., 2002; Shankar et al., 2003)

6.5.4 The Role of Organizational Culture

The cases of Oilco and Consultco demonstrated how the two companies were able to create a knowledge friendly culture and to demonstrate the crucial impact of this culture in supporting KM. The companies' culture of loyalty, love and high trust have significantly affected the knowledge development. This was evident through empowerment of employees and the continuous support for their development. Culture also facilitates informal and formal knowledge sharing through focusing on socializing, open office space within departments in the case of Oilco and throughout the firm in the case of Consultco. In the two cases, this knowledge friendly culture resulted from good pay, job security and satisfaction, reward and recognition systems, encouragement for socializing, and the support for continuous development of employees.

In the case of Compco, no plans were developed as part of the company's KM strategy to create an organizational culture in support of KM. Compco's organizational culture supports knowledge development through empowerment of employees and the support for their continuous development. However, it does not support knowledge sharing and the distribution of tacit knowledge. There were no initiatives to develop reward systems to support knowledge sharing, nor to change people's attitude to encourage them to share their knowledge. The lack of a knowledge friendly organizational culture had a negative effect on the acquisition and distribution of tacit knowledge. Although people had critical tacit knowledge and the technology is there to externalize it such as the SOP system, employees are very reluctant in contributing to the system.

As emphasized by a number of researchers in the literature (Davenport, 1995; Scarbrough et al., 1999; Agresti, 2000; Meso and Smith, 2000; Bhatt, 2001), it is clear that a company's organizational culture has a critical role in facilitating knowledge development and distribution, particularly in the case of tacit knowledge. As engineering organizations rely heavily on tacit knowledge through their employees' skills and experiences, it is important to create a knowledge friendly culture to ensure successful implementation of KM.

6.5.5 The Role of People

The three cases demonstrated the important role of managers in facilitating KM. In the two cases of Oilco and Compco the focus is on middle managers. Middle managers perform a critical role in the implementation of KM in the two companies. This can be seen in agreement with Nonaka (1991) focus on the role of middle managers. They identified needed knowledge and provided means of acquiring, developing, and distributing it. They also exercise their leadership role to support KM practice. Oilco is currently considering establishing a knowledge manager position, as the initiatives are expanding, to ensure that KM implementation extends to the whole organization. In the third company, Consultco a similar role, however on a smaller scale, is performed by department heads as the company has only one level of management.

On the other hand, establishing and maintaining a skilled workforce is emphasized in all three cases. The three companies have an employee training and development program that is directly linked to a company's strategy. The various learning and training programs, the companies offer, provide means for acquiring external knowledge as well as distributing new, internal, and external knowledge. In Oilco, it is realized that different types of knowledge require different methods of distribution. This is in line with Gagne's (1965) conditions of learning. Therefore the company is offering various methods of knowledge distribution from instructor led training through e-learning to blended and integrated learning.

6.5.6 The Role of Information Technology

Oilco and Compco both employ a host of information and communication technologies. These technologies have a key role in enhancing communication and facilitating KM in the two companies. While email systems enhance communication, technologies such as databases, document management systems, management information systems, and engineering software enable the development and distribution of explicit knowledge. Other technologies such as lessons learned systems, the after action review system, and the SOP system support the externalisation of tacit knowledge. Collaboration tools are also employed to facilitate the sharing of tacit knowledge.

In the case of Consultco, the company focused on employing technologies to support engineering and project working. This resulted in the storage of some of the company's explicit knowledge. However, this stored knowledge was not formally developed for reuse and no other technologies were utilized nor employed to facilitate KM. Currently, the company is considering employing technologies to document lessons learned and procedures in an effort to externalise employees' tacit knowledge and make it available for reuse.

Technology is cited in the literature as a main enabler of KM in organizations (Ruggles, 1997; Frappaolo, 1998; Wiig, 1999a; Davenport and Prusak, 2000; Chourides et al., 2003). Various technologies are available to enhance communication and facilitate the management of both explicit and tacit knowledge. There is no general set of technologies that is suitable for all organizations. Firms need to employ the necessary technologies that facilitate their needs and requirements.

6.5.7 The Role of Organizational Structure

The three cases studied demonstrated the effects an organizational structure can have on its KM. Functional departmentalisation and project teams allow for knowledge development and sharing within specialized groups. In the case of Consultco the use of project teams across departmental units enabled knowledge sharing between the various units within the company. The flat organizational structure at Constructo also supported knowledge sharing through providing direct channels of communication. On the other hand, the link with external partners, cop-operators, contractors, and vendors provided a main source of acquiring external knowledge at Oilco and Compco. It also provided means for sharing knowledge with external partners.

6.5.8 Conclusion

The three case studies demonstrate the interest of engineering companies in KM to achieve various business goals. These goals are realized through employing strategies with clear plans and objectives. Plans need to identify needed knowledge and focus on key areas or elements to facilitate KM. The first area of focus would be on creating an organizational culture that facilitates KM. A knowledge friendly organizational culture is critical in supporting knowledge sharing in addition to knowledge development. The second area is identifying and utilizing managers' role in supporting KM and developing employees' skills to accommodate the company's needs. Third, employing and utilizing technology to facilitate the company's KM needs. Fourth, strive to create an organizational structure that facilitates knowledge development and sharing within the organization. It is clear that a successful implementation of KM requires the integration of the various key factors affecting KM in organizations.

CHAPTER 7

QUESTIONNAIRE

7.1 Introduction

The use of a questionnaire in this research follows the completion of the three in-depth case studies described in the previous chapter where the proposed KM model was formulated and tested. The questionnaire enables the triangulation of the findings from the case studies, i.e. validate and generalize the findings from the case study phase. This is achieved through surveying the opinions of managers involved with KM in engineering organizations regarding the importance of the various elements described by the "SCPTS" KM model as well as investigating the current status of these elements in their organizations.

The knowledge management questionnaire is also designed as a starting point tool for managers to identify their KM status with regard to the various key factors described by the "SCPTS" KM model, for example, organizational culture, employee's skills, and technology infrastructure. This would assist managers to raise awareness of the potential gaps that exist within an organization and encourages subsequent actions and steps on part of the management. Managers and their organizations would then be in a better position to initiate a focused KM implementation program. Efforts will be focused towards the weak KM areas.

The first part of this chapter introduces the development of the KM questionnaire. This includes producing the questionnaire and conducting the survey. This is followed by a description of the various sections and questions covered by the questionnaire. The Chapter then presents the findings of the questionnaire and a general discussion.

7.2 Development of the Questionnaire

The first draft of the KM questionnaire was produced after completing the exploratory work and the initial literature review. However, it was recognized that the use of a questionnaire would only be beneficial when the issues to be investigated are clearly understood. Therefore, the development of the KM questionnaire was an iterative process. The KM questionnaire was continuously modified and refined during the course of this research and through the development of the "SCPTS" model as the key factors which affect the implementation of KM in engineering organizations where identified and investigated. Upon completing the case studies and producing the "SCPTS" three-layer KM model, a pilot questionnaire was presented to managers in four engineering organizations to solicit their opinions on the questionnaire and examine the feedback. Having obtaining the feedback from the managers on the pilot questionnaire and made minor necessary modifications, the KM questionnaire was produced in its final form.

The questionnaire was sent through email, to allow for the coverage of a wide geographic area, to general managers and knowledge officers in 426 engineering companies. Companies selected were of various sectors, type of engineering business, and were located in the Middle East, USA, UK, and Europe. Some of these companies were identified during the literature review whereas others were selected randomly through library and Internet search. The only prerequisite that was required for the company to be selected is to be engaged with KM practice at any level. In an attempt to increase the response rate, the questionnaire was designed to be completed by the respondents in less than 15 minutes. A further incentive of offering an electronic summary of the findings was also used. After extending the reply period from one to two months and sending reminder emails to the managers, 19 questionnaires were returned completed (admittedly in the summer period when holidays would impact on response rates). The KM questionnaire is presented in Appendix A.

7.3 The KM Questionnaire

The KM questionnaire is composed of closed questions in which the respondents are offered a choice of alternative replies on a continuum. Closed questions are thought to be the most appropriate for the purpose of the questionnaire in this research. These questions are easier and quicker to answer, therefore allowing for more questions to be asked without increasing the time needed to complete the questionnaire (Oppenheim, 1992). Additionally, the use of closed questions is sufficient in this case as it follows exploratory work, extensive literature review, and conducting in-depth case studies were a rich picture of the factors to be investigated was developed.

The KM questionnaire includes six sections following the background information section. Each section contains a number of closed questions; these vary from five to eleven questions. The response to each question has two independent dimensions; the first addresses the current status in the organization while the second addresses the importance to the organization. In the first (Current Status) dimension, five possible answers are offered: completely implemented, partially implemented, do not know, plan to implement, and not implemented. Similarly, in the second (Importance) dimension, five possible answers are offered: critical, important, do not know, beneficial, and not important. The answers are designed to ensure balance between positive and negative categories within each dimension. In addition, a middle category "Do Not Know" is offered to handle the possibility that respondents are not familiar enough with the subject matter, or their own feelings on a topic, to answer a question thereby obtaining improved measurement (Fowler, 1995).

The sections contained in the KM questionnaire are categorized as follows:

- Section A: *Awareness and commitment.* This section contains five questions (A1-A5). Questions in this section are related to understanding the concept of knowledge management and the commitment of senior management to its use.
- Section B. *Strategy.* This section contains ten questions (B1-B10). Questions in this section are related to strategy; the commitment to a program of KM improvement and managing it to ensure maximum business benefits.
- Section C. *Culture.* This section contains ten questions (C1-C10). Questions in this section are related to organizational culture; behaviours in the organization that enable effective KM.

- Section D. *Structure.* This section contains five questions (D1-D5). Questions in this section are related to organizational structure; structuring the organization to make the most of its knowledge resources.
- Section E. *People.* This section contains nine questions (E1-E9). Questions in this section are related to people; managers and employees in the organization and their support to KM.
- Section F. *Technology.* This section contains eleven questions (F1-F11). Questions in this section are related to technology; whether the right kind of technology is available and is it used effectively enough to support KM.

Each of the above mentioned sections evolve around a key factor that supports knowledge management implementation in engineering organizations as identified by the "SCPTS" KM model. All the questions in the six sections of the KM questionnaire and what does each one aim to investigate are shown in Table 7.1.

Question Number	Question	Investigates
Section A: Awareness and Commitment		
A1	If I use the term knowledge management anywhere in my company, most people will understand what it means for us and how it is applied to the business	Awareness and understanding of KM in the organization
A2	Knowledge management is represented at the management level with a chief knowledge officer position or something similar	Representing KM at the management level
A3	Senior management demonstrate the commitment to KM with resources, action, guidelines and activities	Management commitment to KM
A4	Senior managers support knowledge sharing, learning and other KM desired behaviours. This is often talked about in meetings	Management commitment to KM behaviours and relating it to employees
A5	KM is seen as a vital element of business strategy and knowledge is widely recognized as the basis of our competitive position	KM as an element of business strategy that leads to achieving competitive advantage
Section B: Strategy		
B1	There is vision on how KM should be integrated into the business. It is clear how KM initiatives support the business plan	Organization's KM vision
B2	There is a shared understanding, based on a scenario plan, on what KM should be doing for us in two years time	KM planning
B3	There are defined responsibilities and a budget set for KM initiatives	KM responsibilities and budget
B4	Intellectual assets are inventoried or recognized and some measure of value is attached to each	Knowledge measurement
B5	Key performance indicators for KM are in place	KM performance measurement

"Continue"

Question Number	Question	Investigates
B6	KM principles are well established. There are definitions of key knowledge and guidelines for the creation and management of knowledge	Identifying key knowledge and the need to create new knowledge
B7	There are initiatives within the business plan to improve KM	Plans to improve KM
B8	There is a senior level ongoing review of the effectiveness of KM in the whole company	Reviewing the effectiveness of KM
B9	There is a program of active participation in business conferences and other discussion forums to share ideas and experiences	Acquiring external knowledge
B10	We are committed to a Total Quality Management (TQM) program. Particularly, in the areas of continuous improvement and empowerment of employees	Commitment to continuous improvement and empowerment of employees
Section C:	*Culture*	
C1	Failure is not punished; rather it is seen as an opportunity to learn	Willingness to share knowledge; not punishing failure
C2	Recording and sharing of knowledge is routine and second nature. Next time I have a good idea, I know exactly how to share it	Willingness to share knowledge; providing means of sharing knowledge
C3	Individuals are visibly rewarded for team work and knowledge sharing	Willingness to share knowledge; rewarding knowledge sharing
C4	Holding of knowledge and being secretive about the best way to do something is actively discouraged	Willingness to share knowledge; discouraging holding knowledge
C5	Asking for help from expert co-workers is monitored, encouraged and rewarded	Rewarding knowledge sharing

"Continue"

Question Number	Question	Investigates
C6	Employees feel secure about there jobs. The organization makes it attractive to stay and long term employment is encouraged	Job security
C7	We constantly seek best practice and try to reuse existing projects and knowledge whenever we can	Reusing valuable knowledge
C8	Time is allowed for creative thinking. For example, staff are encouraged to reflect and thinking time is allowed for	Allowing time for creating new knowledge
C9	Physical space supports knowledge transfer. For example, working in open space and providing meeting rooms	Office design supports knowledge development and sharing
C10	Love, care and trust are fostered among team members in the organization	Developing a friendly culture
Section D:	*Structure*	
D1	A flexible, well-structured, up-to-date knowledge map exists to point staff in the direction of the knowledge they seek	Organizational structure; flat and flexible
D2	Formal networks and cross-functional teams exist to facilitate the dissemination of knowledge	Organizational structure; supporting knowledge sharing
D3	Informal networks across the organization are encouraged, in fact management meetings often discuss our communities of practice	Organizational structure; communities of practice facilitating knowledge sharing
D4	Staff are rotated to spread best practice ideas or natural staff turnover is positively used to assist with the dissemination of best practice	Organizational structure; sharing knowledge outside departmental boundaries
D5	We are connected to external networks and knowledge sources which cause us constantly to re-examine what we are doing	External networks; acquiring external knowledge

"Continue"

Question Number	Question	Investigates
Section E: People		
E1	Middle managers play a major role in transferring the organization's KM strategy into specific plans, actions, processes and defined KM roles	Middle manger's role in KM
E2	Managers scan the organization to identify knowledge needs	Managers identifying needed knowledge
E3	Knowledge sharing is seen as strength. Managers are responsible for motivating, mentoring and coaching their employees	Managers as leaders and mentors
E4	We know who our leading experts are in all areas of activity. We take active steps to ensure that they share knowledge and do not leave without leaving their knowledge in the organization	Identifying sources of internal tacit knowledge and actively sharing it
E5	Managers give considerable attention to creating the right mix of people when forming teams	Managers' role; forming teams
E6	Everyone is willing to give advice or help on request to anyone else in the company	Employees' willingness to share tacit knowledge
E7	Training and development programs in KM behaviour and procedures are encouraged from recruitment onwards	Training and development in KM behaviours
E8	We have a number of people who are assigned the responsibility of ensuring that knowledge is transferred internally and externally	KM teams
E9	Specialized teams are assigned the responsibility of storing and maintaining knowledge	KM support teams
Section F: Technology		
F1	Technology is a key enabler in ensuring the right information is available to the right people at the right time	Technology as a key enabler to KM

"Continue"

Question Number	Question	Investigates
F2	The information services team are constantly checking to ensure that our IT support our knowledge needs	IT supports KM
F3	Internet and a local intranet are available to support KM	Hardware to support KM
F4	Organization policies, standards and manuals are stored in databases and made available to employees	Technology; managing explicit knowledge
F5	Procedures and lessons-learned from experience are documented and stored in databases	Technology; externalizing tacit knowledge
F6	IT makes the search for information much easier. It is supported by search engines and document management systems	Technology to facilitate the development and distribution of explicit knowledge
F7	IT network is integrated with the specialized business software tools. For example, CAD/CAM and project management tools	Specialized engineering software utilized to support KM
F8	Modelling systems, decision support systems and artificial intelligence are in use	Sophisticated technologies to facilitate managing tacit knowledge
F9	IT allows effective communication across boundaries and even time zones aided by massaging systems and conference tools	Technology; enabling communication across boundaries
F10	Directories of staff indicating their field of expertise and their contacts are available for easy identification	Technology; identify sources of tacit knowledge
F11	Our hardware and software are updated routinely without significant debate	Updating organization's technology

Table 7.1: Questions in the KM questionnaire

As the KM questionnaire in this research aims to investigate the response to each question (statement) independently, no scale was developed or employed to rate the various questions. However, when the KM questionnaire is to be used by an organization to evaluate their current status on the various KM key factors, then simple weights (Likert scales) 5, 4, 3, 2, and 1 may be given to the five positions in the continuum for scoring purposes (Oppenheim, 1992). For example, a fully implemented answer to a particular statement will score 5, whereas not implemented will score 1. Total scores on each section can then be added to aid the organization in assessing their status on each factor. Alternatively, organizations can compare their response on the two dimensions and determine any existing gaps, i.e. compare the elements (statements) they value as critical or important to succeed in KM, and their status in their organization.

It is important to note that the questionnaire findings are used in this research as a secondary validating method following the qualitative in-depth case studies. While it is believed that the sampling is significant for this purpose, no claim is made to use this as the basis of making sweeping generalization. The total responses to all the questions in the various sections of the KM questionnaire are shown in Figure 7.1.

A	Awareness and Commitment	Current status in your organization					How important is it to your organization				
	Understanding the concept of knowledge management (KM) and commitment of senior management to its use	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
A1	If I use the term knowledge management anywhere in my company, most people will understand what it means for us and how it is applied to the business	2	9	1	7	-	10	8	1	-	-
A2	Knowledge management is represented at the management level with a chief knowledge officer position or something similar	4	1	2	8	4	4	9	2	4	-
A3	Senior management demonstrate the commitment to KM with resources, action, guidelines and activities	3	6	-	10	-	11	8	-	-	-
A4	Senior managers support knowledge sharing, learning and other KM desired behaviours. This is often talked about in meetings	3	9	-	7	-	14	5	-	-	-
A5	KM is seen as a vital element of business strategy and knowledge is widely recognized as the basis of our competitive position	8	10	-	1	-	15	4	-	-	-

Figure 7.1: KM questionnaire indicating total response

B	Strategy	Current status in your organization					How important is it to your organization				
	Commitment to a program of KM improvement and managing it to ensure maximum business benefits	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
B1	There is vision on how KM should be integrated into the business. It is clear how KM initiatives support the business plan	5	7	-	7	-	14	5	-	-	-
B2	There is a shared understanding, based on a scenario plan, on what KM should be doing for us in two years time	3	12	1	3	-	4	14	-	1	-
B3	There are defined responsibilities and a budget set for KM initiatives	6	3	-	10	-	9	10	-	-	-
B4	Intellectual assets are inventoried or recognized and some measure of value is attached to each	2	3	2	11	1	3	13	2	1	-
B5	Key performance indicators for KM are in place	5	2	-	12	-	8	11	-	-	-
B6	KM principles are well established. There are definitions of key knowledge and guidelines for the creation and management of knowledge	4	9	-	6	-	13	6	-	-	-
B7	There are initiatives within the business plan to improve KM	6	7	-	5	1	8	11	-	-	-
B8	There is a senior level ongoing review of the effectiveness of KM in the whole company	4	5	1	7	2	7	12	-	-	-
B9	There is a program of active participation in business conferences and other discussion forums to share ideas and experiences	8	10	1	-	-	2	13	-	4	-
B10	We are committed to a Total Quality Management (TQM) program. Particularly, in the areas of continuous improvement and empowerment of employees	8	6	-	4	1	3	13	-	3	-

Figure 7.1: KM questionnaire indicating total response (Continue)

C	Culture	Current status in your organization					How important is it to your organization				
	Behaviours in the company enable effective KM	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
C1	Failure is not punished; rather it is seen as an opportunity to learn	9	5	-	5	-	9	10	-	-	-
C2	Recording and sharing of knowledge is routine and second nature. Next time I have a good idea, I know exactly how to share it	8	3	1	6	1	14	5	-	-	-
C3	Individuals are visibly rewarded for team work and knowledge sharing	7	10	-	1	1	16	3	-	-	-
C4	Holding of knowledge and being secretive about the best way to do something is actively discouraged	10	7	1	1	-	14	3	-	2	-
C5	Asking for help from expert co-workers is monitored, encouraged and rewarded	5	10	-	3	1	14	3	-	2	-
C6	Employees feel secure about there jobs. The organization makes it attractive to stay and long term employment is encouraged	10	7	2	-	-	13	6	-	-	-
C7	We constantly seek best practice and try to reuse existing projects and knowledge whenever we can	8	10	-	1	-	15	4	-	-	-
C8	Time is allowed for creative thinking. For example, staff are encouraged to reflect and thinking time is allowed for	3	11	-	3	2	8	9	1	1	-
C9	Physical space supports knowledge transfer. For example, working in open space and providing meeting rooms	9	3	2	3	2	4	8	1	5	1
C10	Love, care and trust are fostered among team members in the organization	8	8	3	-	-	14	3	-	2	-

Figure 7.1: KM questionnaire indicating total response (Continue)

D	Structure	Current status in your organization					How important is it to your organization				
	The company is organized to make the most of its knowledge resources	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
D1	A flexible, well-structured, up-to-date knowledge map exists to point staff in the direction of the knowledge they seek	4	5	1	9	-	6	11	-	2	-
D2	Formal networks and cross-functional teams exist to facilitate the dissemination of knowledge	5	6	-	7	1	7	10	-	2	-
D3	Informal networks across the organization are encouraged, in fact management meetings often discuss our communities of practice	3	7	1	6	2	4	8	2	5	-
D4	Staff are rotated to spread best practice ideas or natural staff turnover is positively used to assist with the dissemination of best practice	3	6	-	6	4	5	7	-	6	1
D5	We are connected to external networks and knowledge sources which cause us constantly to re-examine what we are doing	4	8	1	4	2	5	5	2	6	1

Figure 7.1: KM questionnaire indicating total response (Continue)

E	People	Current status in your organization					How important is it to your organization				
	Managers and employees in the company support KM	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
E1	Middle managers play a major role in transferring the organization's KM strategy into specific plans, actions, processes and defined KM roles	7	9	-	3	-	9	7	-	3	-
E2	Managers scan the organization to identify knowledge needs	5	10	-	4	-	7	10	-	2	-
E3	Knowledge sharing is seen as strength. Managers are responsible for motivating, mentoring and coaching their employees	9	9	-	1	-	16	3	-	-	-
E4	We know who our leading experts are in all areas of activity. We take active steps to ensure that they share knowledge and do not leave without leaving their knowledge in the organization	5	10	-	4	-	14	5	-	-	-
E5	Managers give considerable attention to creating the right mix of people when forming teams	8	7	1	3	-	8	8	1	2	-
E6	Everyone is willing to give advice or help on request to anyone else in the company	5	7	1	6	-	15	4	-	-	-
E7	Training and development programs in KM behaviour and procedures are encouraged from recruitment onwards	10	8	-	1	-	15	4	-	-	-
E8	We have a number of people who are assigned the responsibility of ensuring that knowledge is transferred internally and externally	6	10	1	2	-	7	11	1	-	-
E9	Specialized teams are assigned the responsibility of storing and maintaining knowledge	4	6	-	9	-	13	5	-	1	-

Figure 7.1: KM questionnaire indicating total response (Continue)

F	Technology	Current status in your organization					How important is it to your organization				
	The right kind of technology is available and it is used effectively enough to support KM	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
F1	Technology is a key enabler in ensuring the right information is available to the right people at the right time	4	12	-	3	-	14	4	-	1	-
F2	The information services team are constantly checking to ensure that our IT support our knowledge needs	7	7	2	2	1	6	9	2	2	-
F3	Internet and a local intranet are available to support KM	7	5	-	3	4	5	9	-	5	-
F4	Organization policies, standards and manuals are stored in databases and made available to employees	5	10	-	3	1	8	9	-	2	-
F5	Procedures and lessons-learned from experience are documented and stored in databases	4	6	-	4	5	8	10	-	1	-
F6	IT makes the search for information much easier. It is supported by search engines and document management systems	4	8	-	4	3	6	11	-	2	-
F7	IT network is integrated with the specialized business software tools. For example, CAD/CAM and project management tools	5	10	-	4	-	7	9	-	3	-
F8	Modelling systems, decision support systems and artificial intelligence are in use	2	5	-	5	7	5	6	-	7	1
F9	IT allows effective communication across boundaries and even time zones aided by massaging systems and conference tools	6	6	-	6	1	5	12	1	1	-
F10	Directories of staff indicating their field of expertise and their contacts are available for easy identification	3	10	-	6	-	12	6	-	1	-
F11	Our hardware and software are updated routinely without significant debate	7	5	1	5	1	9	7	1	2	-

Figure 7.1: KM questionnaire indicating total response (Continue)

7.4 Questionnaire Findings

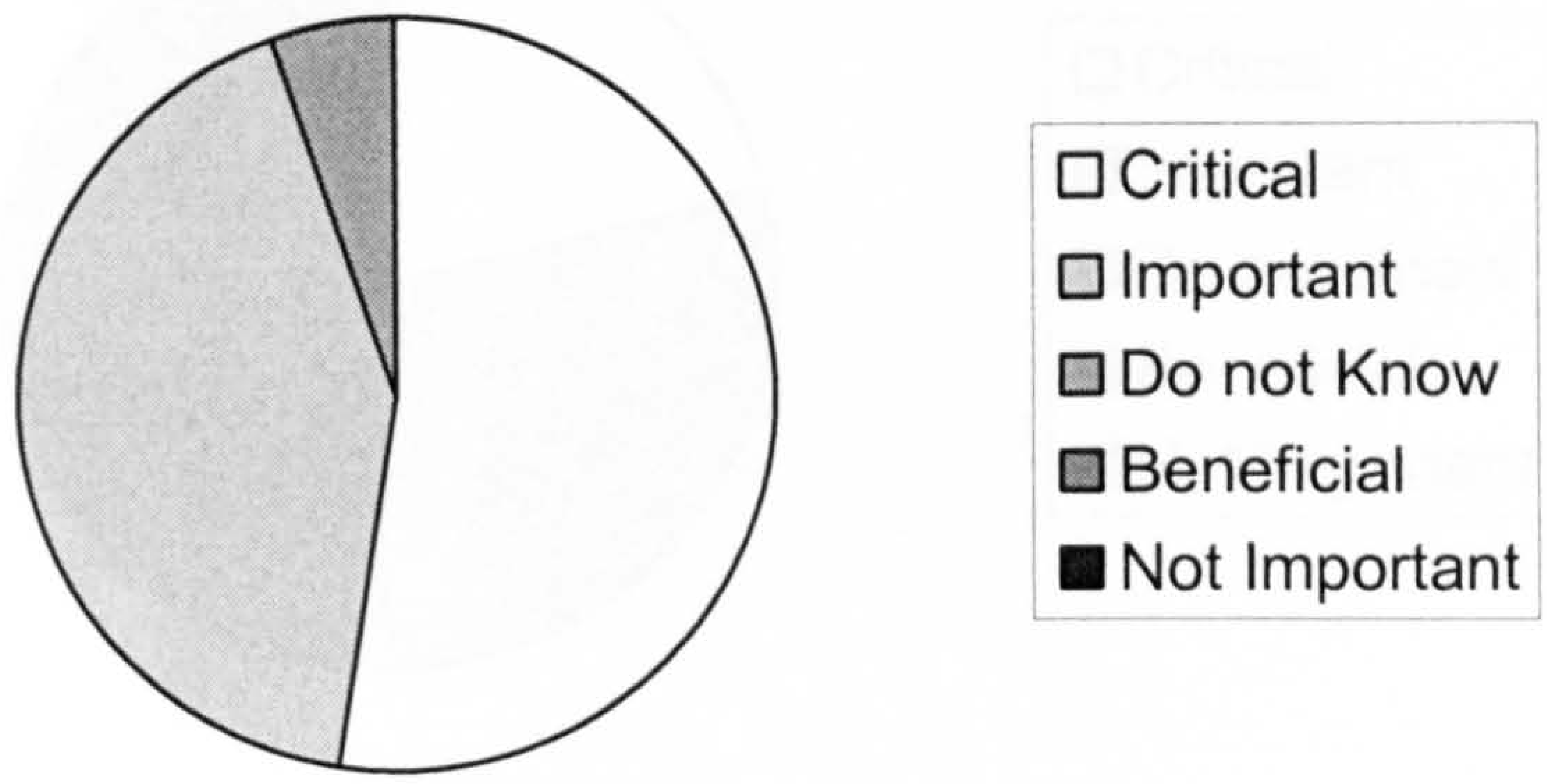
The completed questionnaires were received from companies in the oil, construction, consulting, manufacturing and production industries. These companies were of different sizes and are located in the Middle East, USA, UK, and Europe. Table 7.2 shows a breakdown of the responses according to the type of business, location, number of employees, and position of person completing the questionnaire.

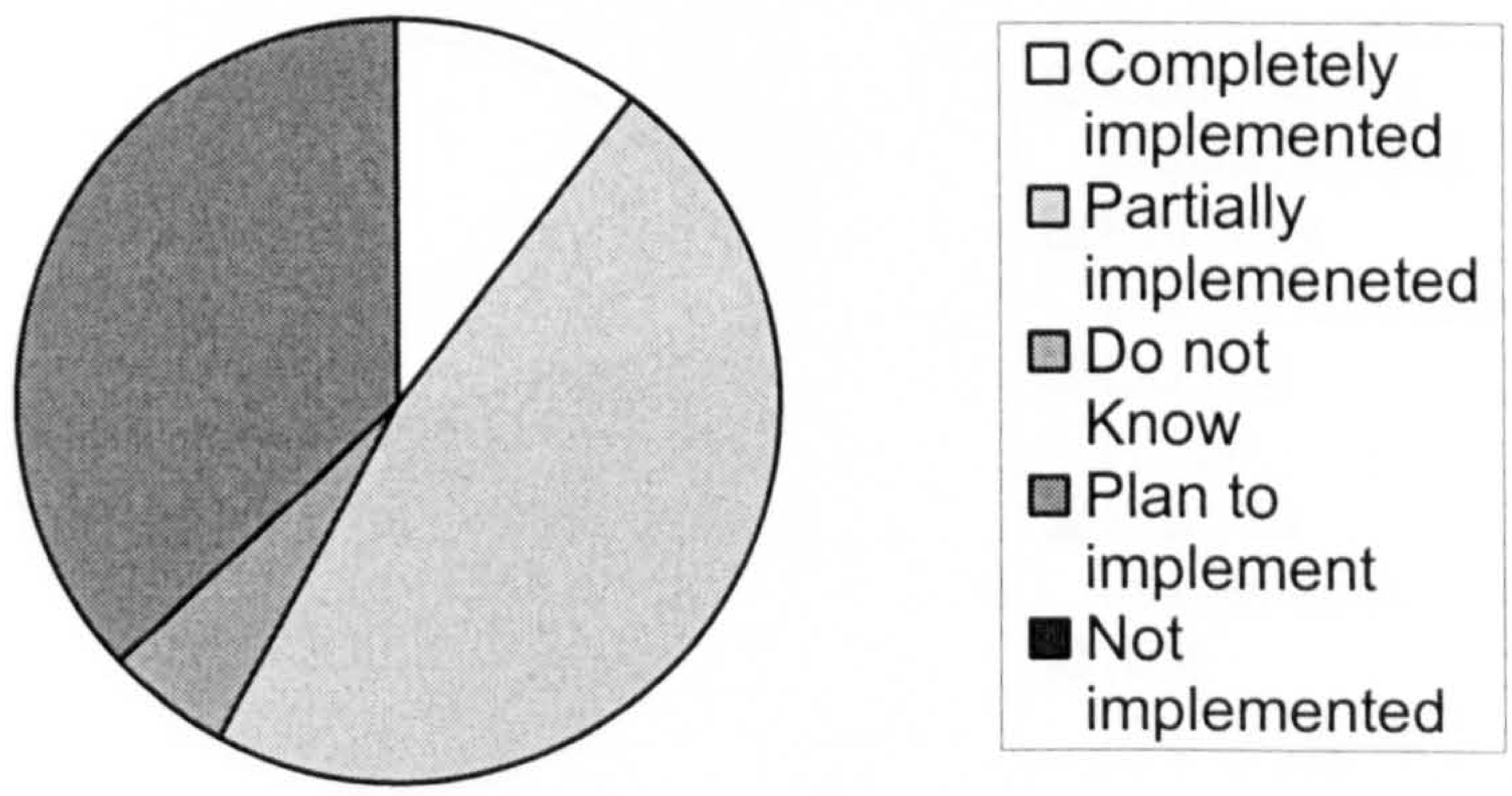
The following pages present each question in the KM questionnaire, figures to show the total response to the question in the two dimensions based on the data collected, and the corresponding finding.

Company	Type of Business	Location	Number of employees	Position of person completing the questionnaire
1	Oil	Middle East	Over 500	Senior HR Advisor
2	Oil	Middle East	Over 500	IT Manager
3	Oil	France	Over 500	Knowledge Manager
4	Oil	USA	Over 500	Knowledge Broker
5	Oil	USA	Over 500	Knowledge Broker
6	Construction	Middle East	100-500	Managing Director
7	Construction	Middle East	100-500	Area Manager
8	Construction	UK	Over 500	Project Manager
9	Construction	Germany	Over 500	Managing Director
10	Consultants	Middle East	Less than 100	General Manager
11	Consultants	Middle East	Less than 100	General Manager
12	Consultants	Middle East	Less than 100	Project Manager
13	Consultants	UK	100-500	Project Manager
14	Manufacturing	Middle East	100-50+0	Production Manager
15	Manufacturing	Middle East	100-500	IT Manager
16	Manufacturing	Middle East	100-500	Production Manager
17	Manufacturing	Middle East	Over 500	IT Manager
18	Manufacturing	UK	100-500	Design Engineer
19	Manufacturing	USA	Over 500	Knowledge Manager

Table 7.2: Breakdown of the responses to the KM questionnaire

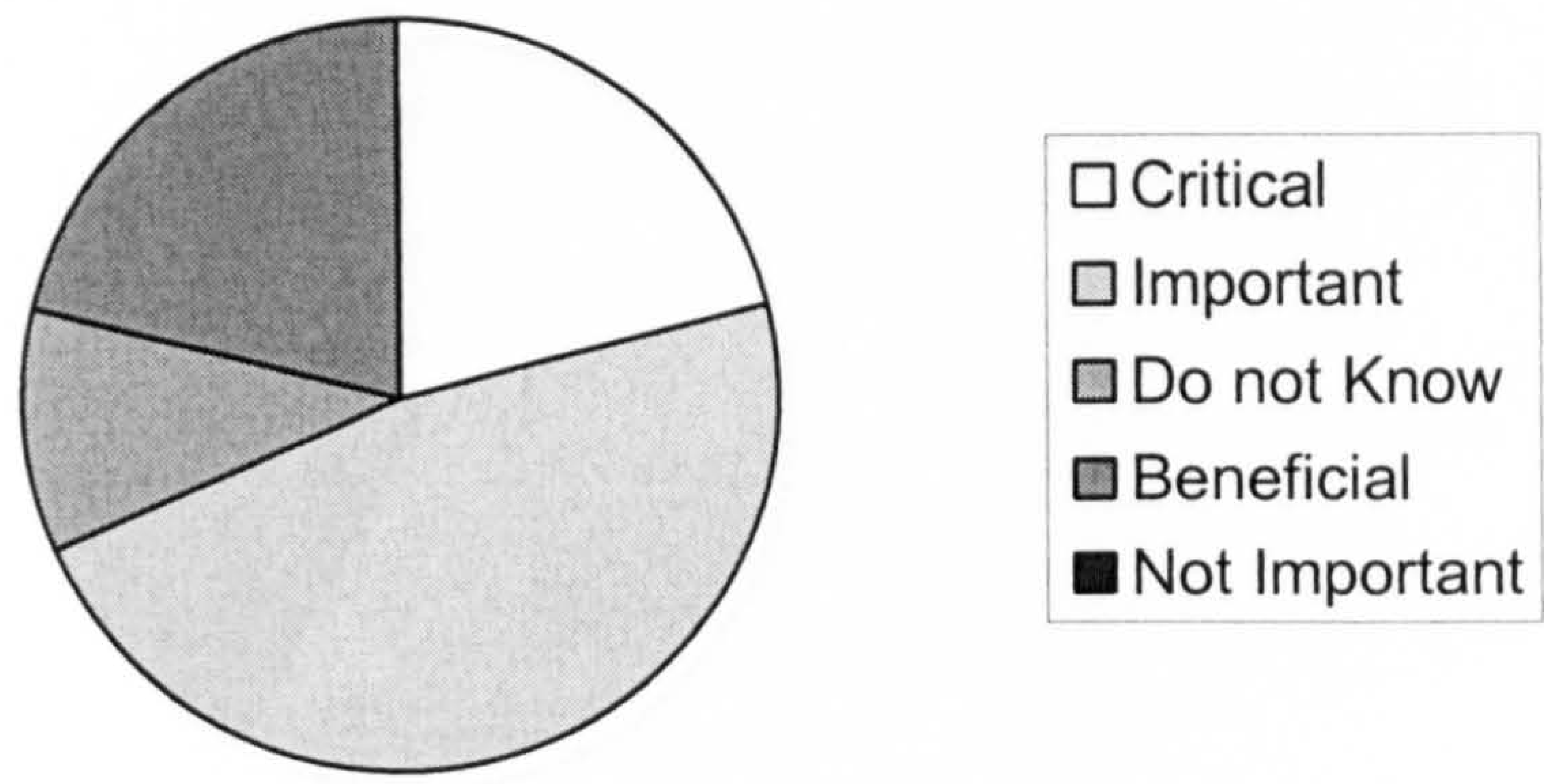
Question: **A1.** If I use the term knowledge management anywhere in my company, most people will understand what it means for us and how it is applied to the business.

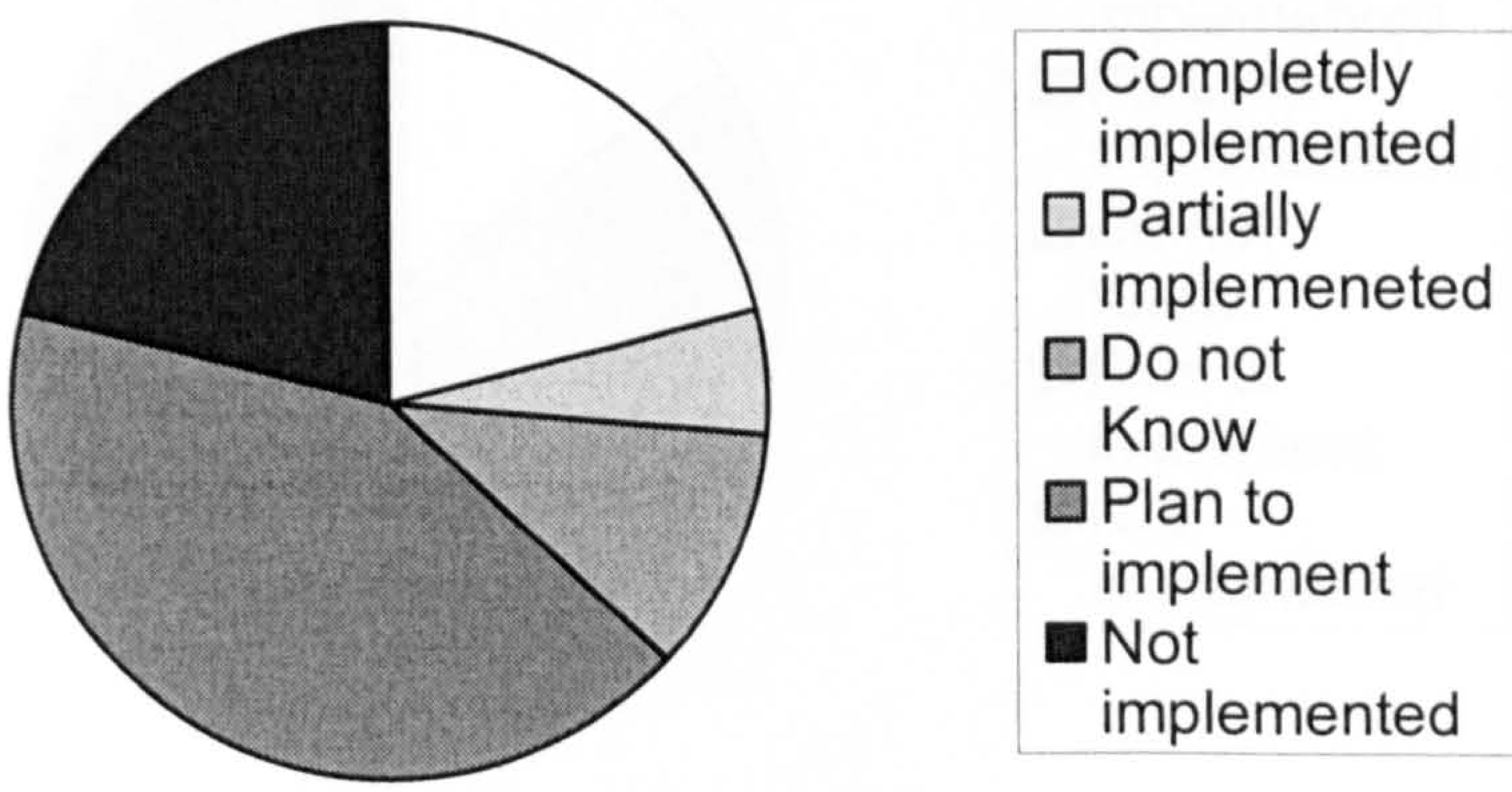




Finding: 95% of the respondents reported that it is critical or important for people in the organization to be aware of KM and how it is applied to the business. On the other hand, as far as the current status in their organizations is concerned, respondents reported as follows: 11% reported that this is completely implemented, 47% partially implemented, and 37% plan to implement.

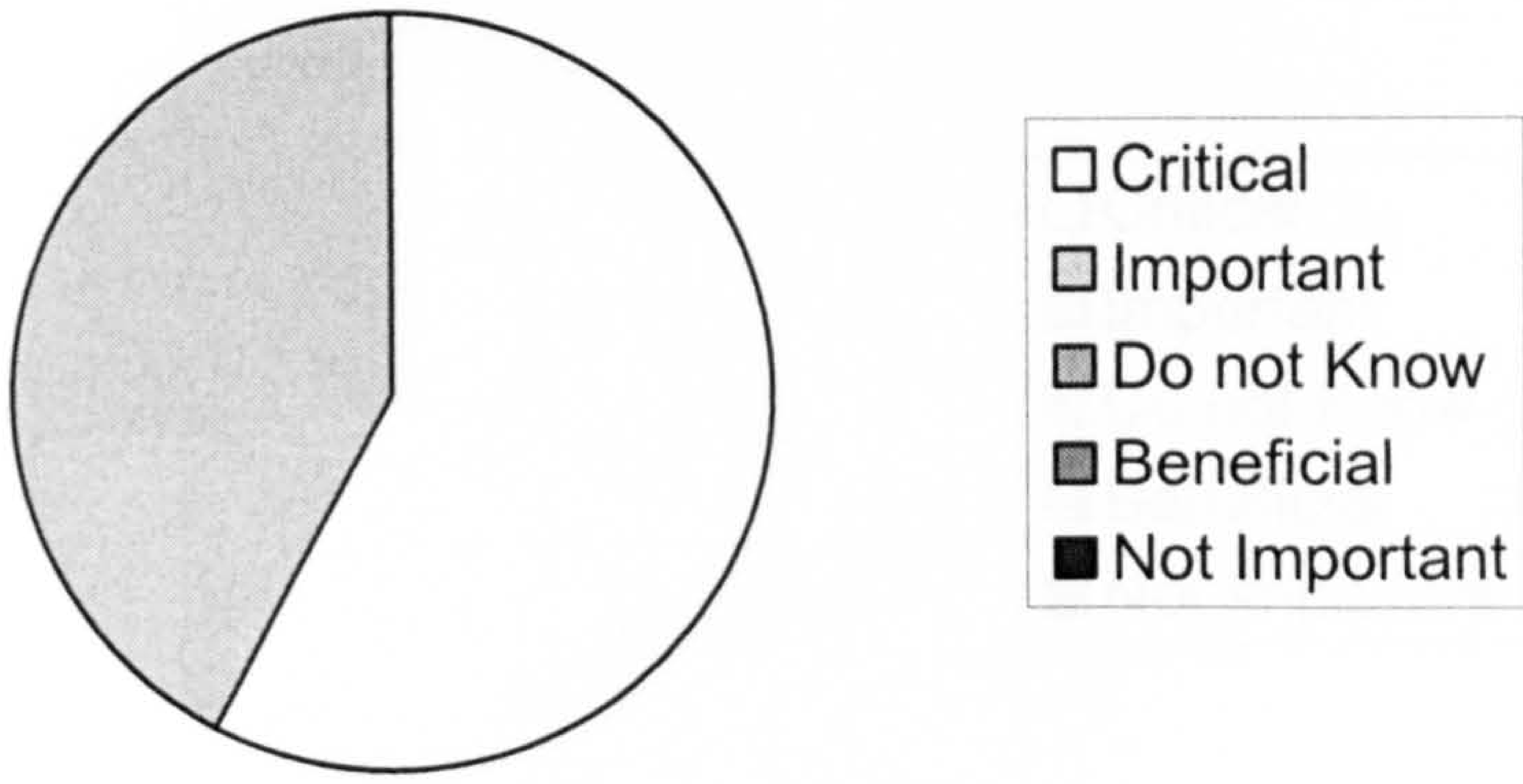
Question: A2. Knowledge management is represented at the management level with a chief knowledge officer position or something similar.

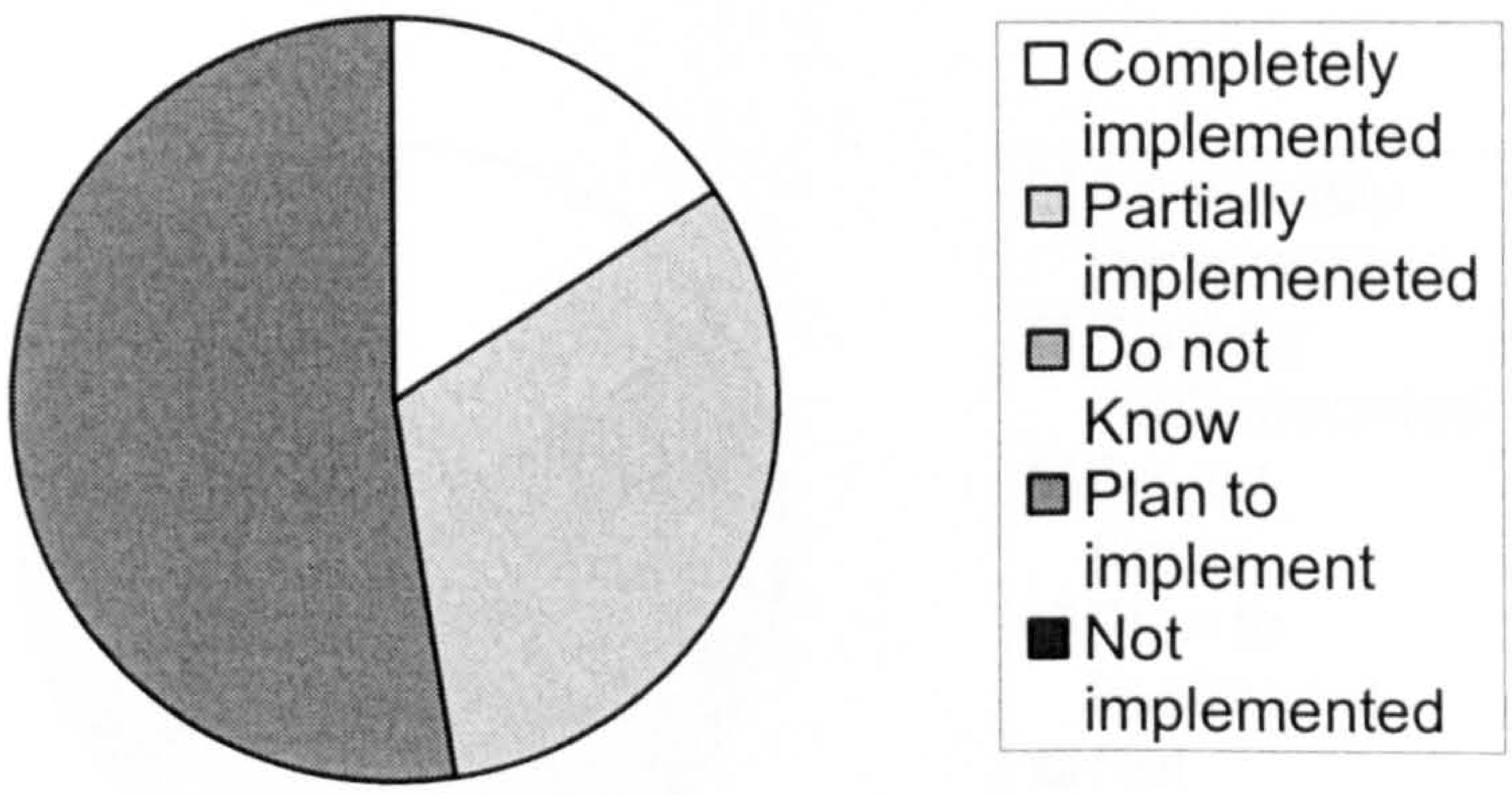




Finding: 68% of the respondents reported that it is critical or important for KM to be represented at the management level and 21% reported that it is beneficial. On the other hand, 42% reported that they plan to implement this in their organization and 21% reported that it is not implemented.

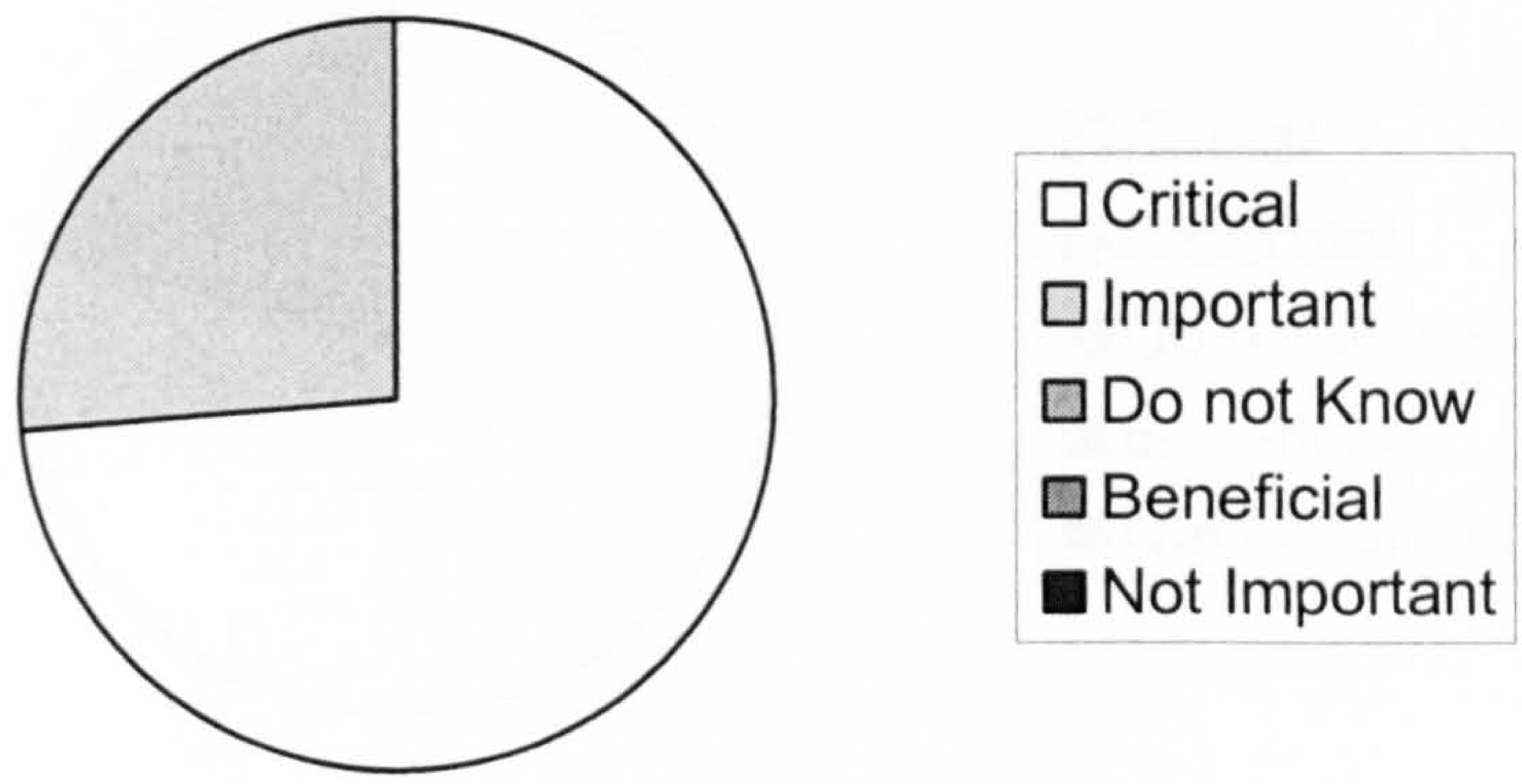
Question: A3. Senior management demonstrate the commitment to KM with resources, action, guidelines and activities.

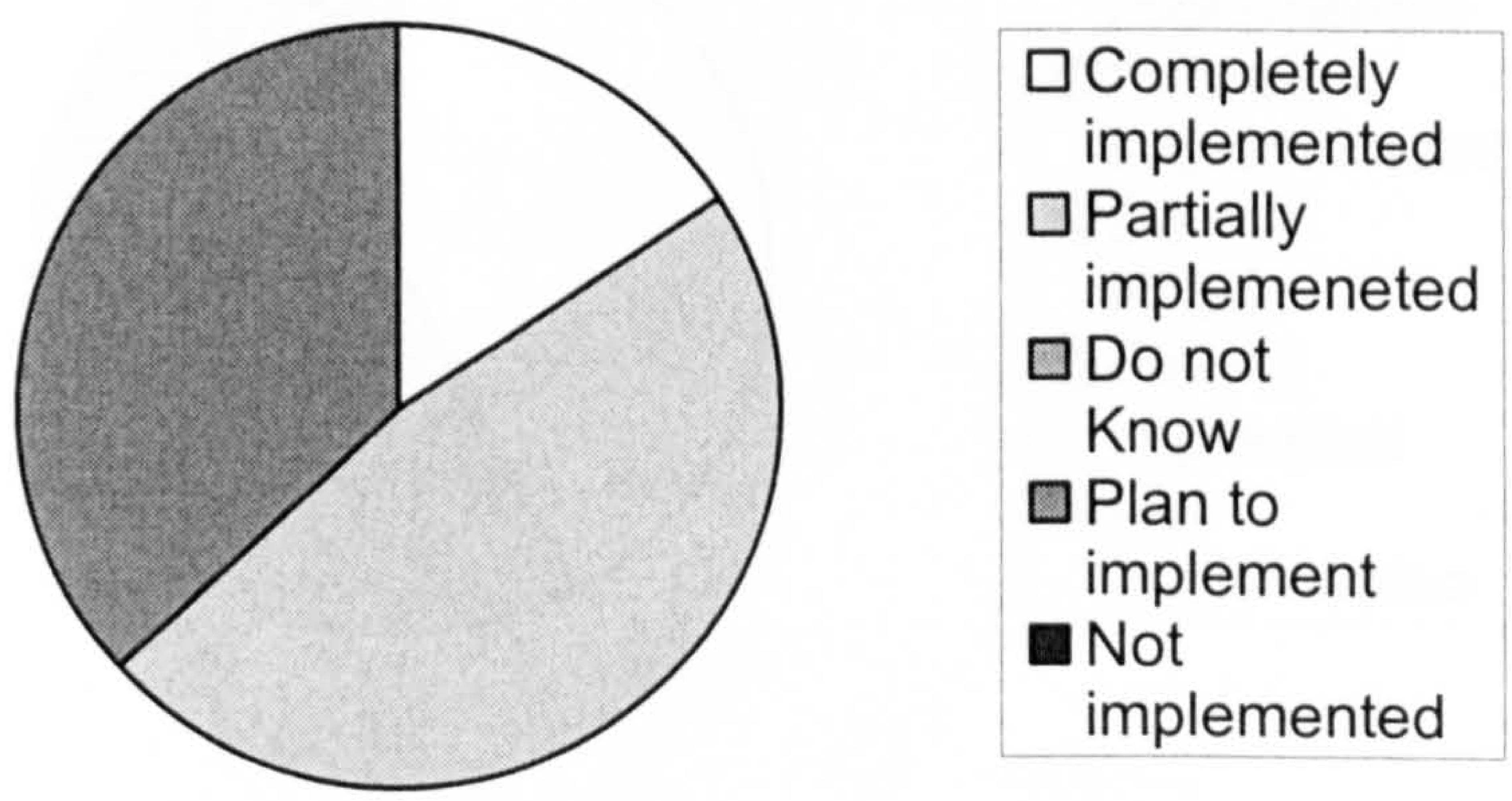




Finding: 100% of the respondents reported that it is critical or important for senior management to demonstrate their commitment to KM with resources, action, guidelines, and activities. On the other hand, as far as the current status in their organizations is concerned, respondents reported as follows: 16% reported that this is completely implemented, 32% partially implemented, and 53% plan to implement.

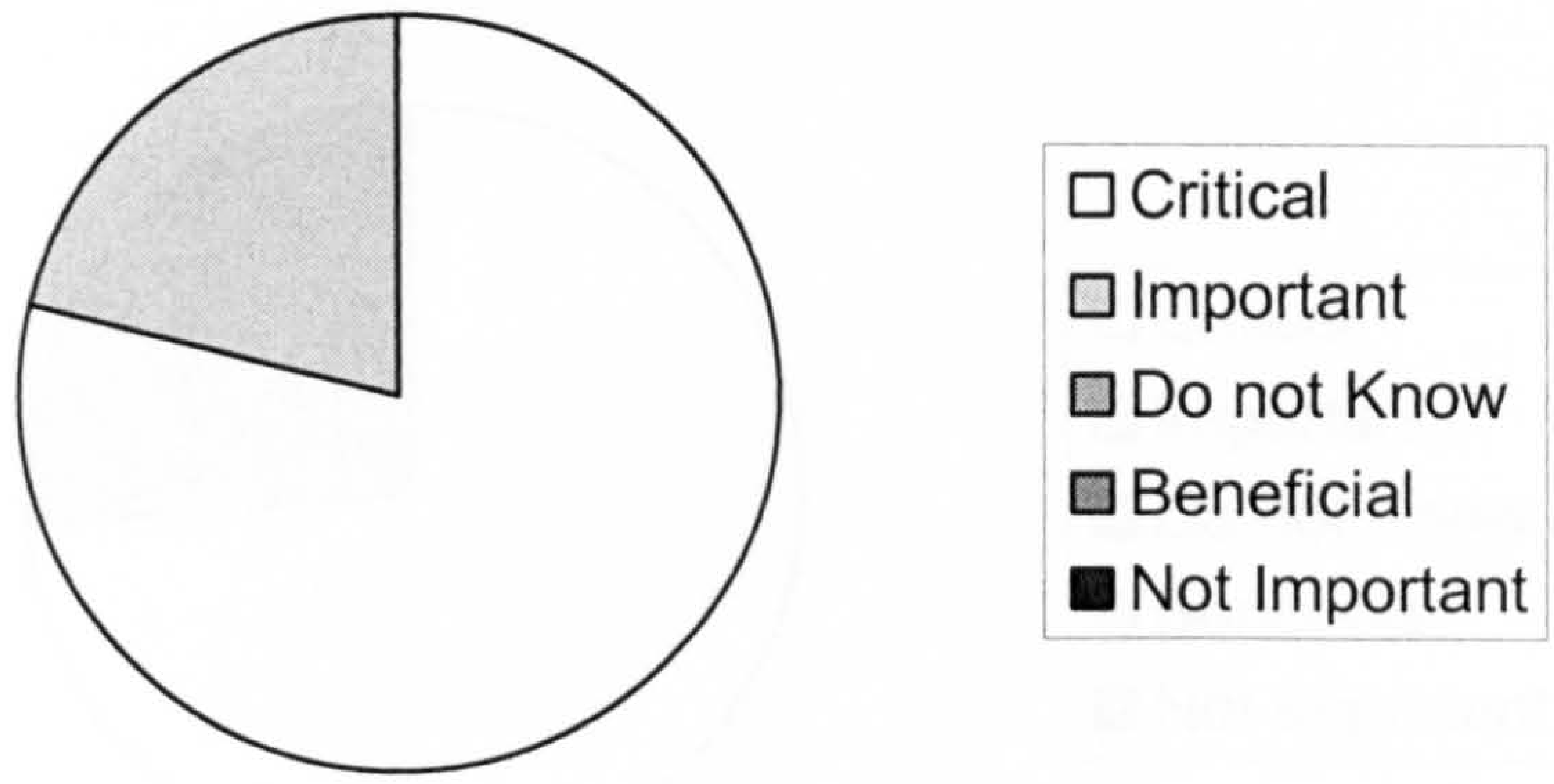
Question: A4. Senior managers support knowledge sharing, learning and other KM desired behaviours. This is often talked about in meetings.

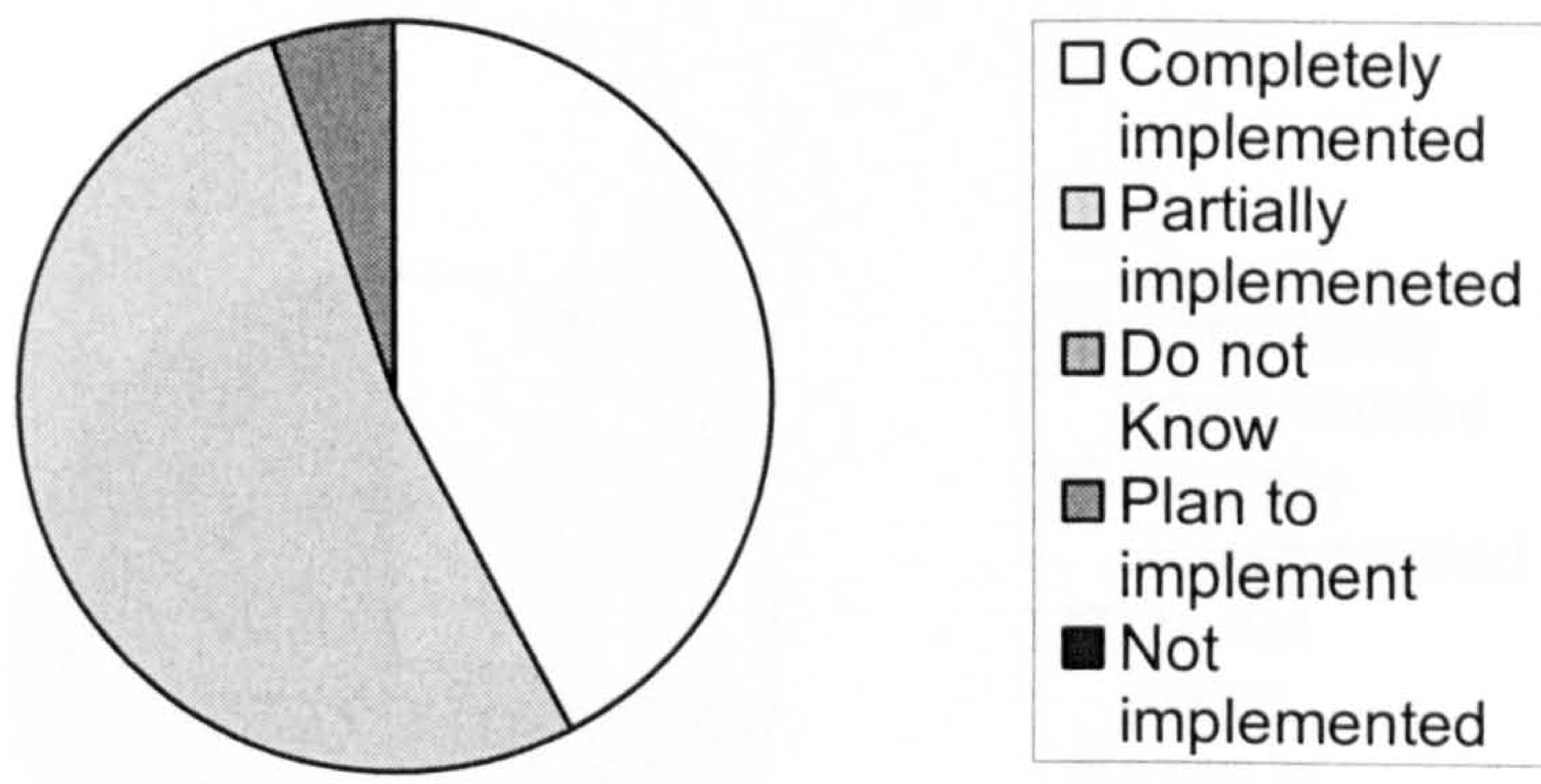




Finding: 100% of the respondents reported that it is critical or important for senior managers to support knowledge sharing, learning and other KM desired behaviours. On the other hand, as far as the current status in their organizations is concerned, respondents reported as follows: 16% reported that this is completely implemented, 47% partially implemented, and 37% plan to implement.

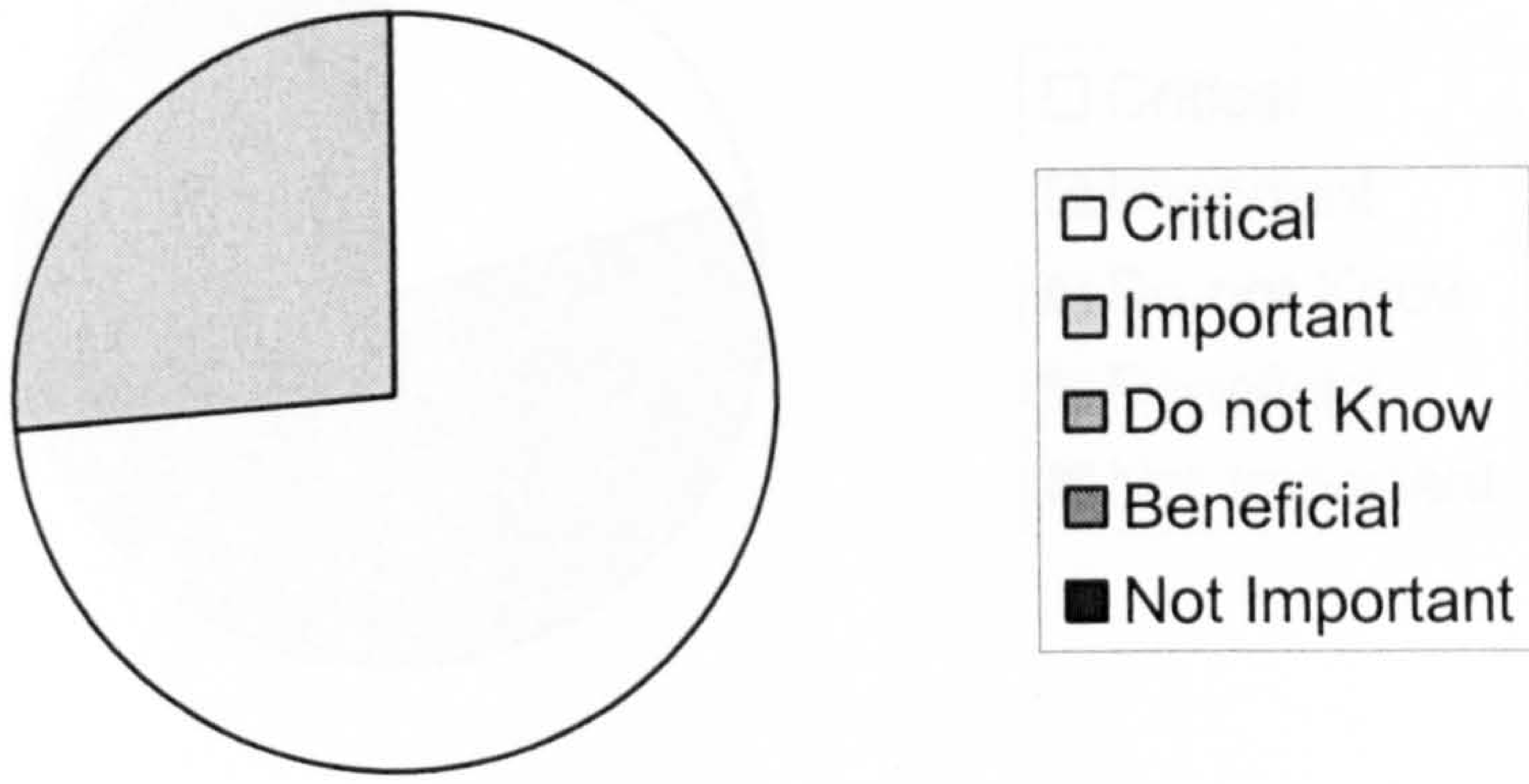
Question: A5. KM is seen as a vital element of business strategy and knowledge is widely recognized as the basis of our competitive position.

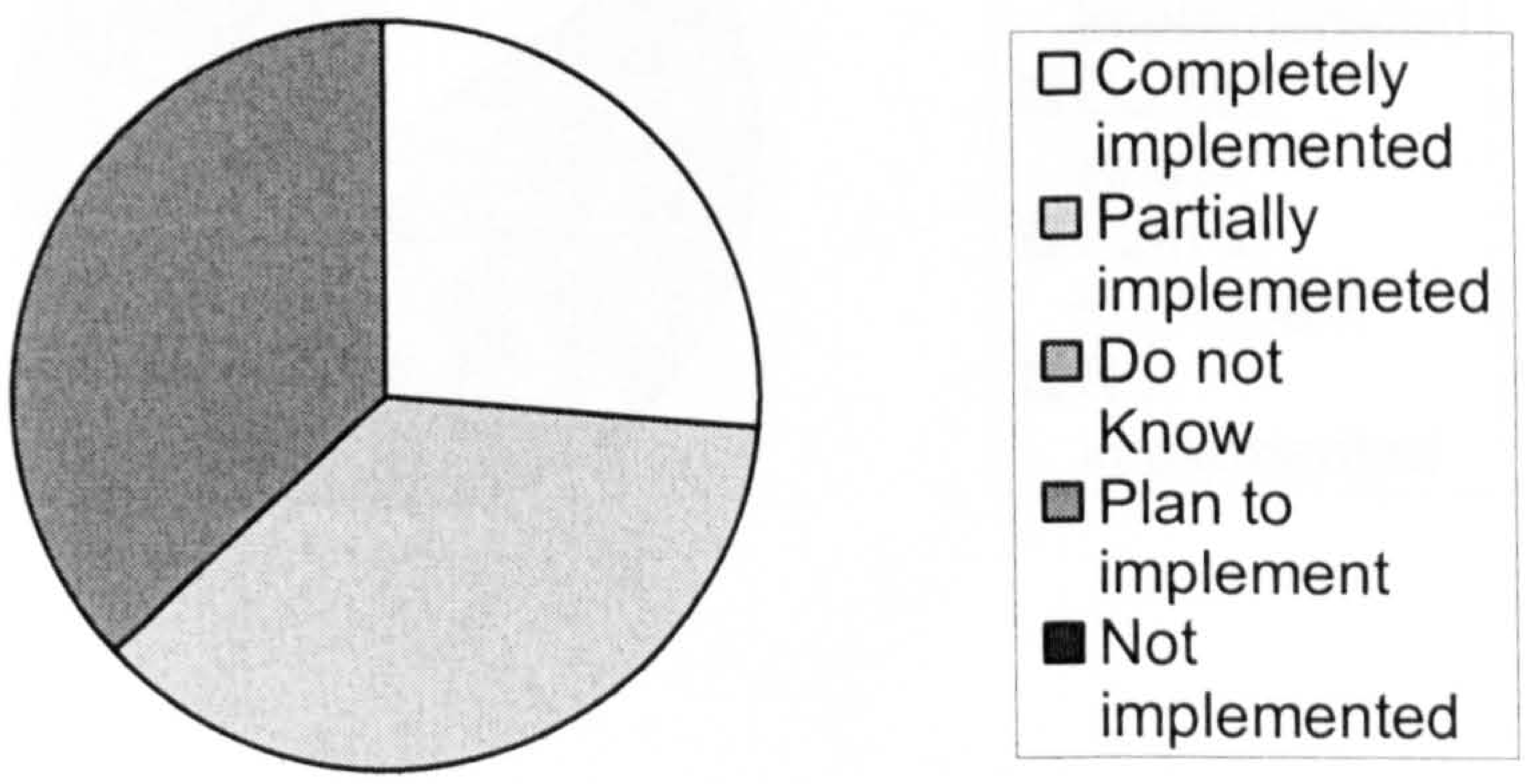




Finding: 79% of the respondents reported that it is critical to see KM as a vital element of business strategy and to recognize knowledge as the basis of a company's competitive position. The other 21% reported that this is important. On the other hand 42% reported that this is completely implemented and 53% reported that it is partially implemented in their organization

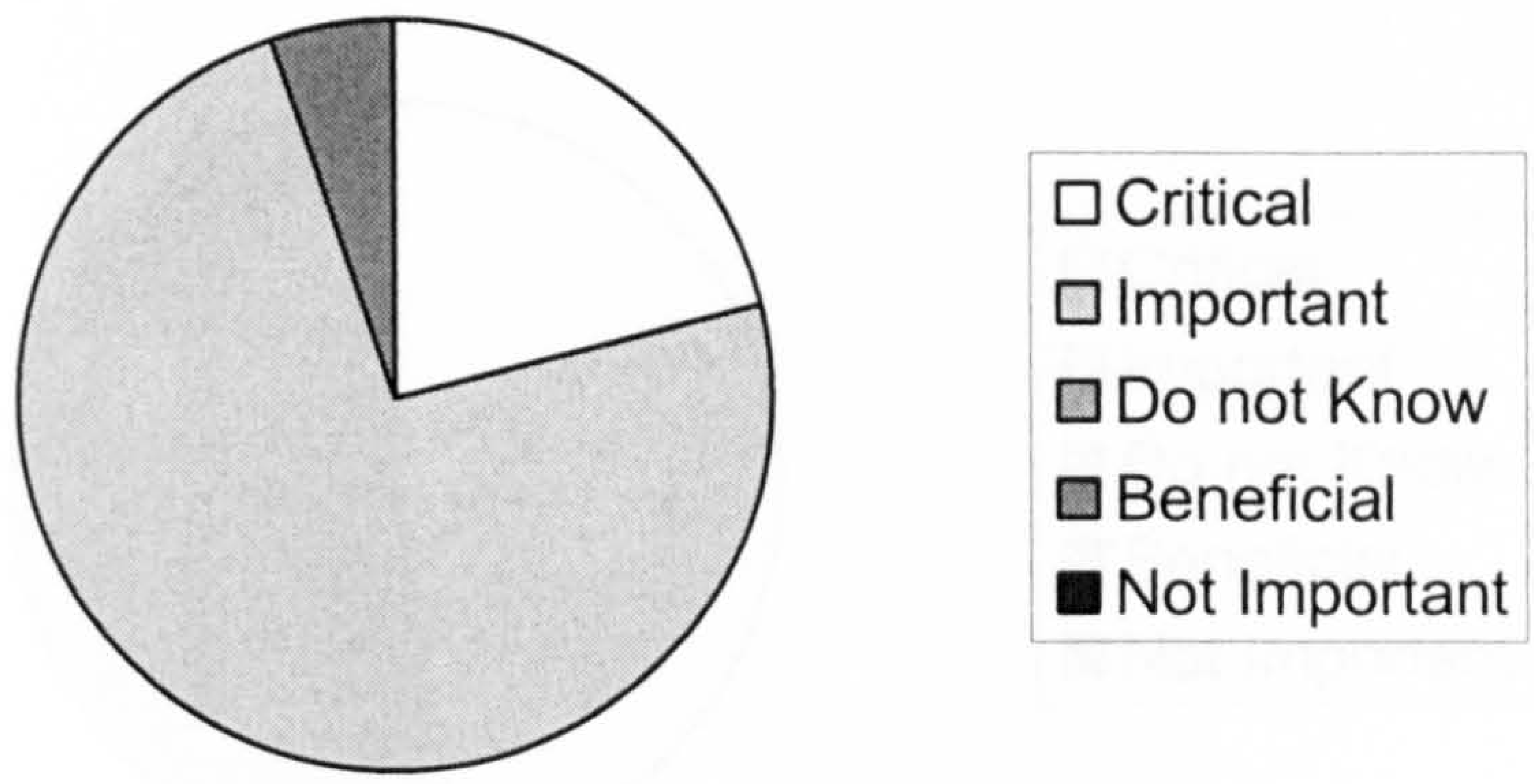
Question: **B1**. There is vision on how KM should be integrated into the business. It is clear how KM initiatives support the business plan.

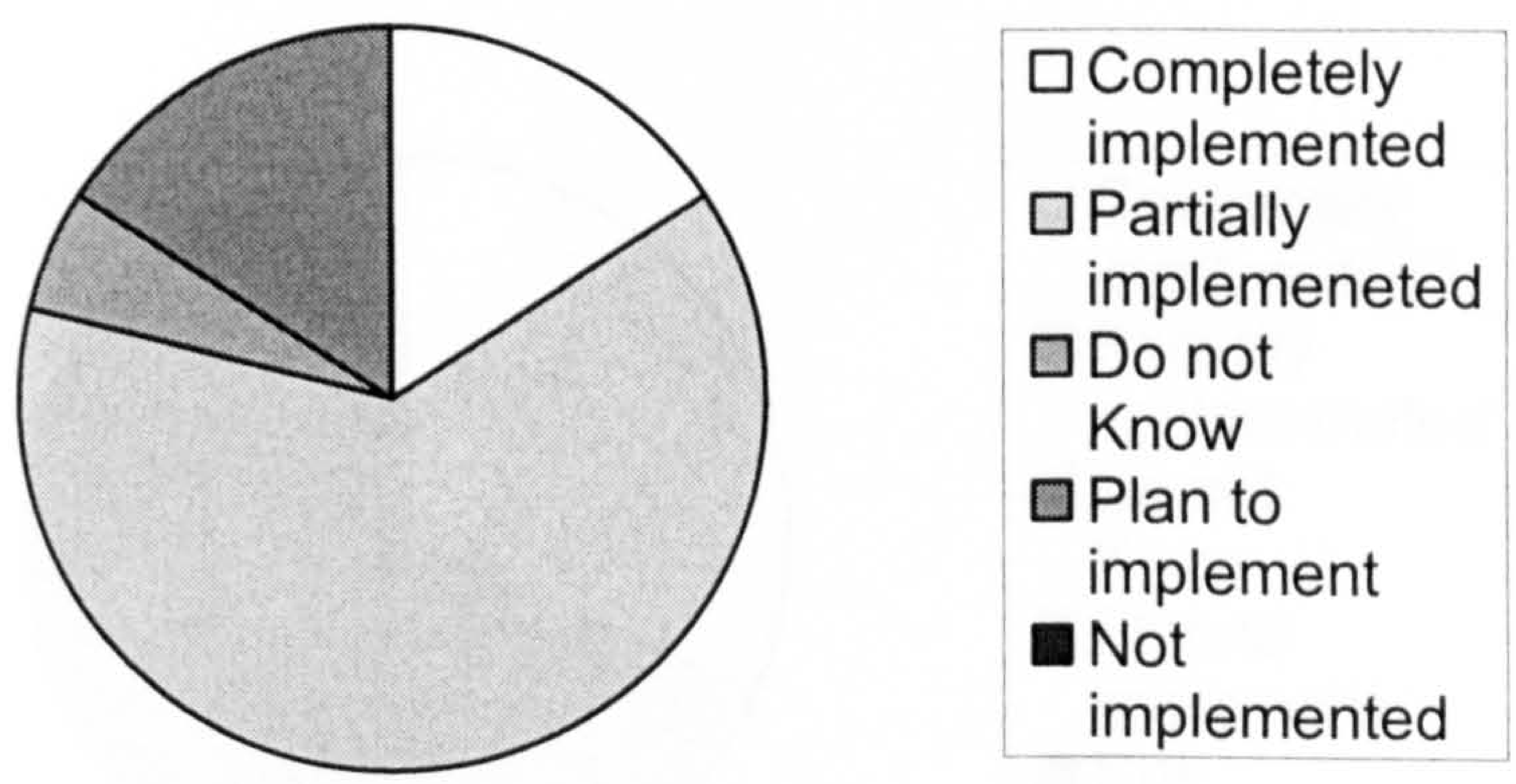




Finding: 100% of the respondents reported that it is critical or important to have a vision on how KM should be integrated into the business. On the other hand, as far as the current status in their organizations is concerned, respondents reported as follows: 26% reported that this is completely implemented, 37% partially implemented, and 37% plan to implement.

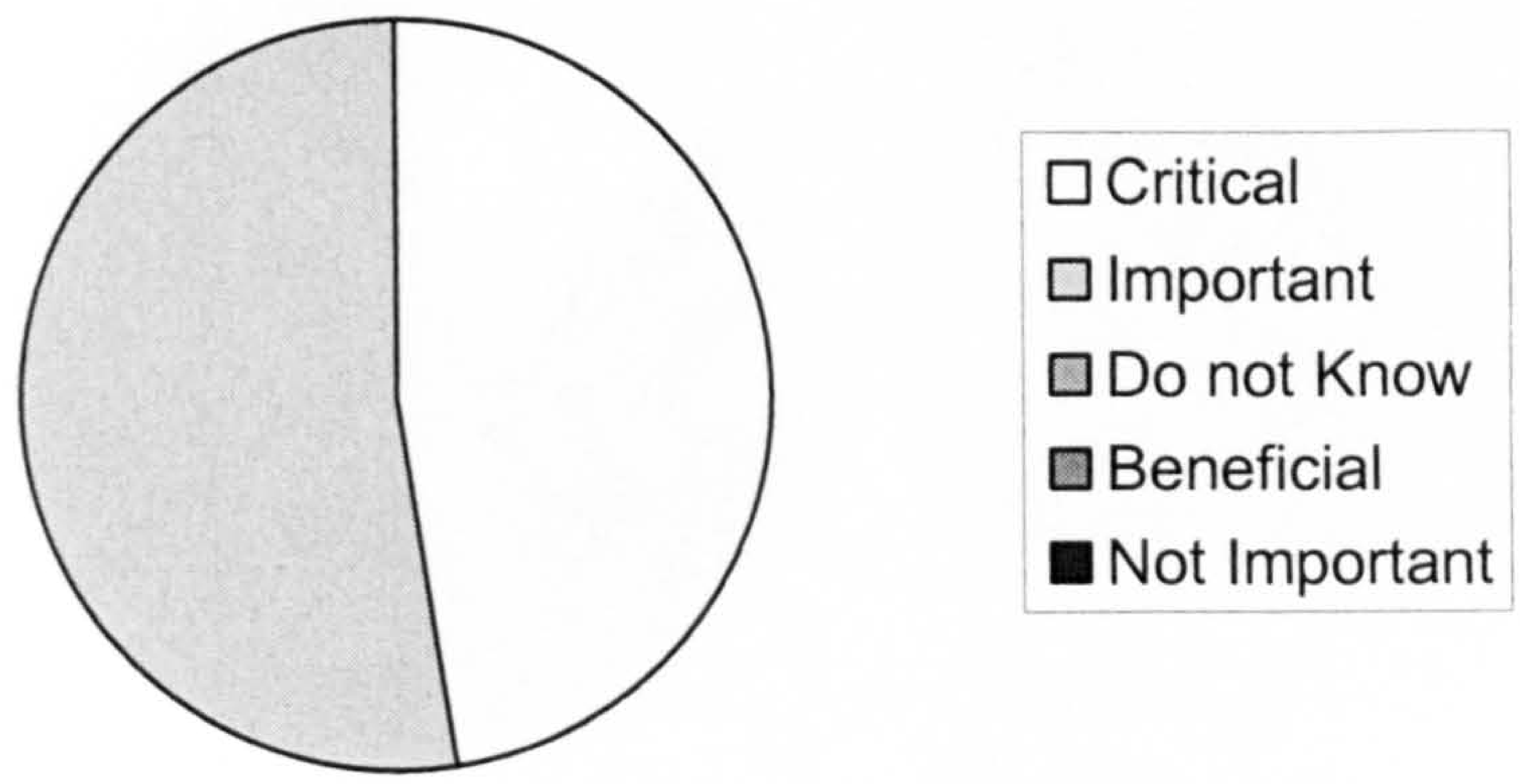
Question: B2. There is a shared understanding, based on a scenario plan, on what KM should be doing for us in two years time.

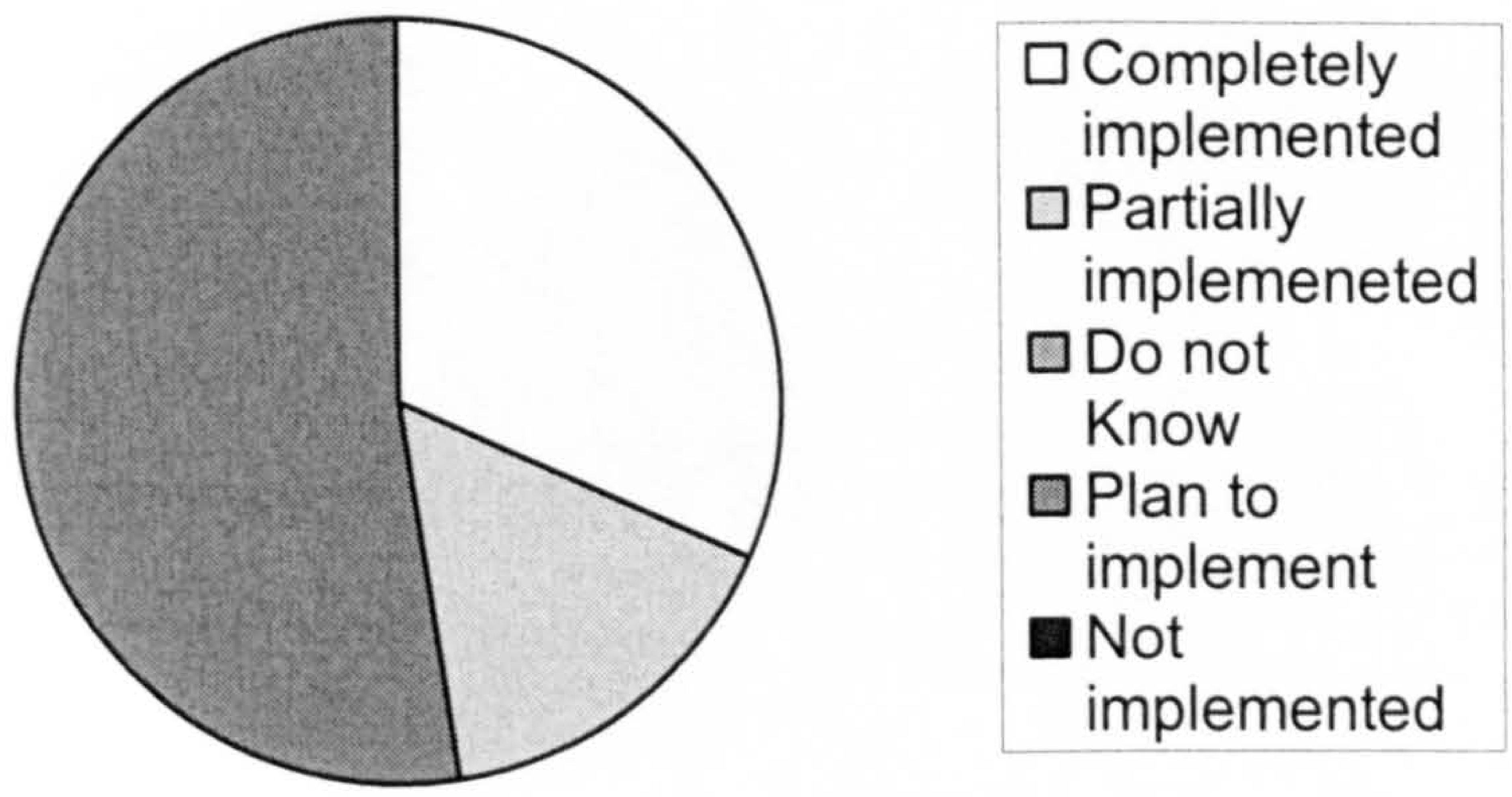




Finding: 95% of the respondents reported that it is critical or important to have a scenario plan of what KM should be doing for the organization in two years time. On the other hand, as far as the current status in their organizations is concerned, respondents reported as follows: 16% reported that this is completely implemented, 63% partially implemented, and 16% plan to implement.

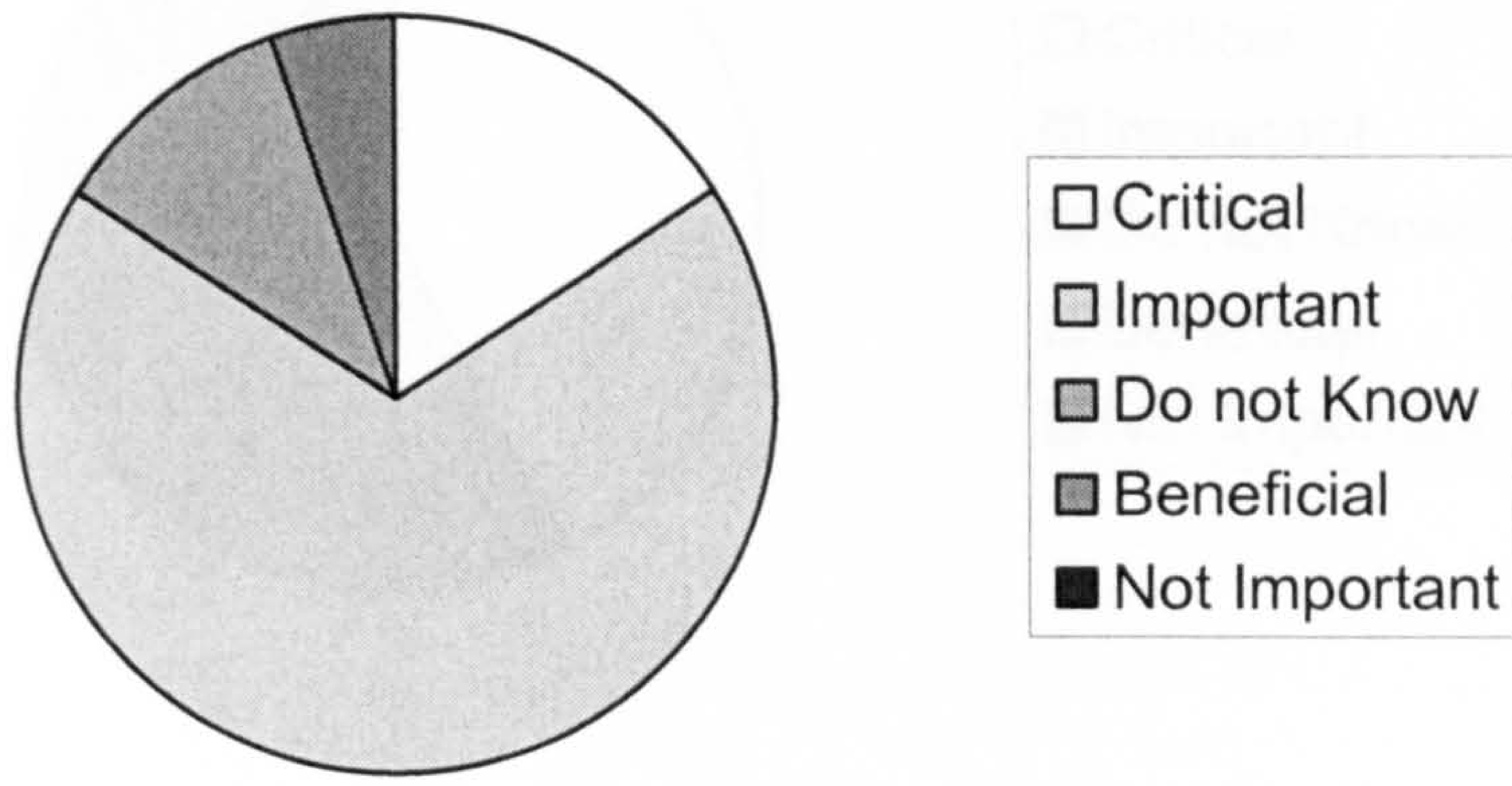
Question: B3. There are defined responsibilities and a budget set for KM initiatives.

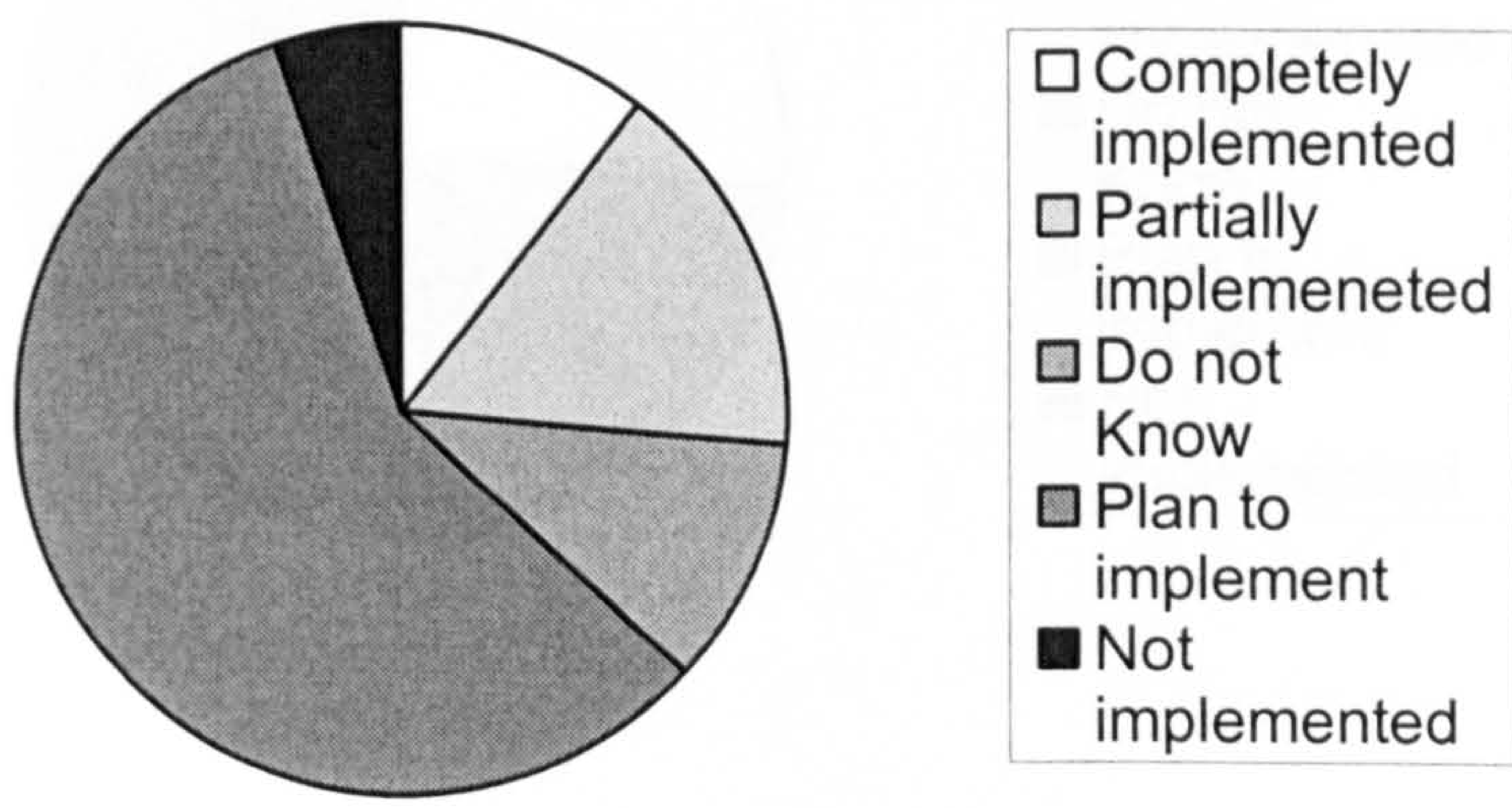




Finding: 100% of the respondents reported that it critical or important to have defined responsibilities and a budget set for KM initiatives. However, 53% reported that they only now plan to implement this.

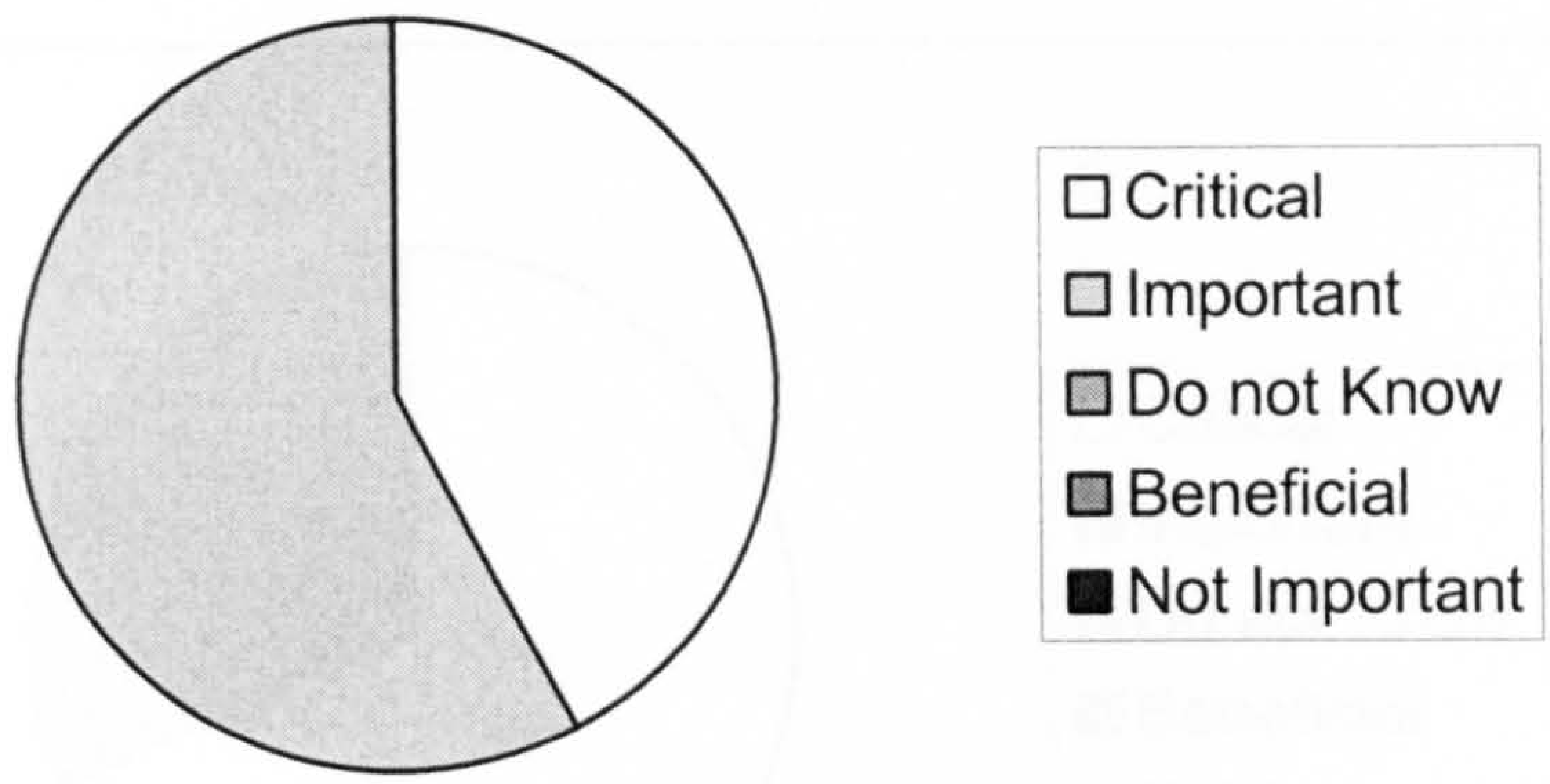
Question: **<u>B4</u>.** Intellectual assets are inventoried or recognized and some measure of value is attached to each.

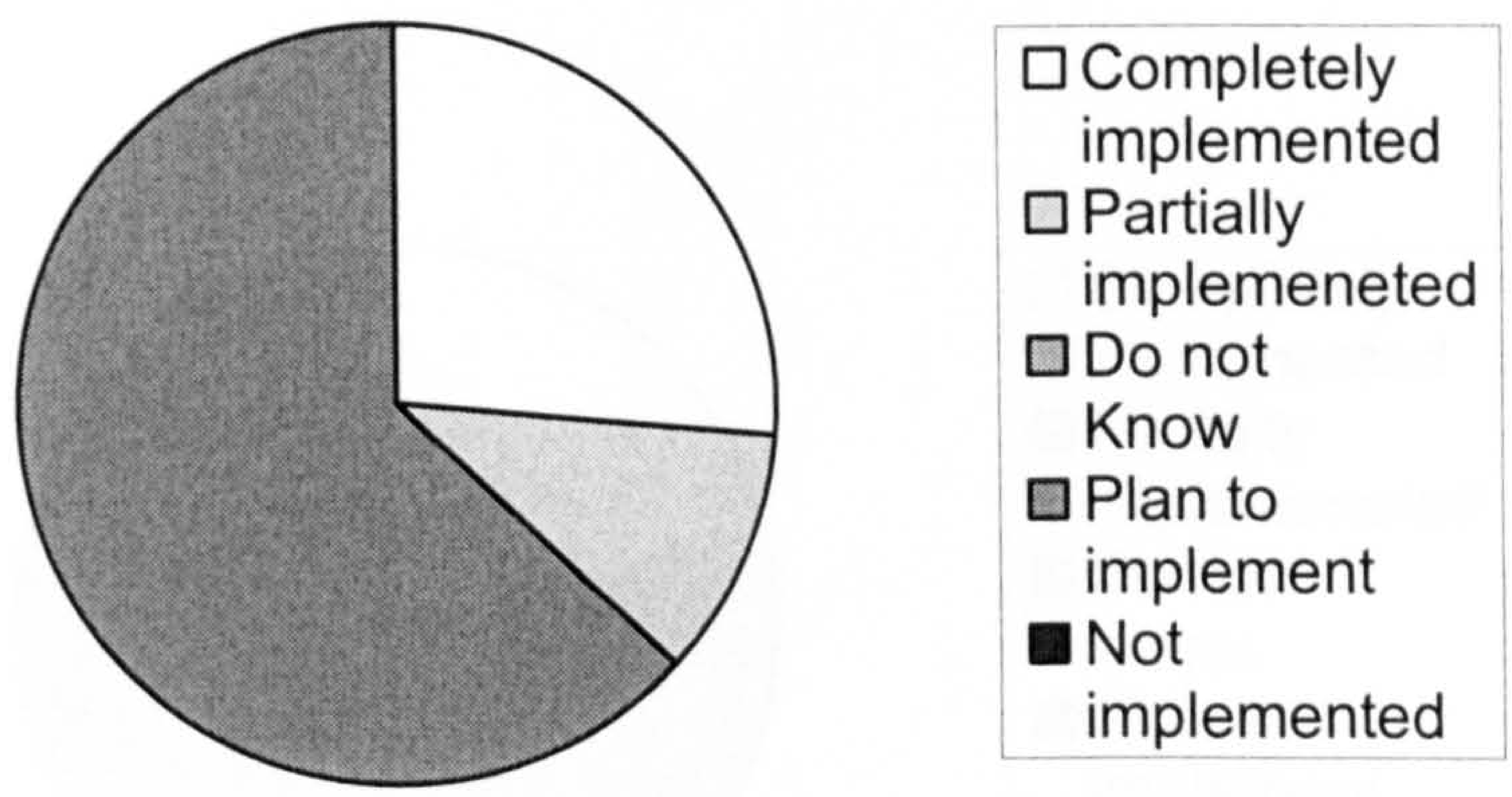




Finding: 84% of the respondents reported that it critical or important to inventory and measure intellectual assets. However, 58% reported that they only now plan to implement this.

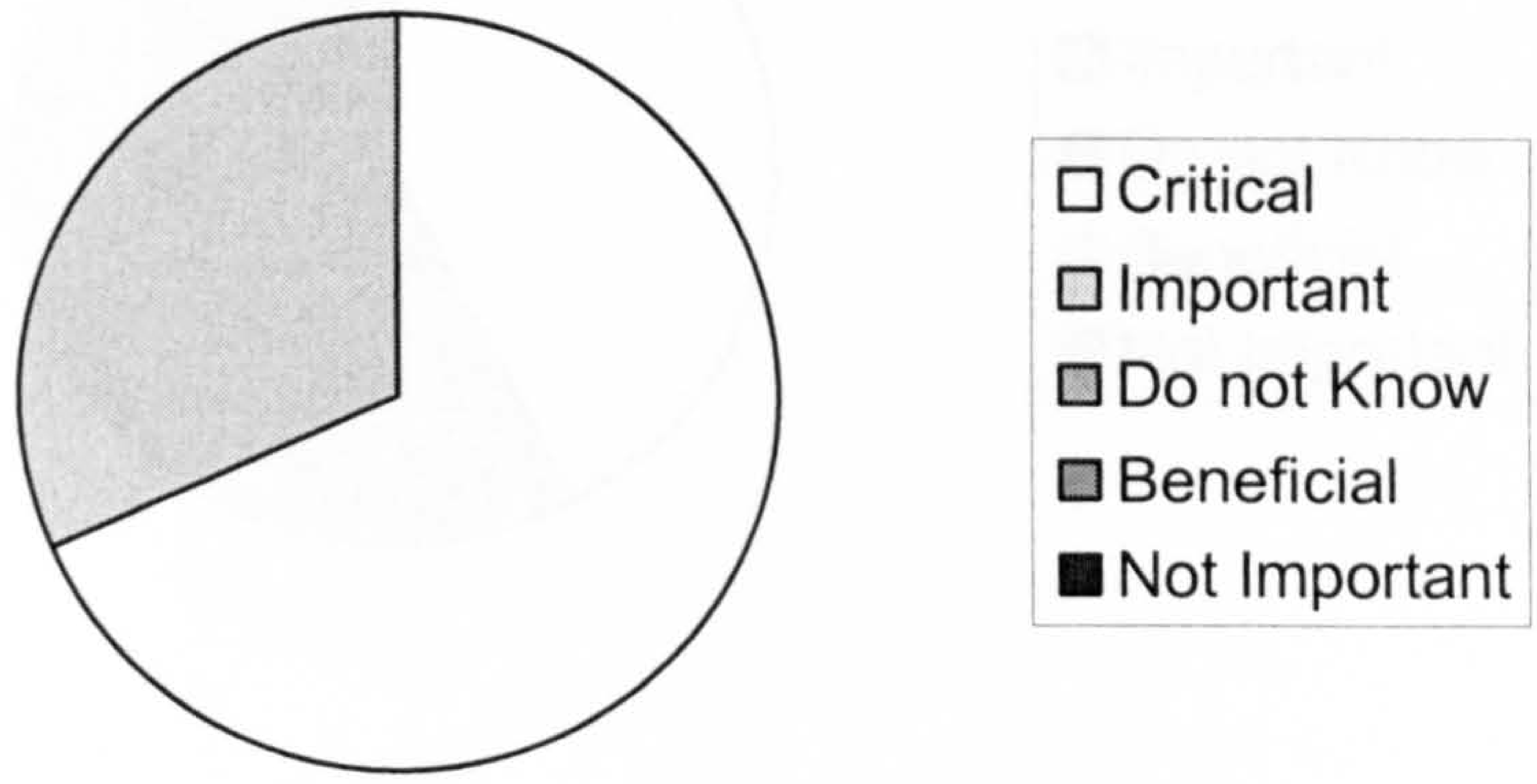
Question: B5. Key performance indicators for KM are in place.

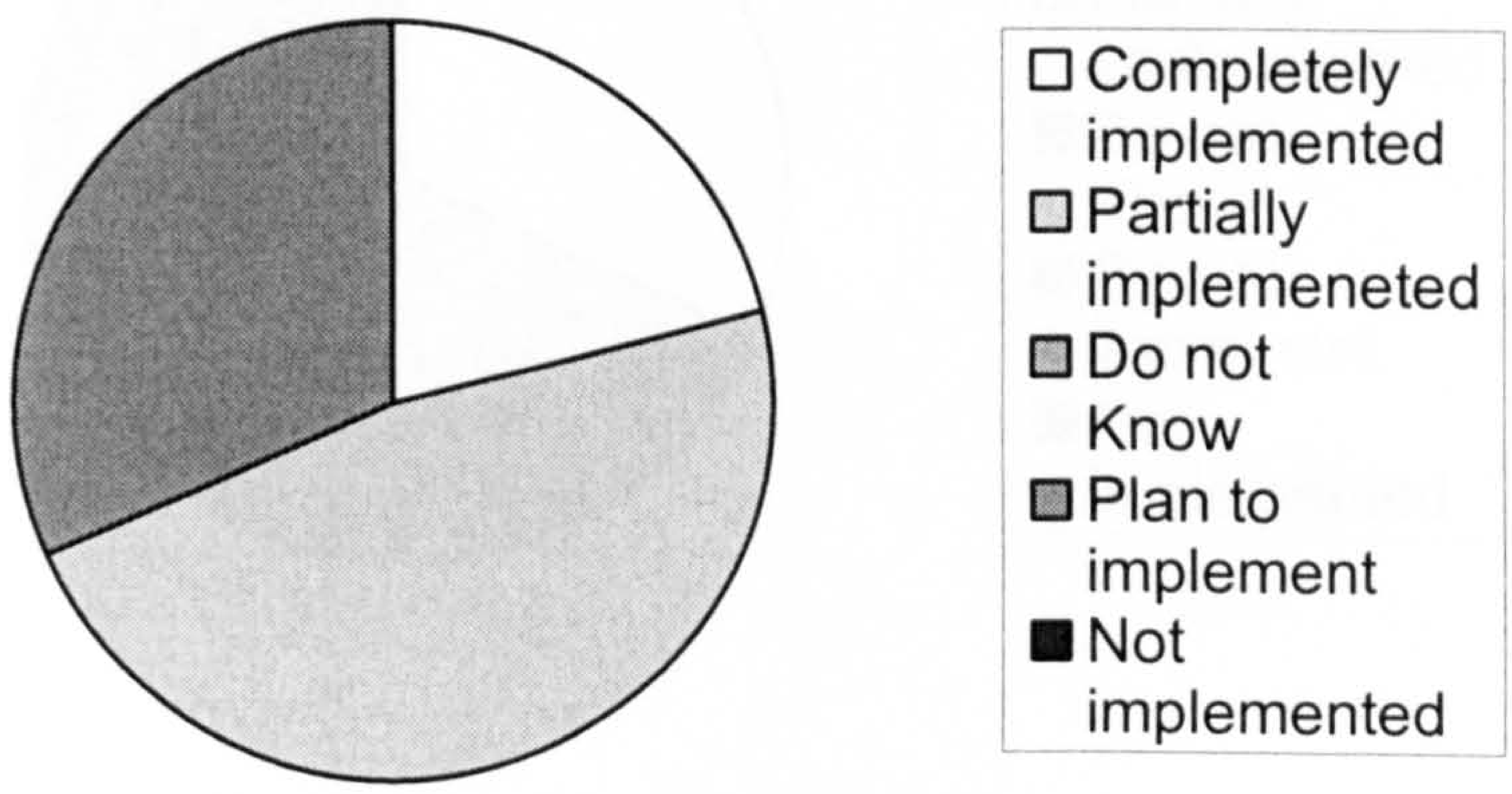




Finding: 100% of the respondents reported that it is critical or important to have key performance indicators for KM in place. However, 63% reported that they only now plan to implement this.

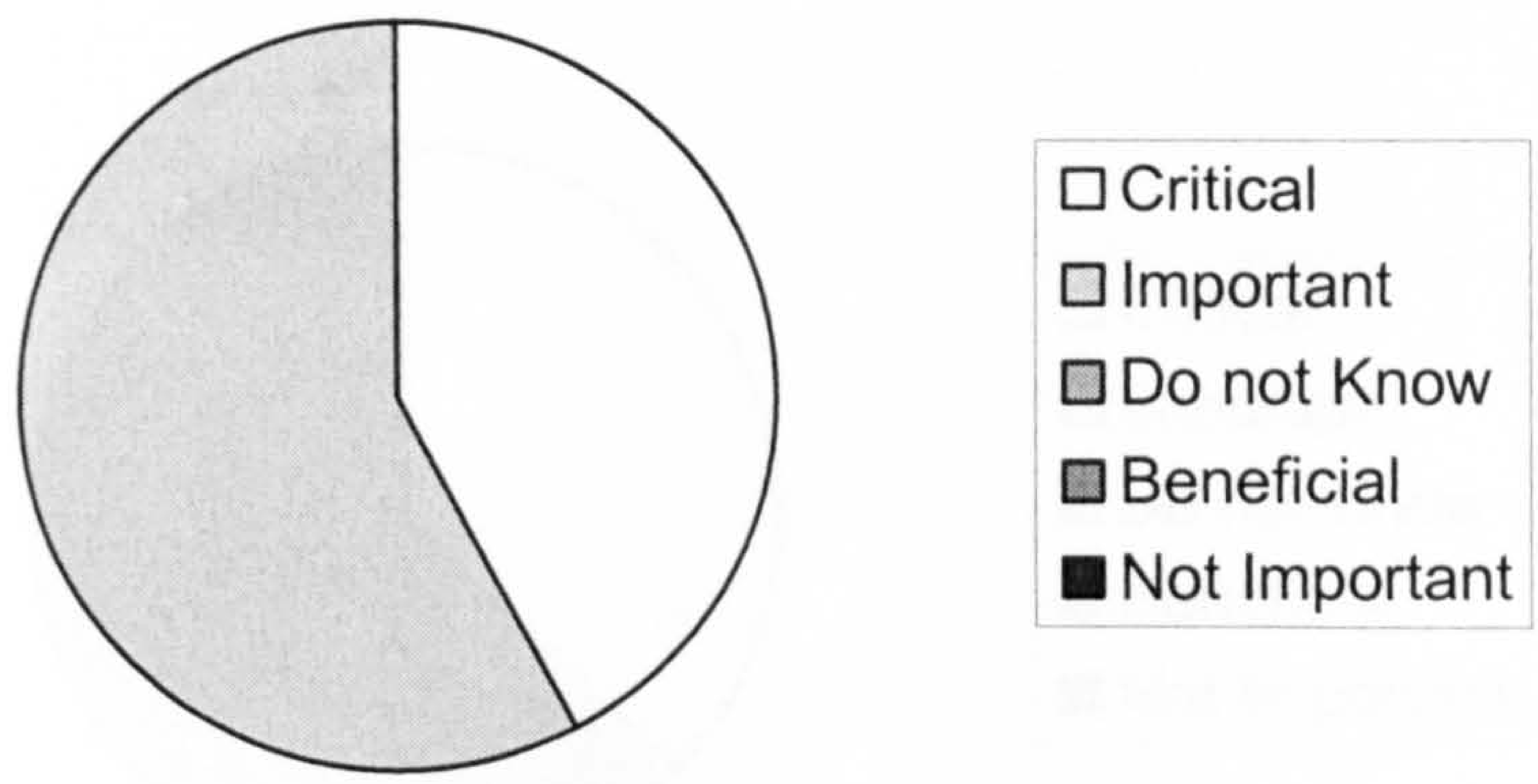
Question: B6. KM principles are well established. There are definitions of key knowledge and guidelines for the creation and management of knowledge.

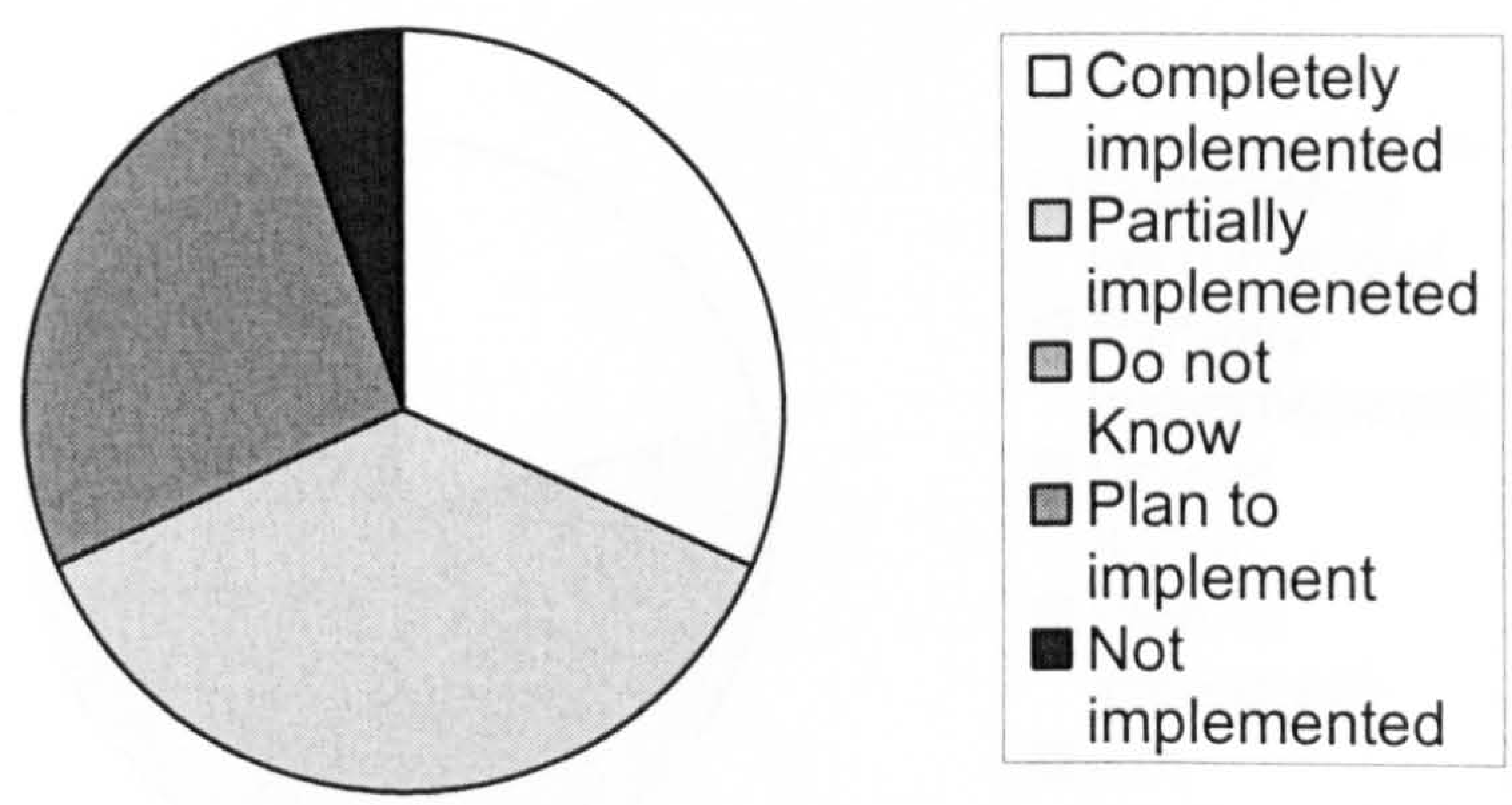




Finding: 100% of the respondents reported that it critical or important to have definitions of key knowledge and guidelines for creating new knowledge. On the other hand, 47% reported that this is partially implemented and 26% reported that they plan to implement it.

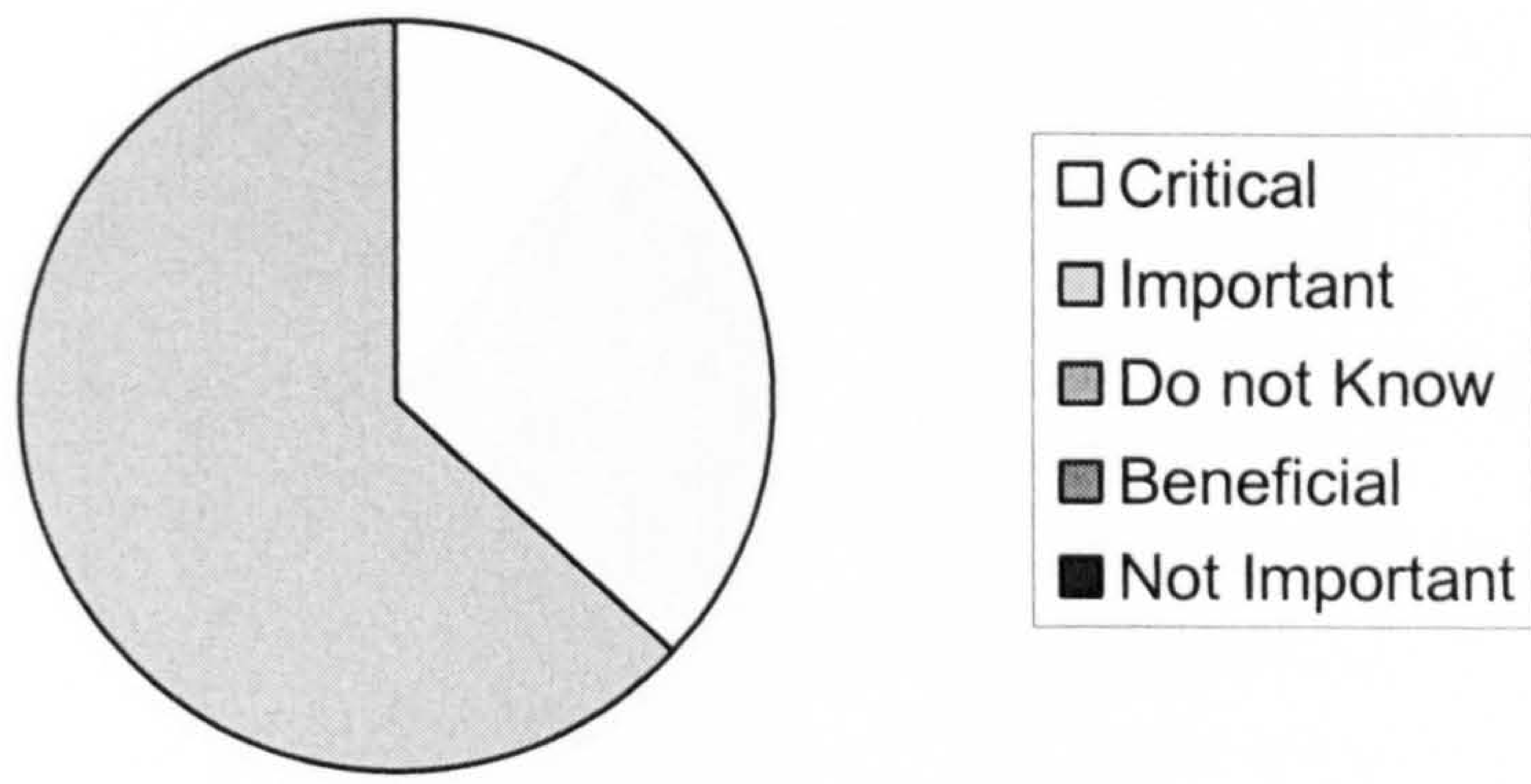
Question: B7. There are initiatives within the business plan to improve KM.

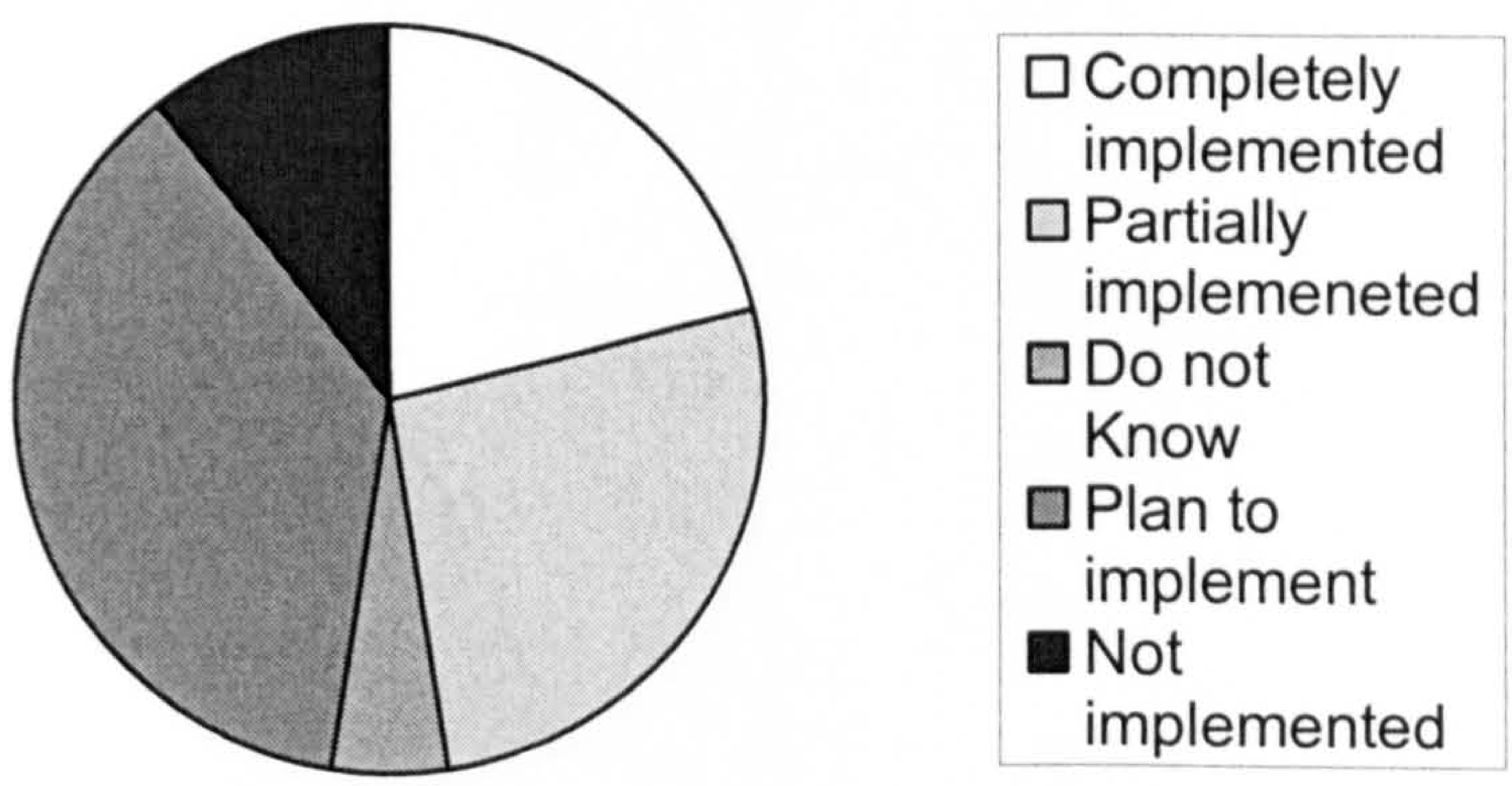




Finding: 100% of the respondents reported that it critical or important to have initiatives within the business plan to improve KM. On the other hand, 39% reported that this is partially implemented and 26% reported that they plan to implement it.

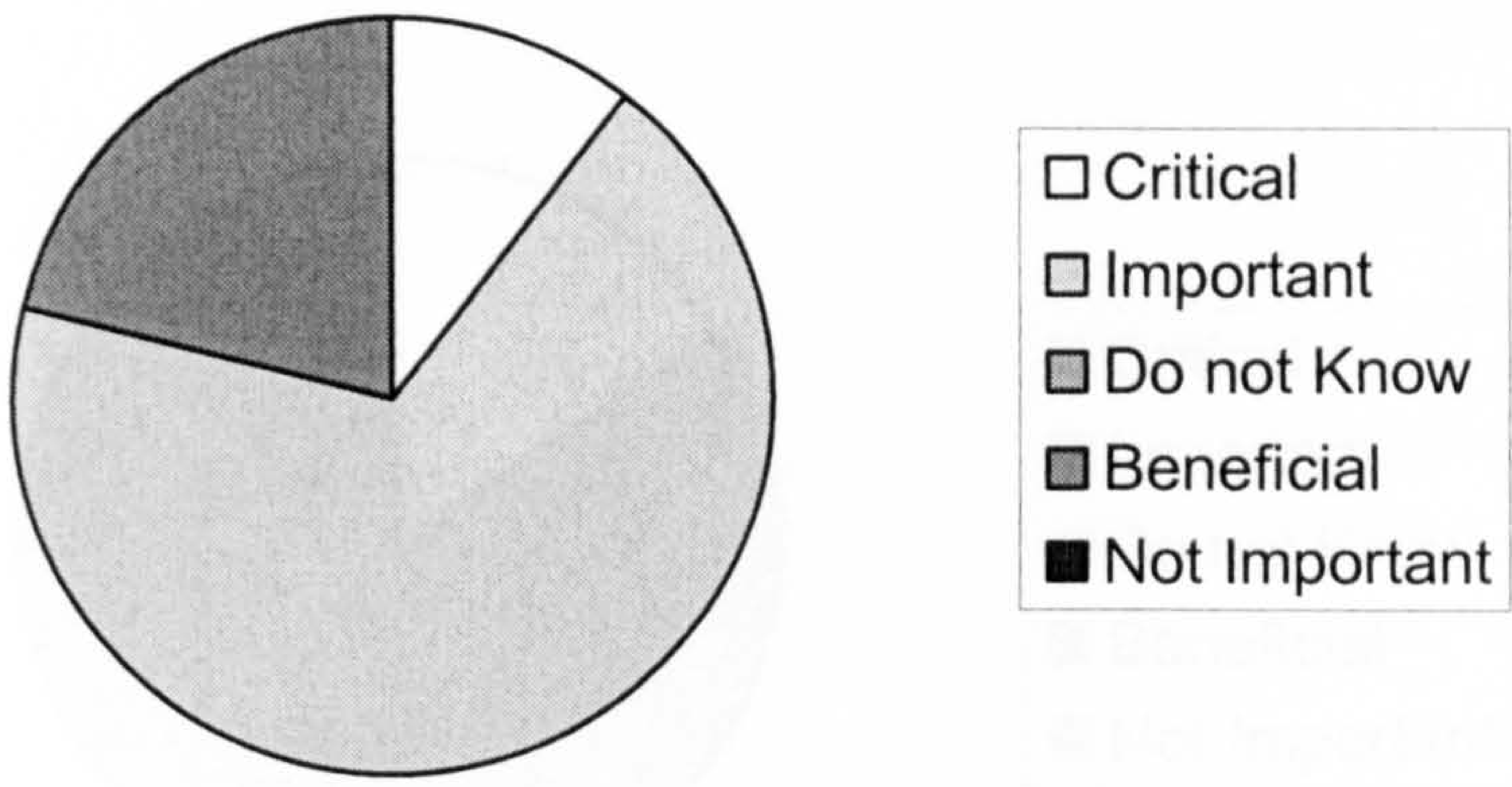
Question: B8. There is a senior level ongoing review of the effectiveness of KM in the whole company.

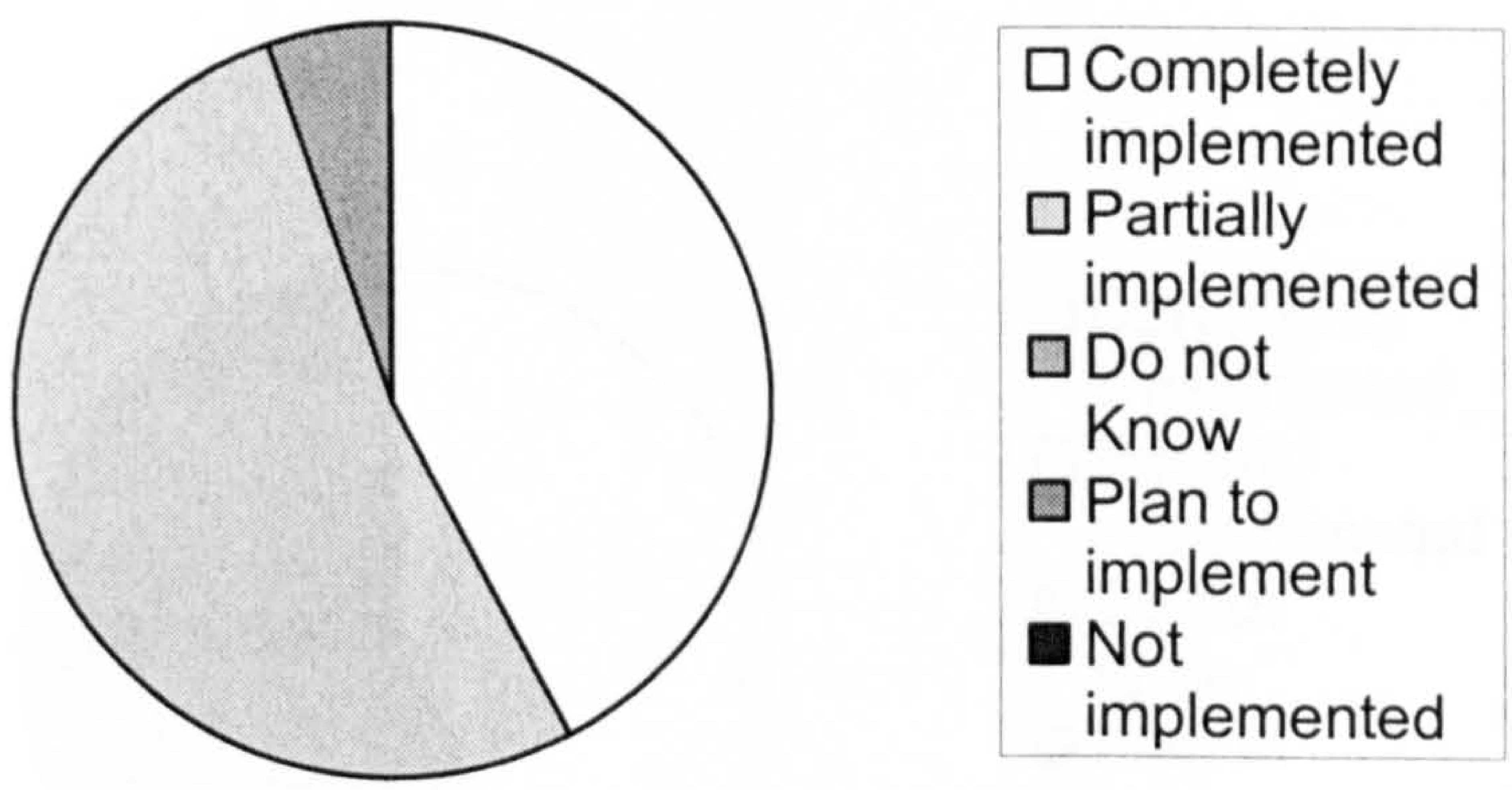




Finding: 100% of the respondents reported that it is critical or important for senior management to have ongoing review of the effectiveness of KM in the whole company. However, with regard to the current status in their organizations, respondents reported as follows: 21% completely implemented, 26% partially implemented, 5% do not know, 37% plan to implement, and 11% not implemented.

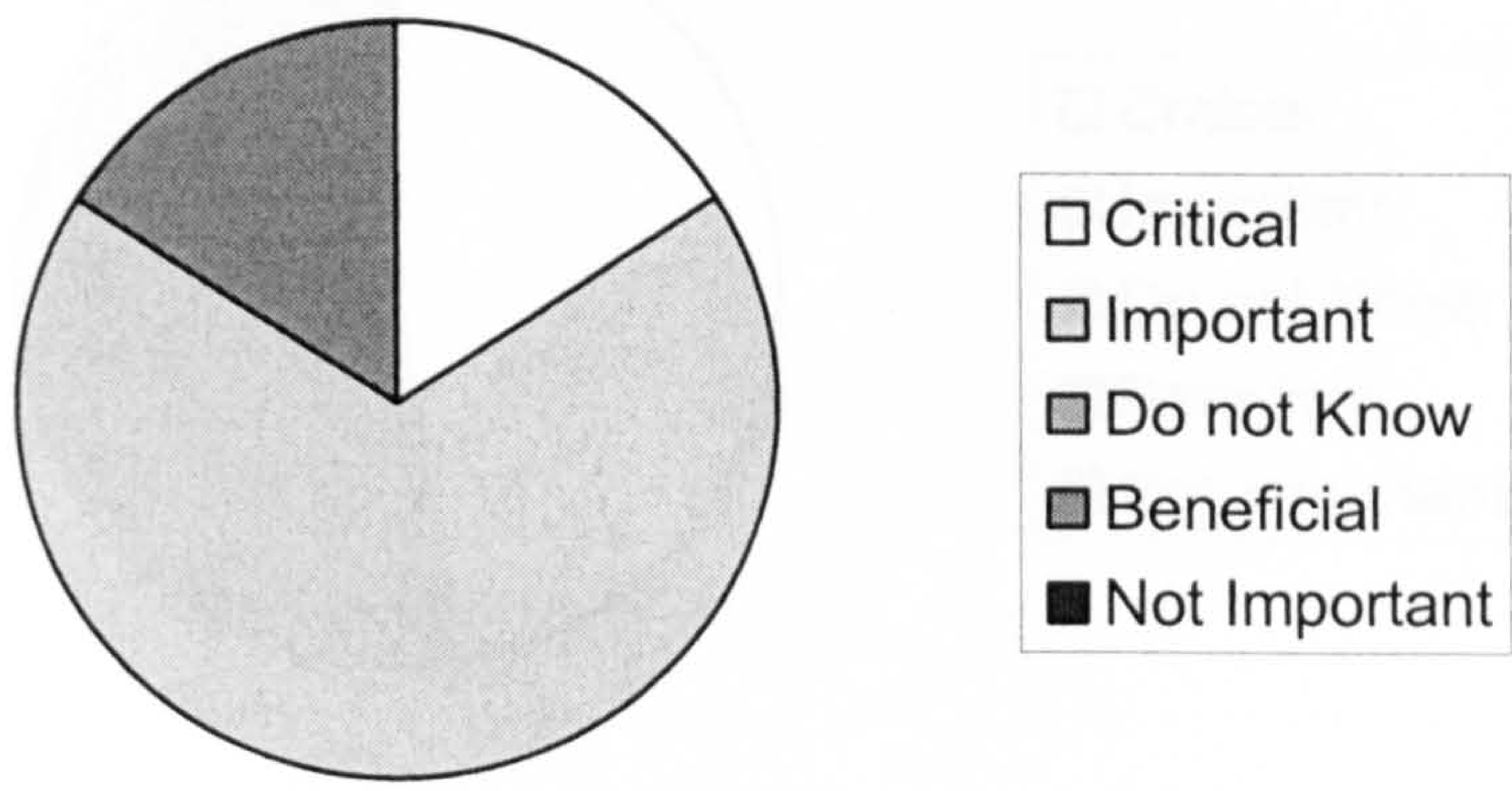
Question: <u>B9</u>. There is a program of active participation in business conferences and other discussion forums to share ideas and experiences.

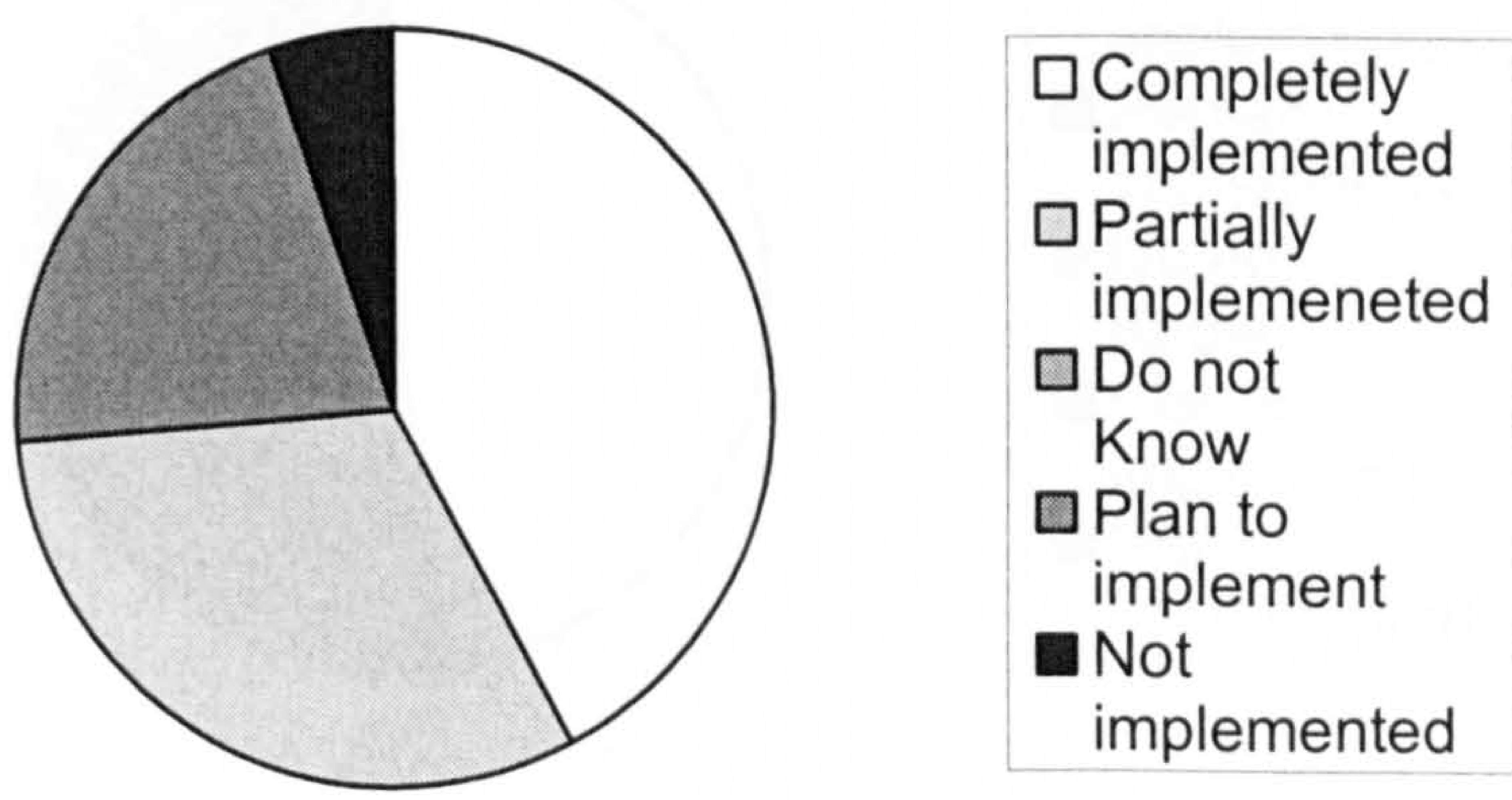




Finding: 79% of the respondents reported that it is critical or important to have a program of active participation in business conferences and discussion forums to share knowledge and experiences. The other 21% reported that it is beneficial. On the other hand, 42% reported that this is completely implemented and 53% reported that it is partially implemented.

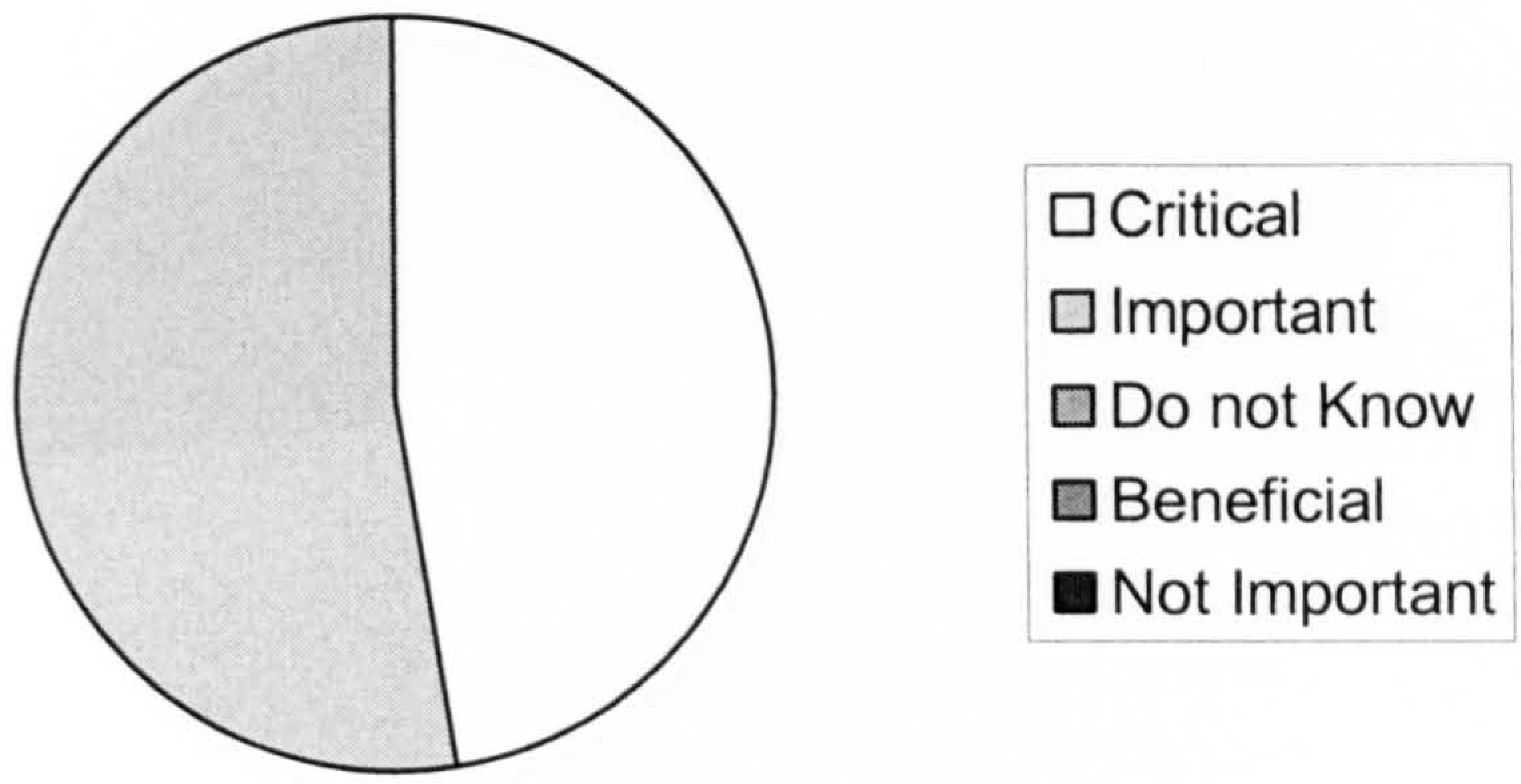
Question: B10. We are committed to a Total Quality Management (TQM) program. Particularly, in the areas of continuous improvement and empowerment of employees.

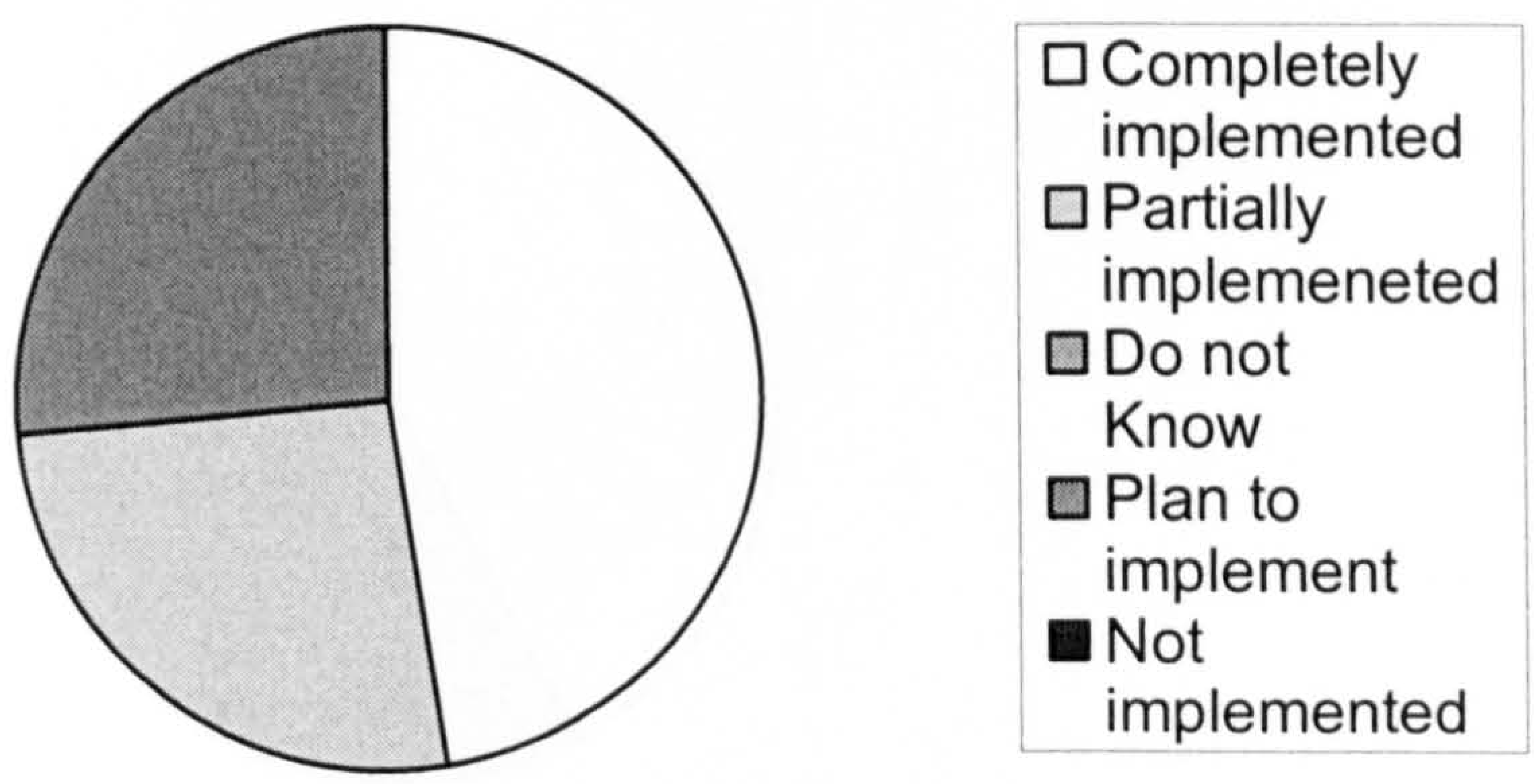




Finding: 84% of the respondents reported that it is critical or important for the organization to be committed to continuous improvement and empowerment of employees. The other 16% reported that it is beneficial. On the other hand, 32% reported that this is partially implemented and 21% reported that they plan to implement it.

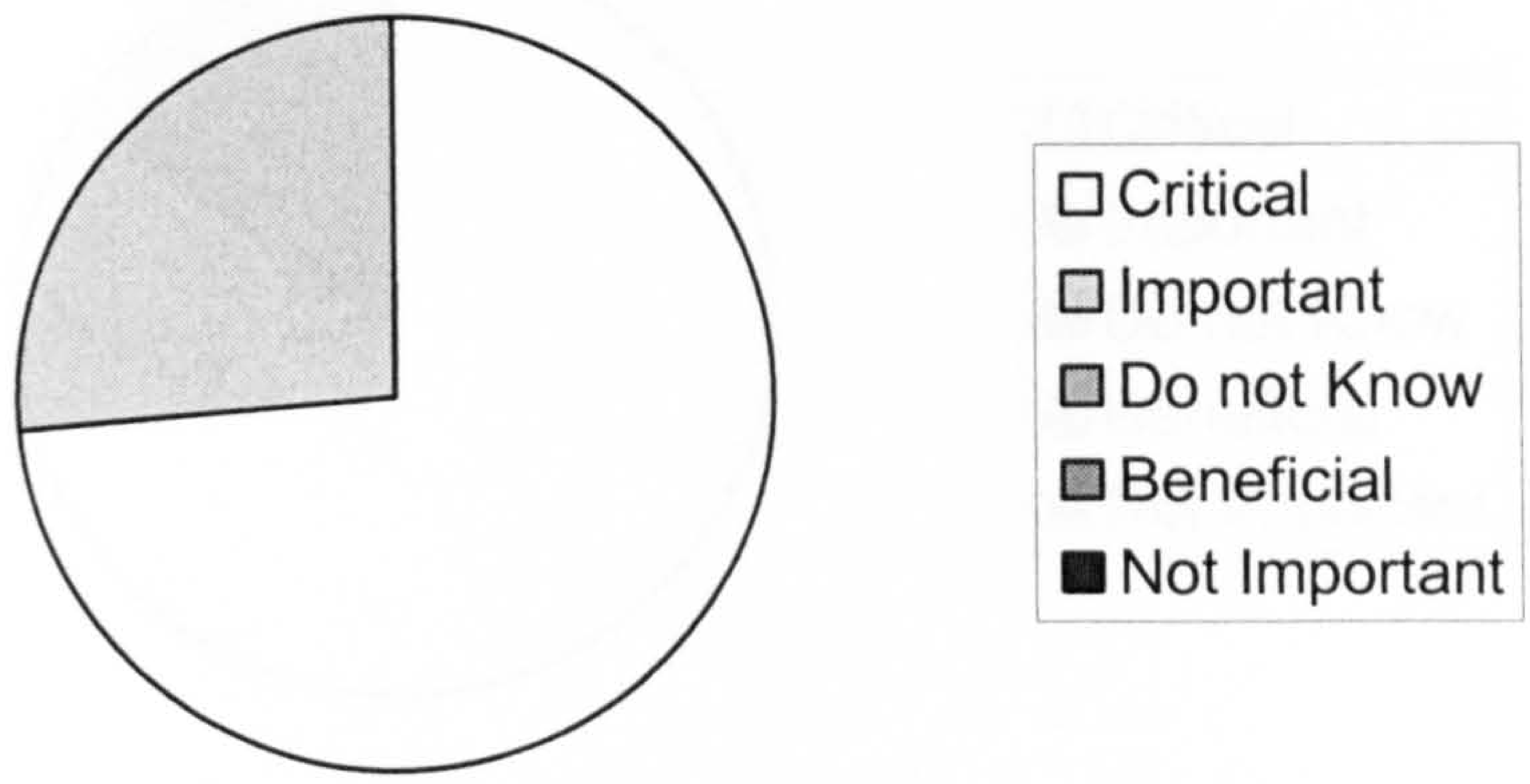
Question: C1. Failure is not punished; rather it is seen as an opportunity to learn.

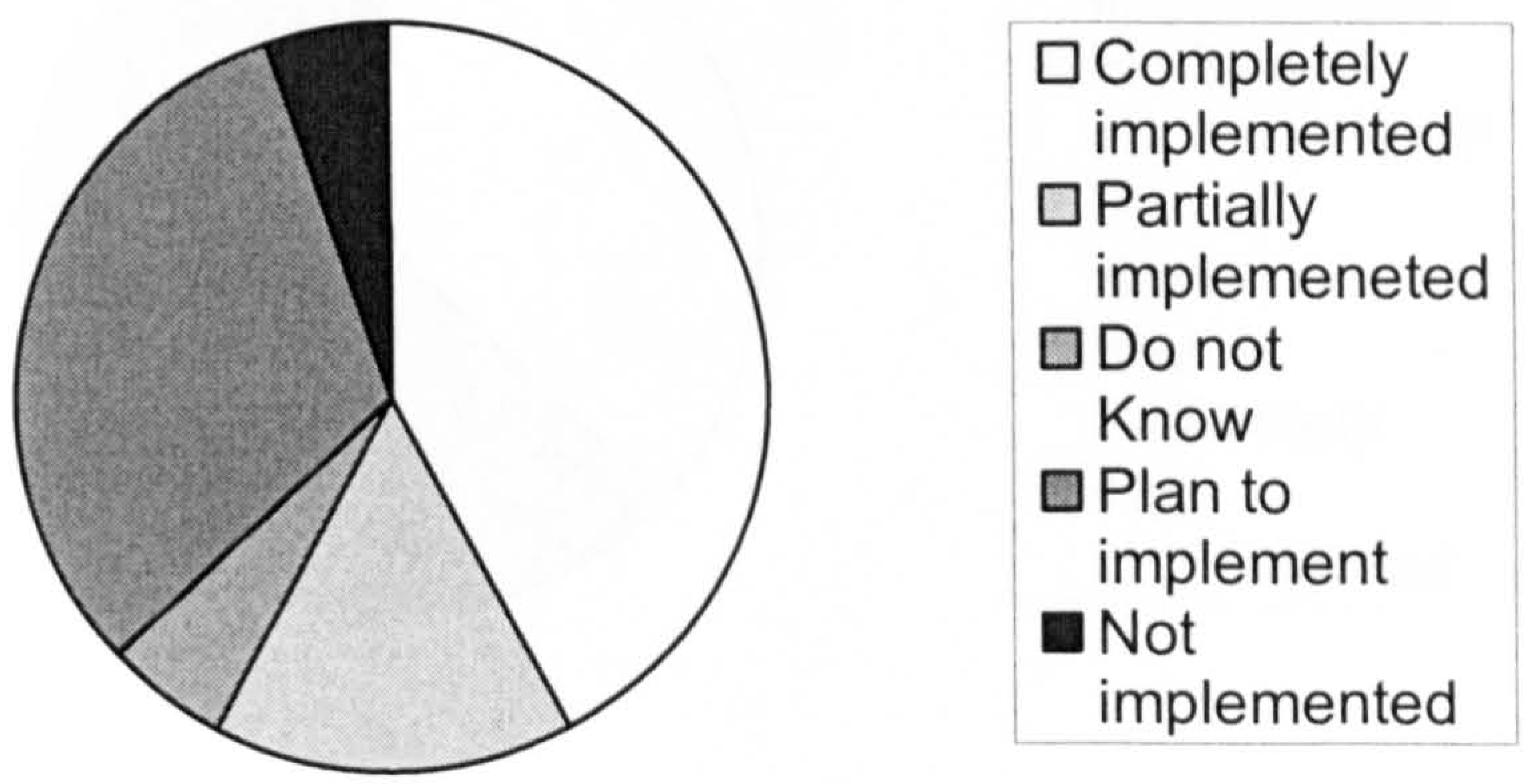




Finding: 100% of the respondents reported that it is critical or important not to punish failure and rather see it as an opportunity to learn. On the other hand, 26% reported that this is partially implemented and 26% reported that they plan to implement it.

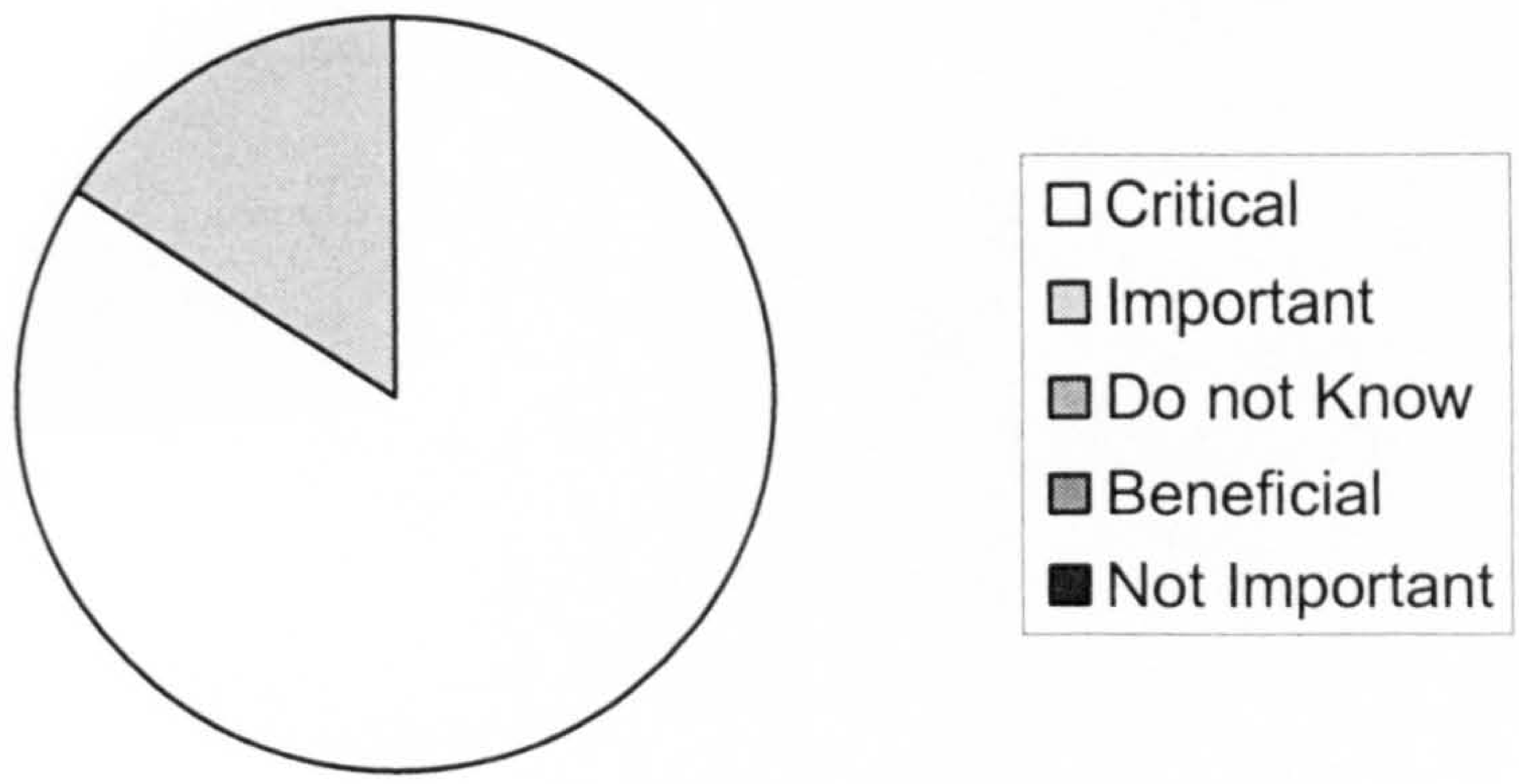
Question: C2. Recording and sharing of knowledge is routine and second nature. Next time I have a good idea, I know exactly how to share it.

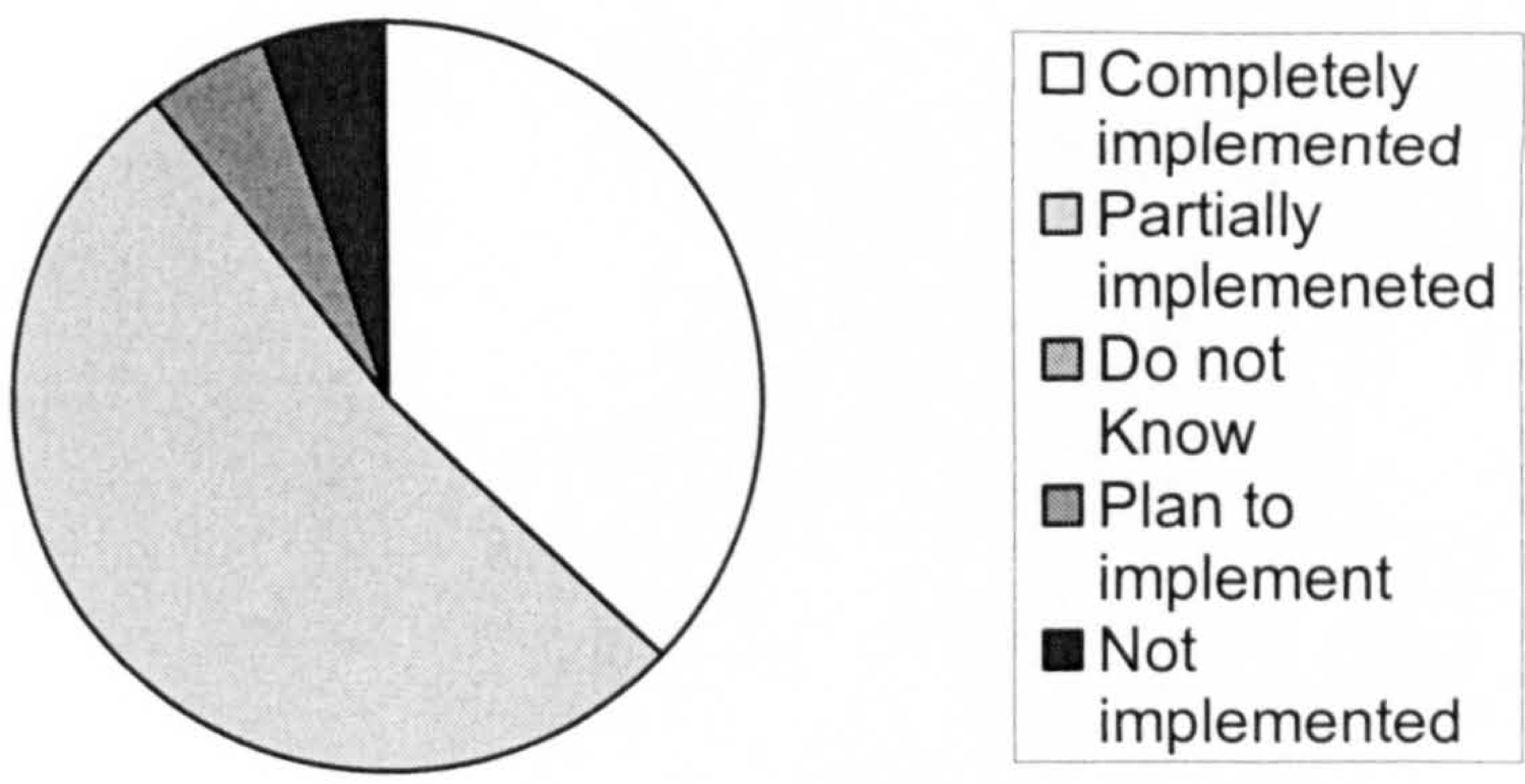




Finding: 100% of the respondents reported that it is critical or important for recording of knowledge to be routine and second nature. On the other hand, 16% reported that this is partially implemented and 32% reported that they plan to implement it.

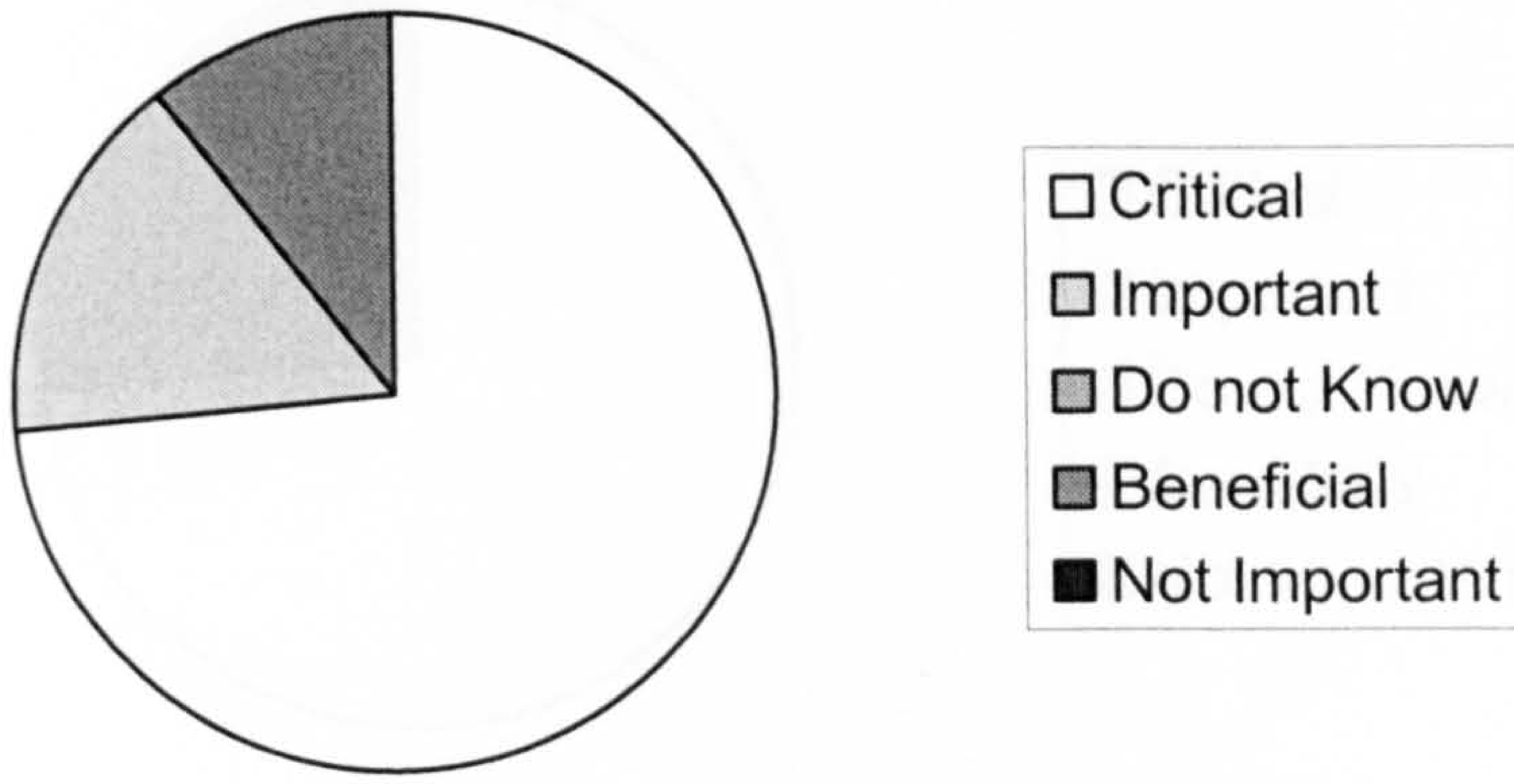
Question: C3. Individuals are visibly rewarded for team work and knowledge sharing.

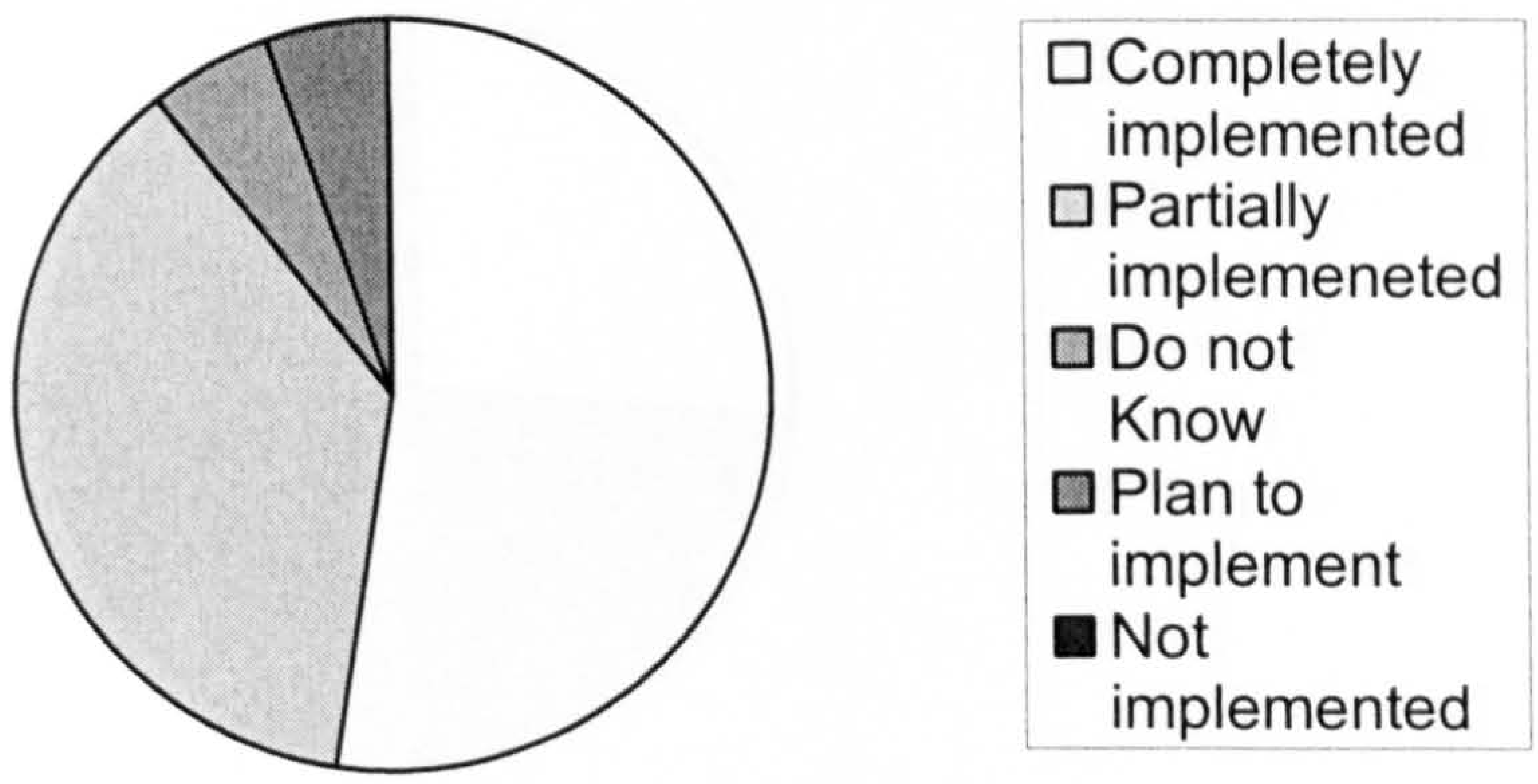




Finding: 84% of the respondents reported that it is critical that individuals be rewarded for team work and knowledge sharing. The other 16% reported that it is important. On the other hand, 37% reported that this is completely implemented and 53% reported that it is partially implemented.

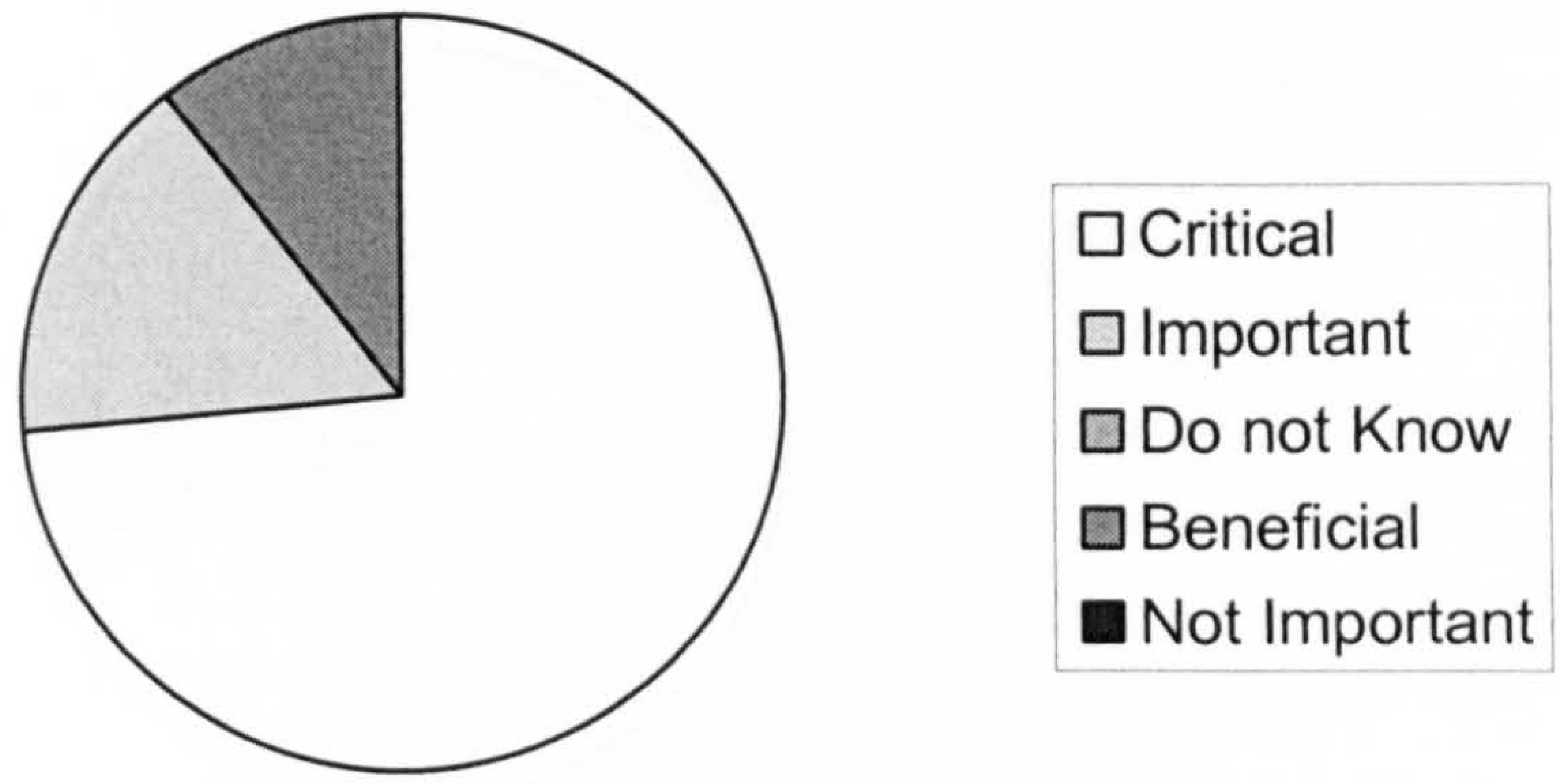
Question: C4. Holding of knowledge and being secretive about the best way to do something is actively discouraged.

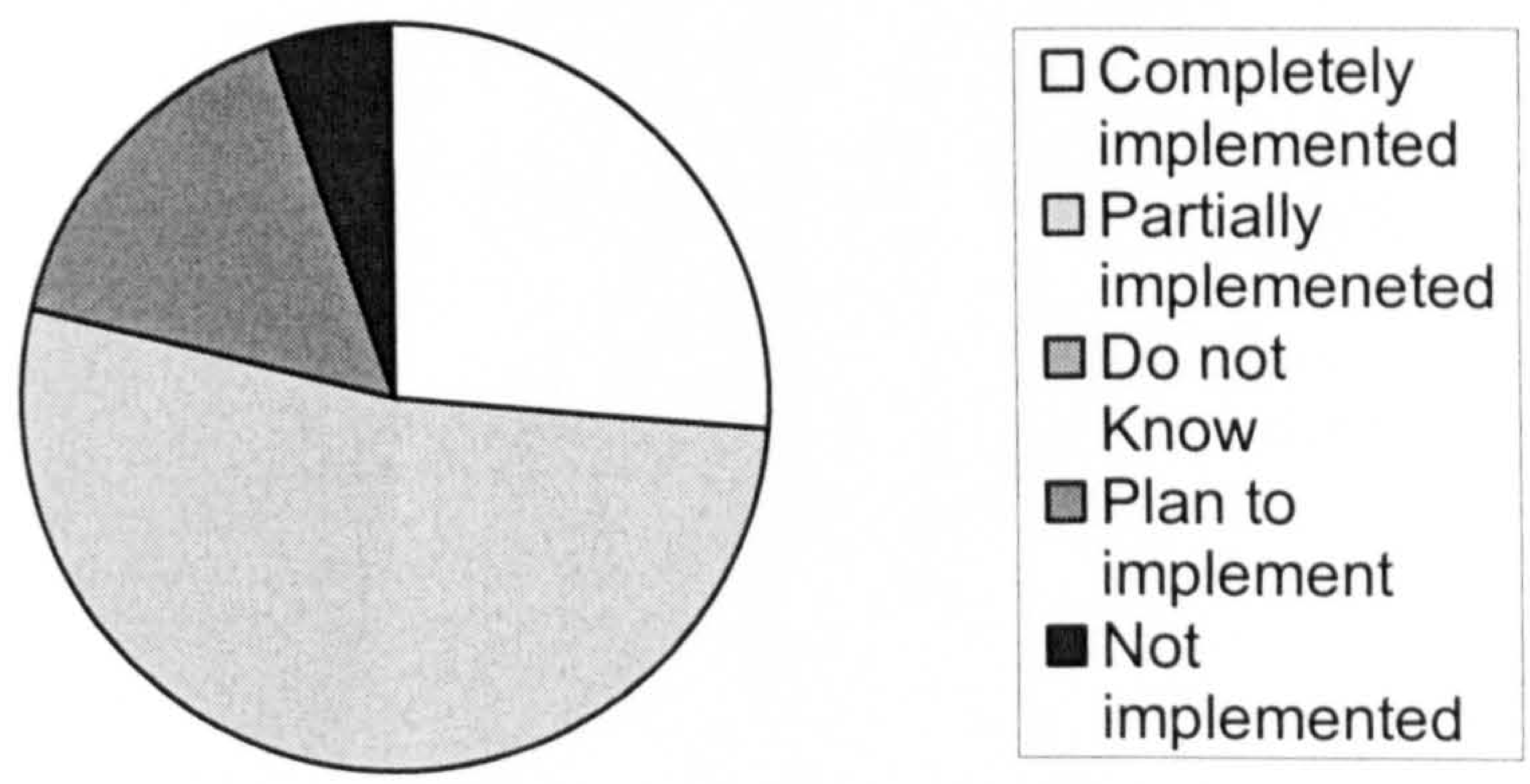




Finding: 89% of the respondents reported that it is critical or important to discourage holding of knowledge. The other 11% reported that it is beneficial. On the other hand, 53% reported that this is completely implemented and 37% reported that it is partially implemented.

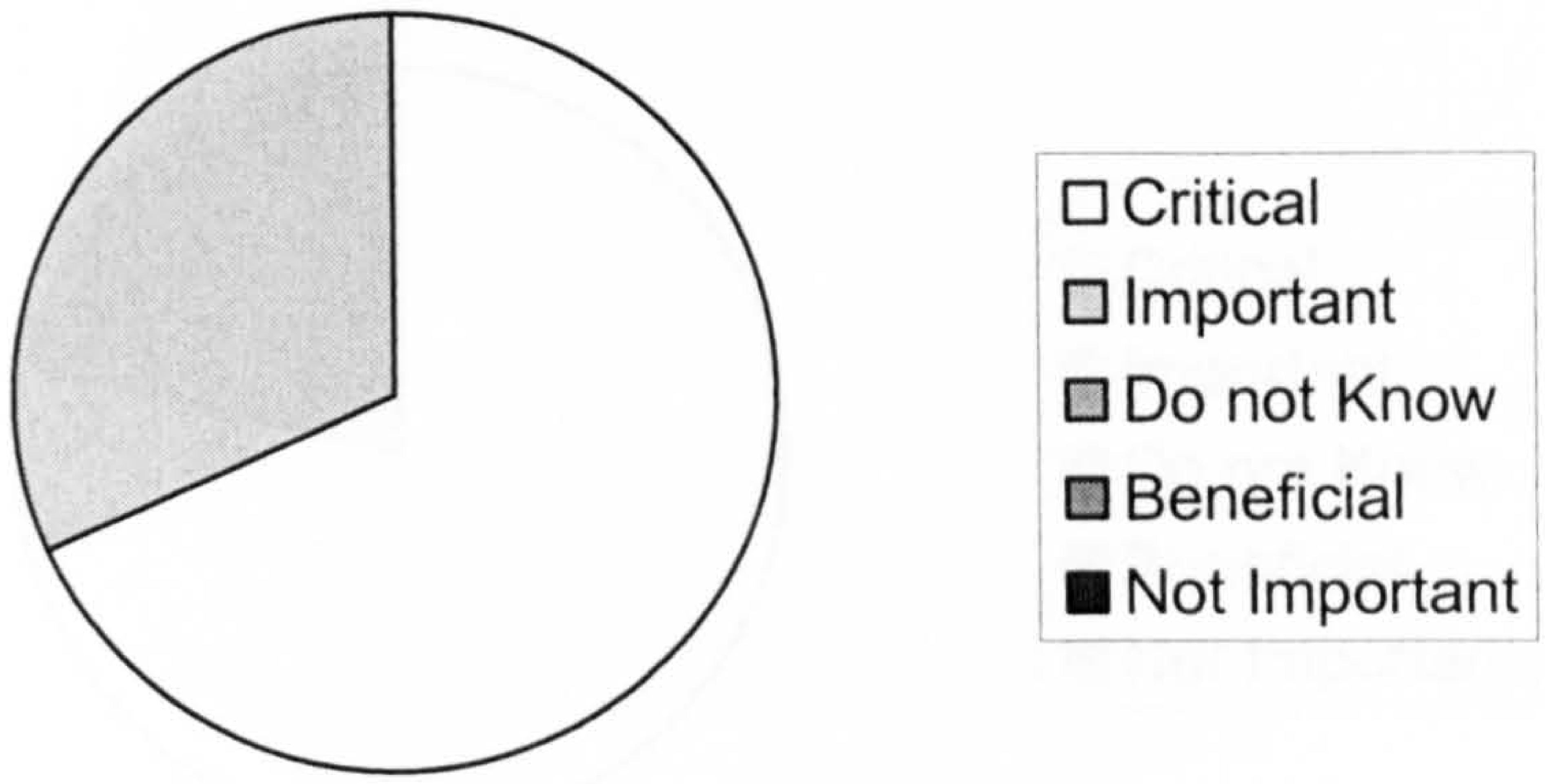
Question: <u>C5</u>. Asking for help from expert co-workers is monitored, encouraged and rewarded.

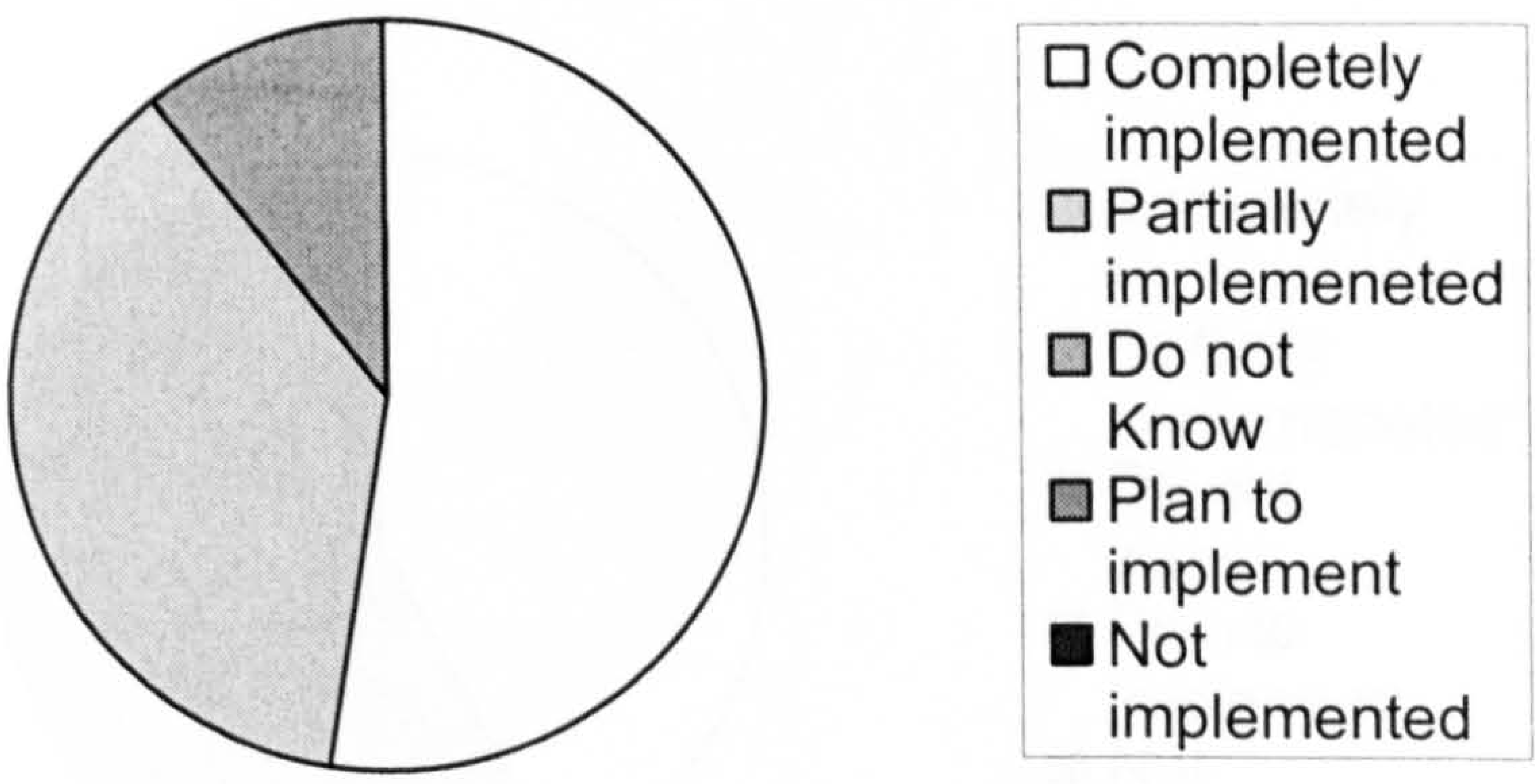




Finding: 89% of the respondents reported that it is critical or important to monitor, encourage, and reward asking for help from expert co-workers. The other 11% reported that it is beneficial. On the other hand, 26% reported that this is completely implemented, 53% reported that it is partially implemented, and 16% plan to implement it.

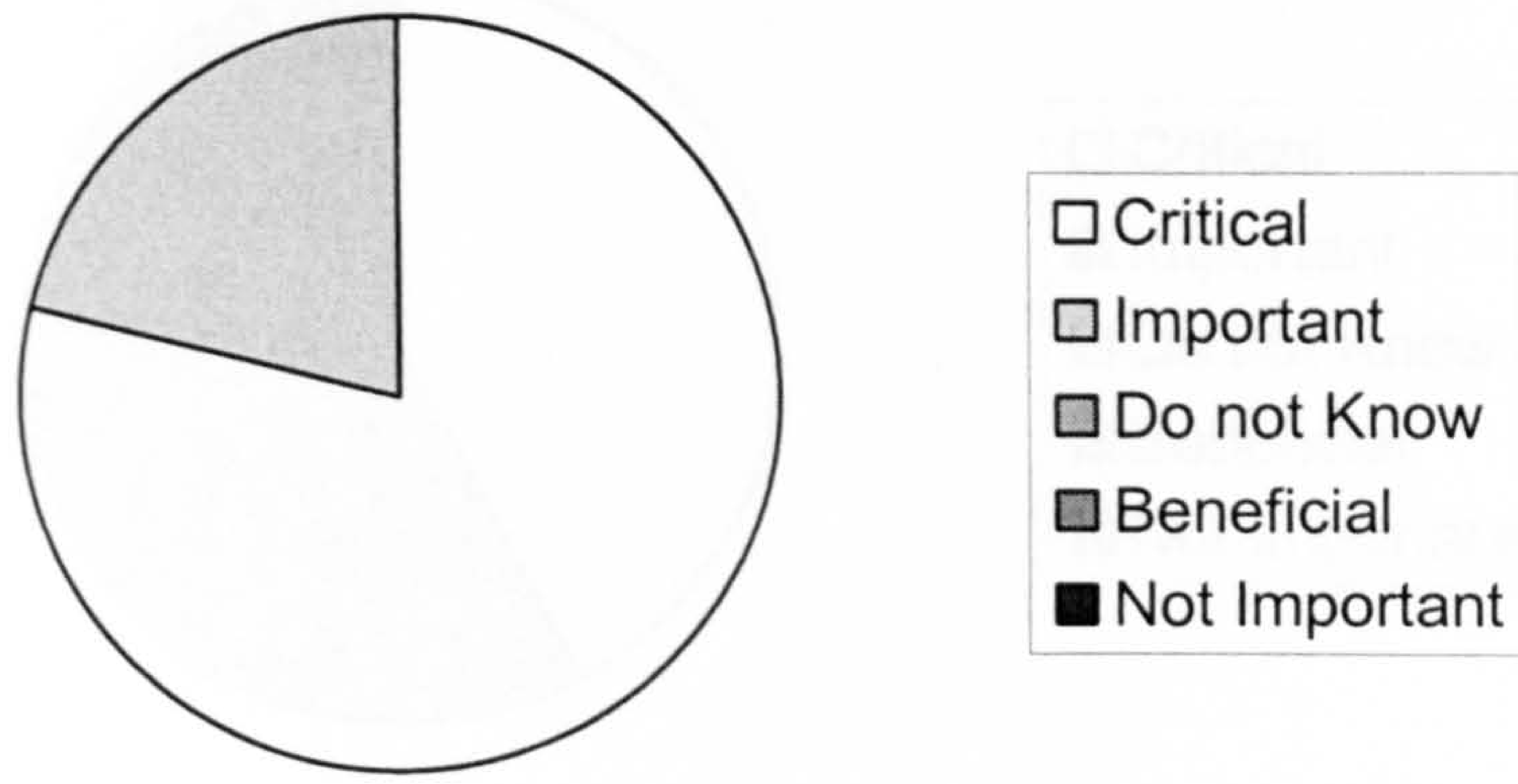
Question: C6. Employees feel secure about there jobs. The organization makes it attractive to stay and long term employment is encouraged.

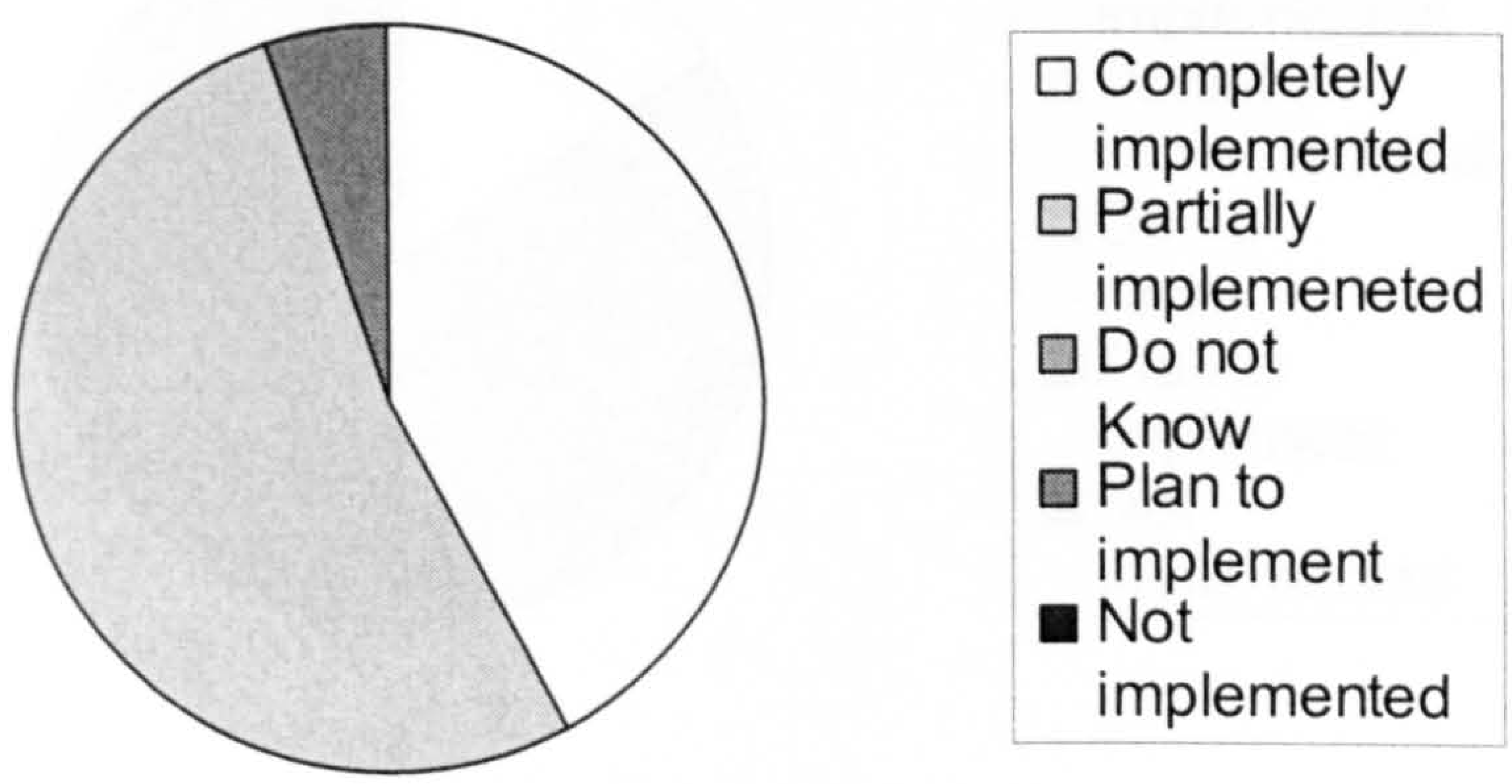




Finding: 100% of the respondents reported that it is critical or important that employees feel secure about their jobs. On the other hand, 53% reported that this is completely implemented and 37% reported that it is partially implemented.

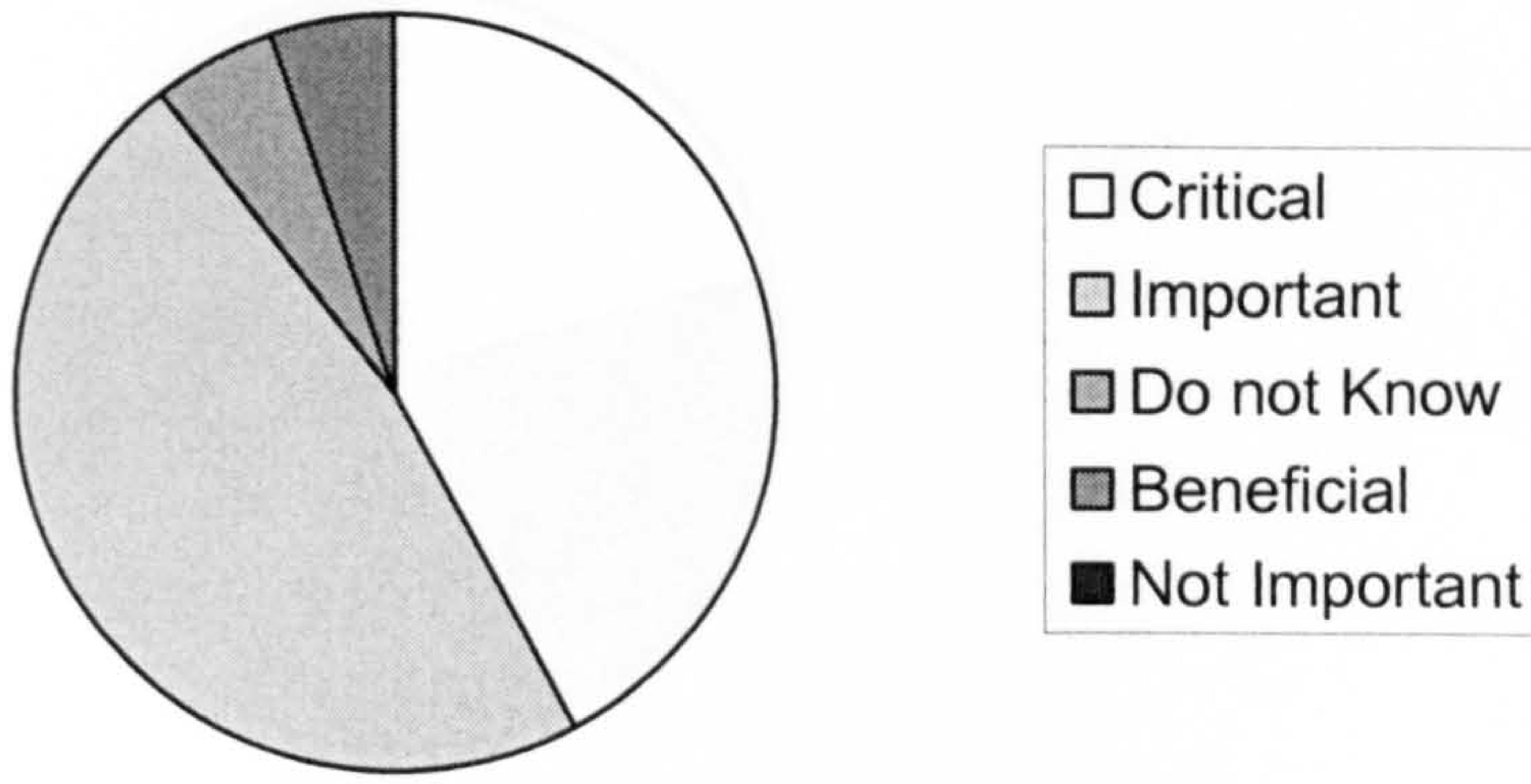
Question: C7. We constantly seek best practice and try to reuse existing projects and knowledge whenever we can.

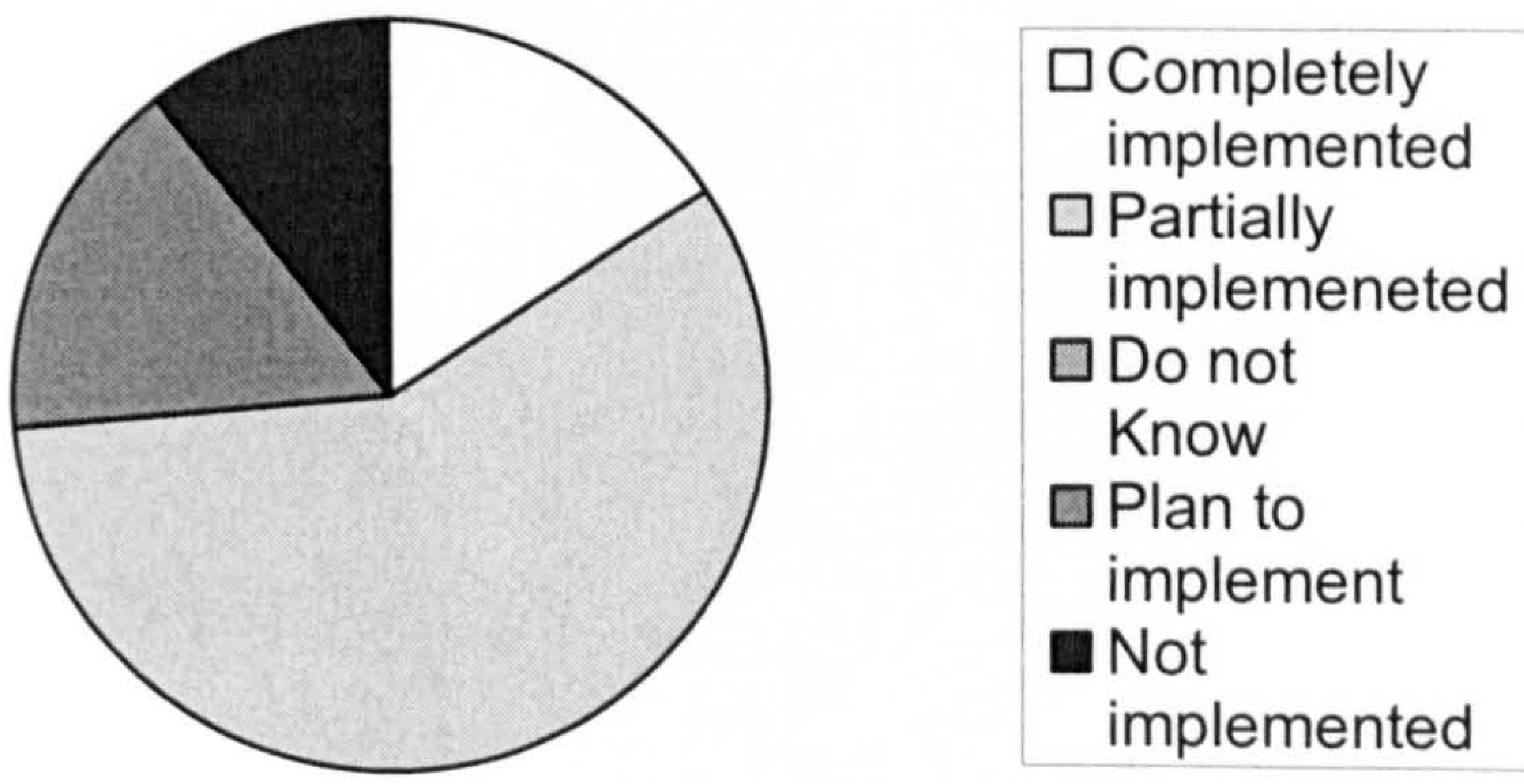




Finding: 79% of the respondents reported that it is critical to constantly seek best practices and try to reuse existing projects and knowledge. The other 21% reported that it is important. On the other hand, 42% reported that this is completely implemented and 53% reported that it is partially implemented.

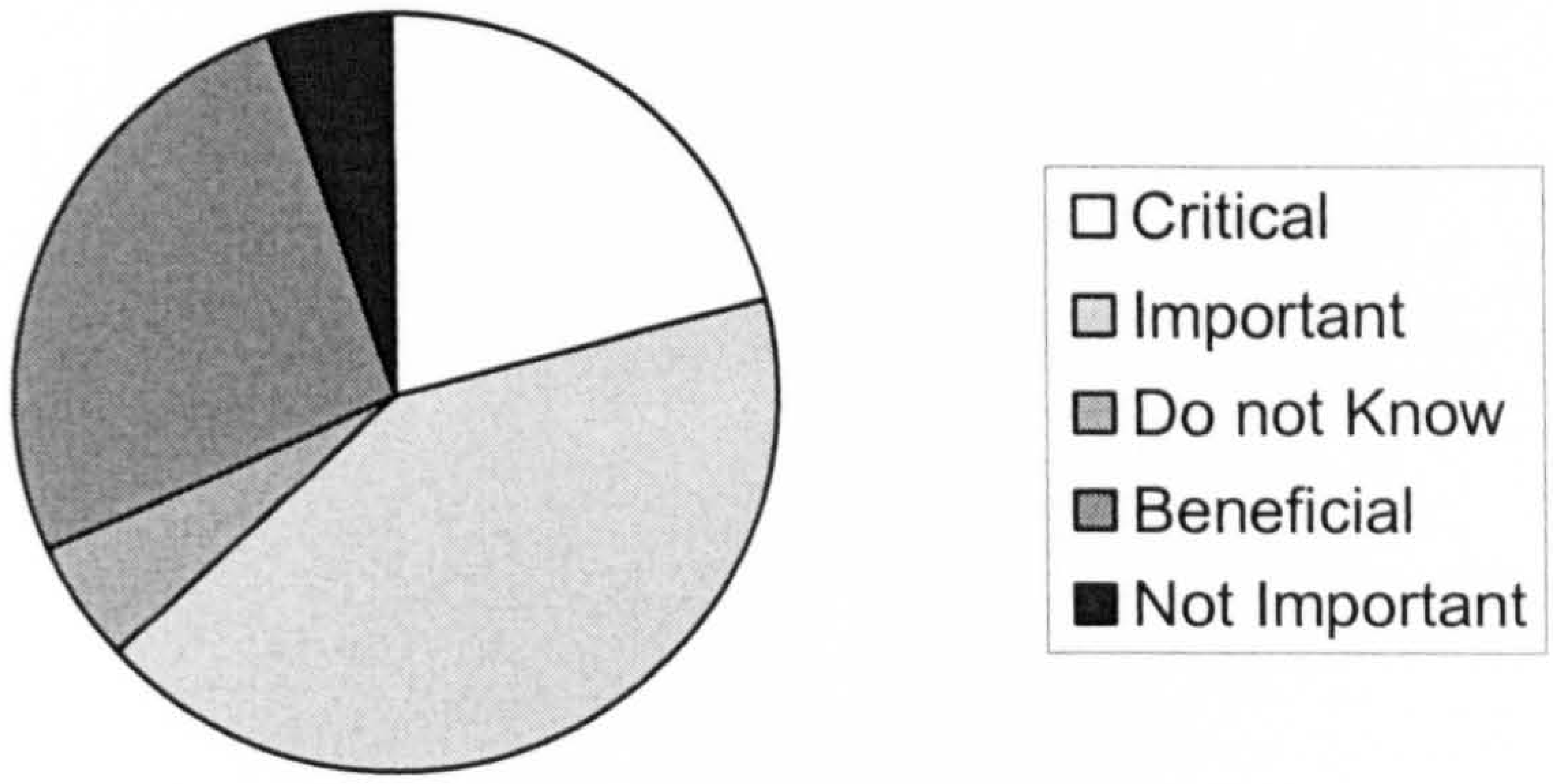
Question: C8. Time is allowed for creative thinking. For example, staff are encouraged to reflect and thinking time is allowed for.

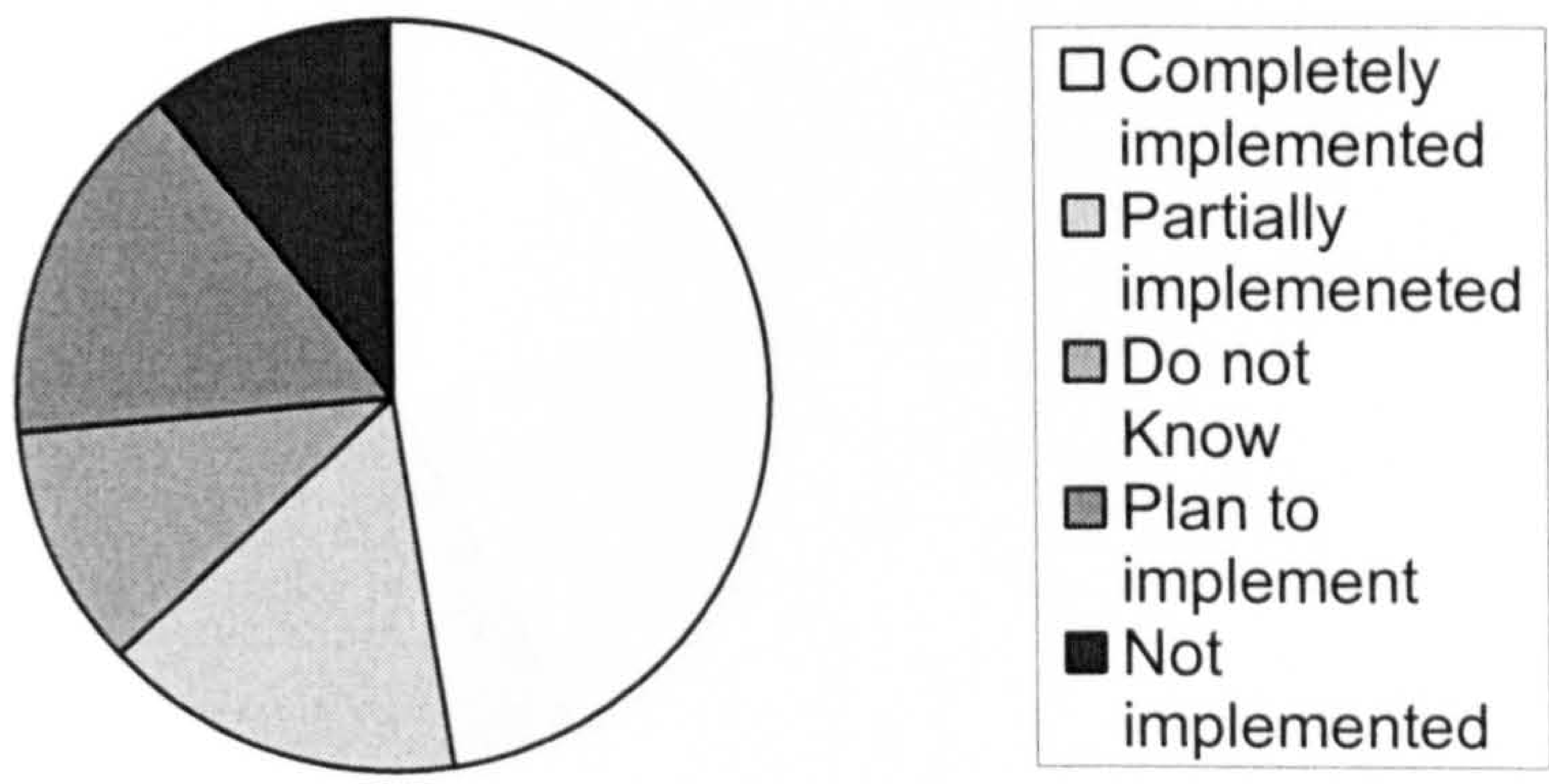




Finding: 89% of the respondents reported that it is critical or important to allow time for creative thinking. On the other hand, 16% reported that this is completely implemented, 58% reported that it is partially implemented, 16% plan to implement it, and 11% not implemented.

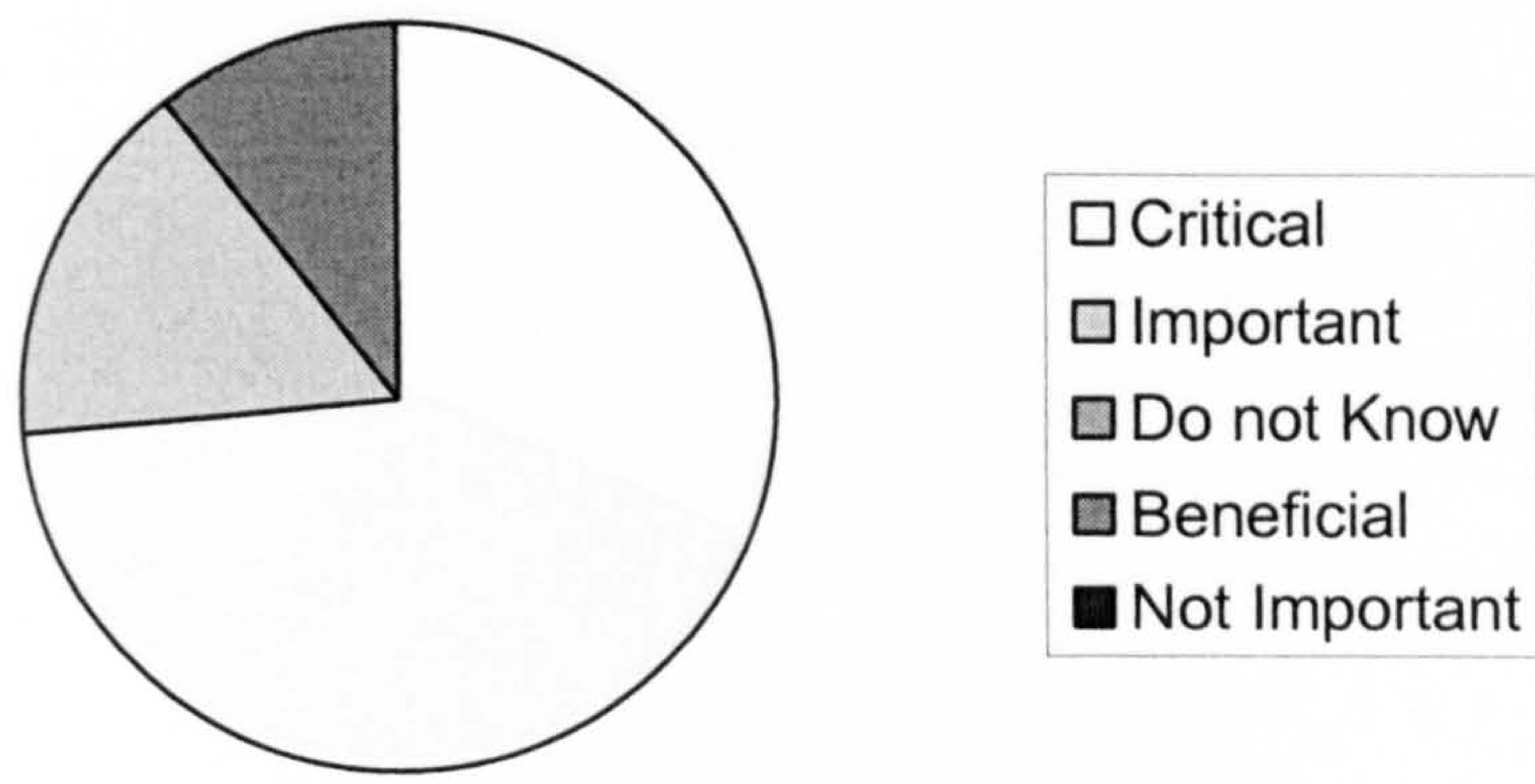
Question: C9. Physical space supports knowledge transfer. For example, working in open space and providing meeting rooms.

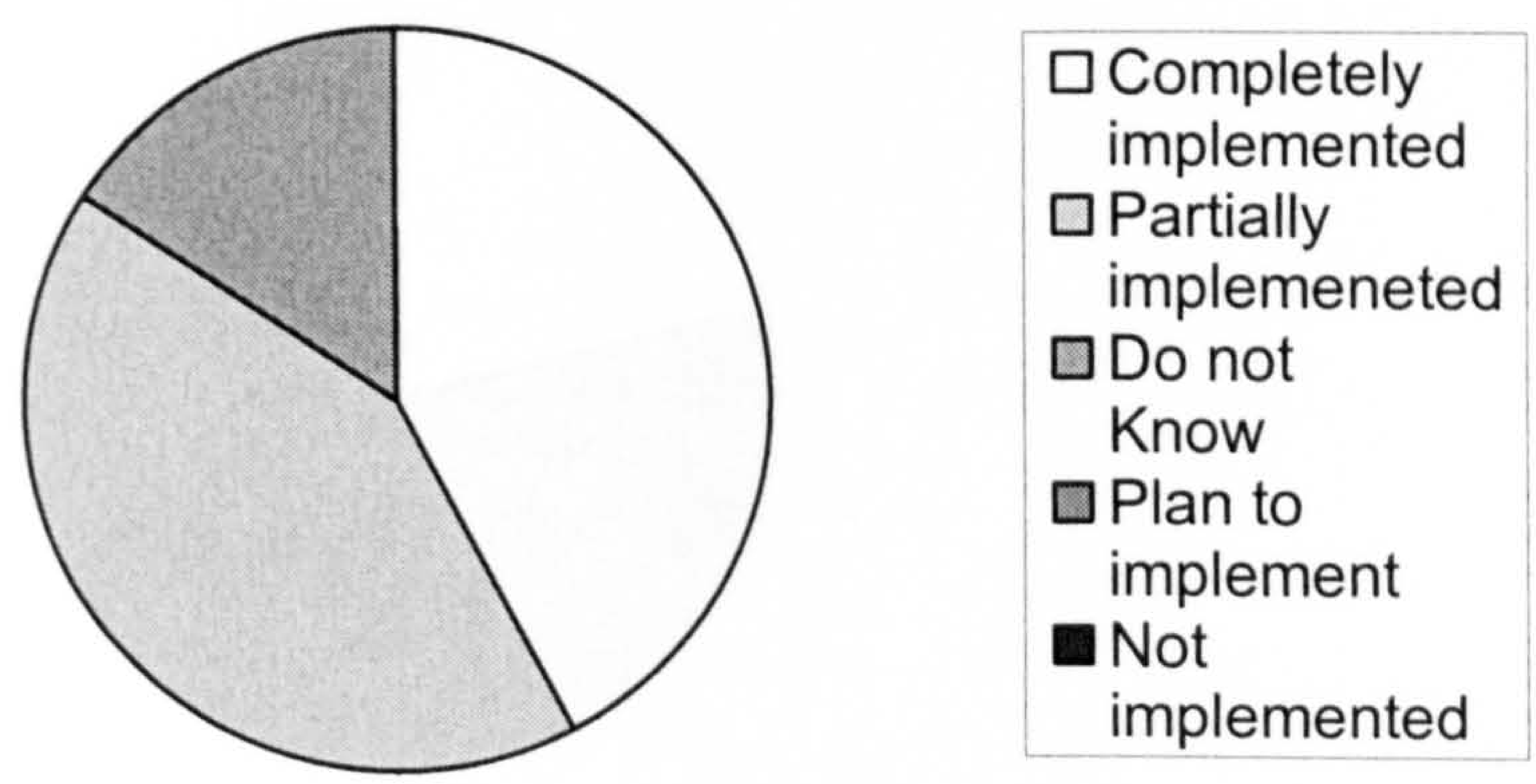




Finding: 63% of the respondents reported that it is critical or important to have a physical space that supports KM and 26% reported that it is beneficial. On the other hand, 47% reported that this is completely implemented, 16% reported that it is partially implemented, 16% plan to implement it, and 11% not implemented.

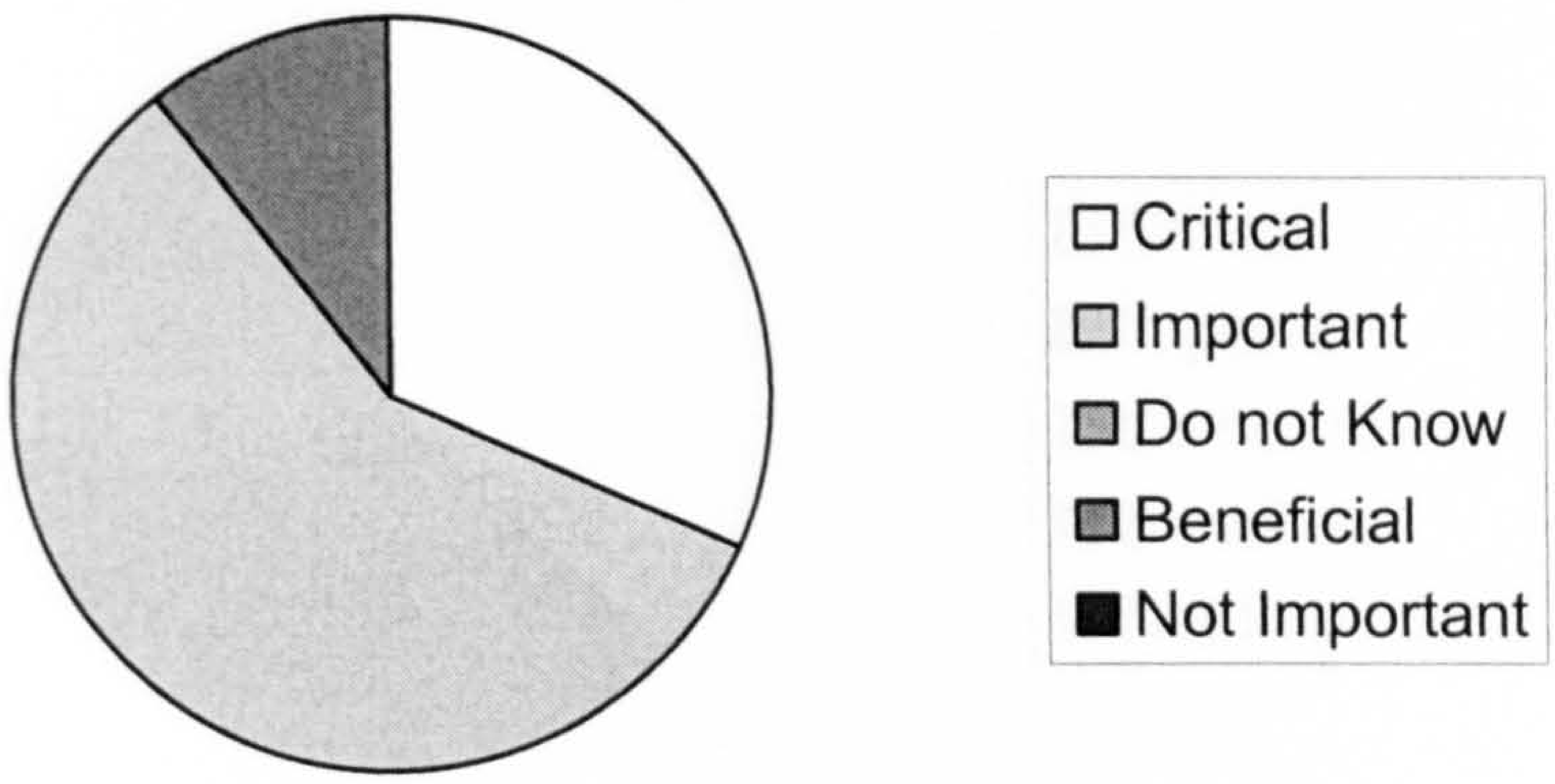
Question: C10. Love, care and trust are fostered among team members in the organization.

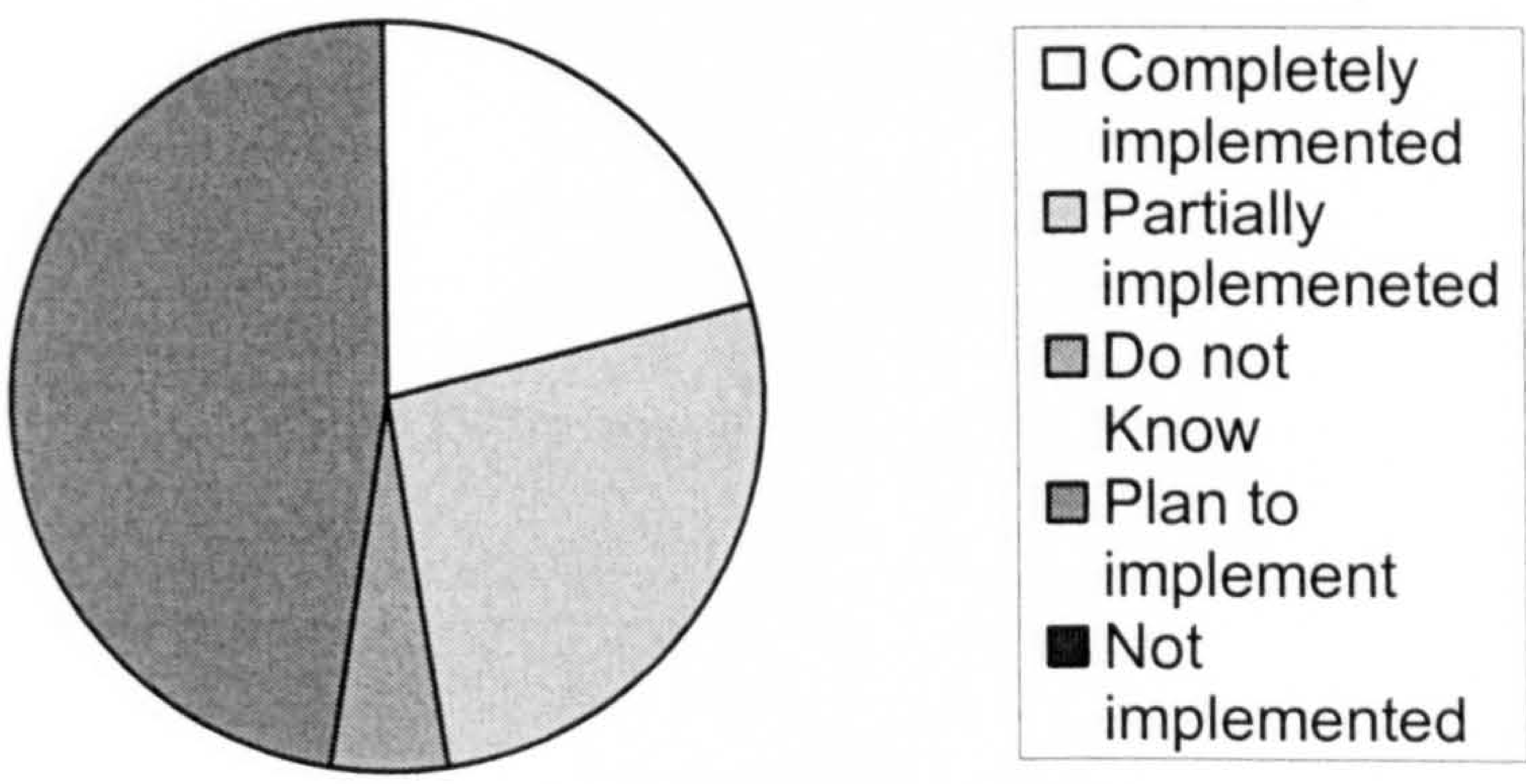




Finding: 89% of the respondents reported that it is critical or important to foster love, care, and trust among members of the organization. The other 26% reported that it is beneficial. On the other hand, 42% reported that this is completely implemented, 42% reported that it is partially implemented, and 16% plan to implement it.

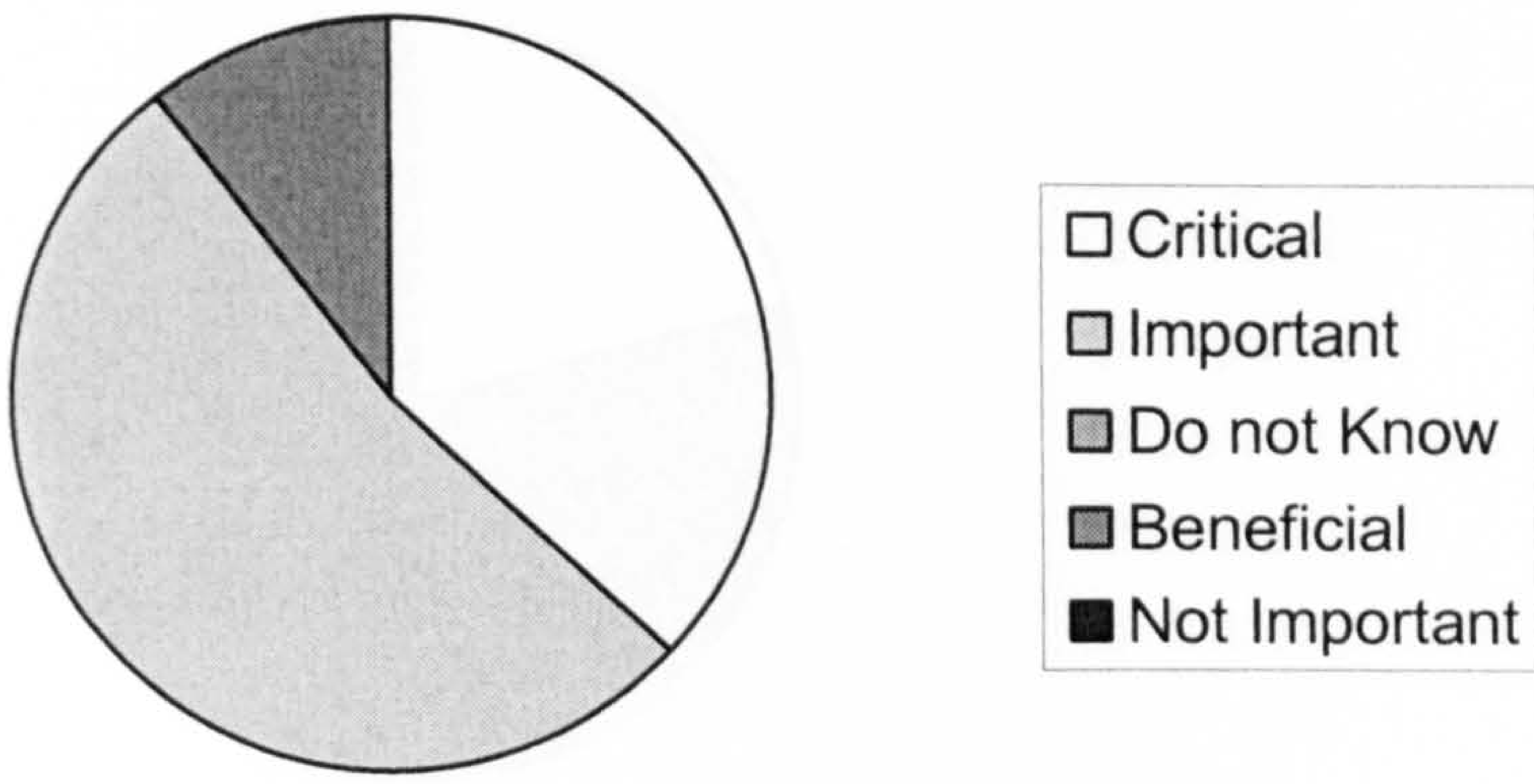
Question: D1. A flexible, well-structured, up-to-date knowledge map exists to point staff in the direction of the knowledge they seek.

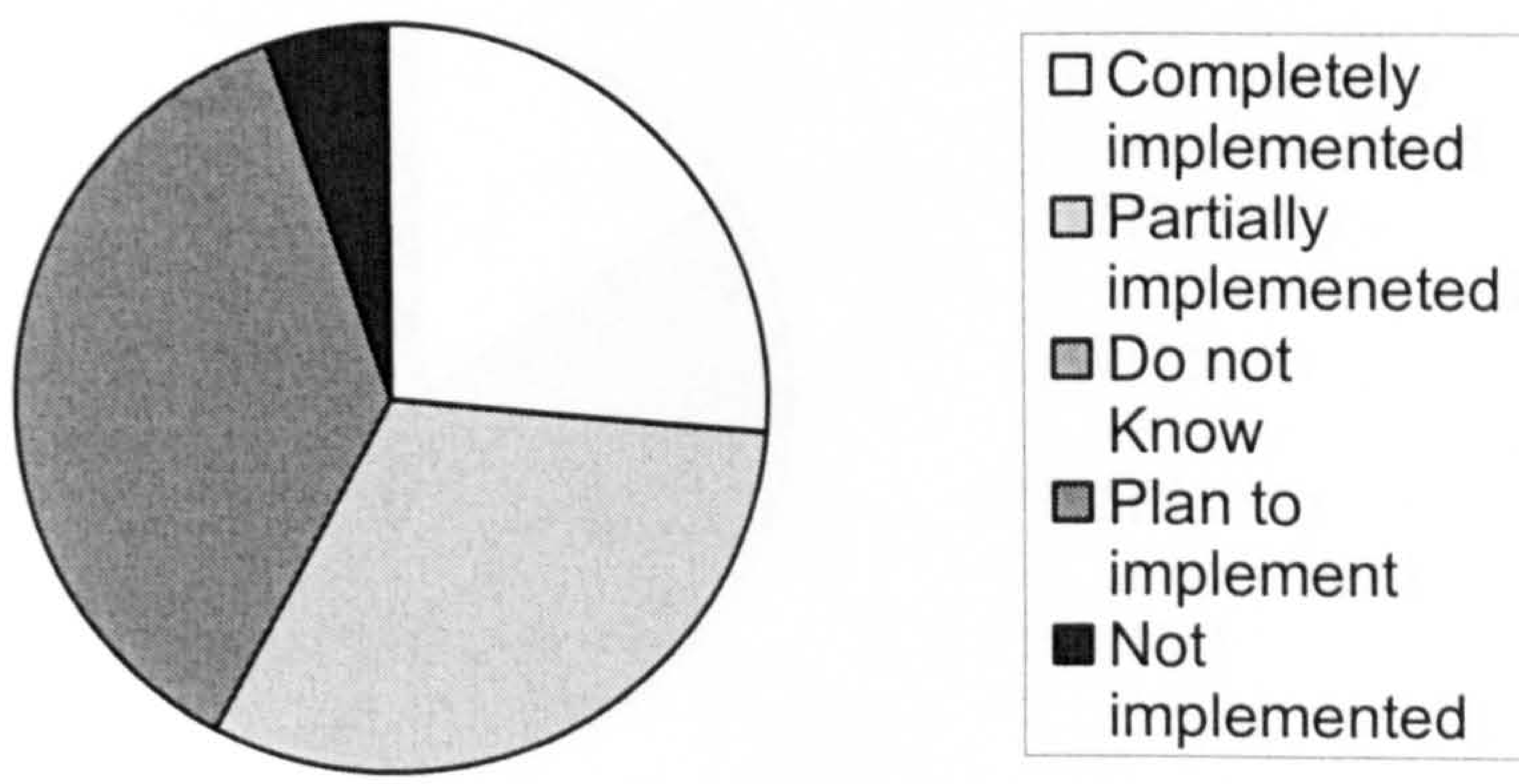




Finding: 89% of the respondents reported that it is critical or important to have a flexible, well-structured, up-to-date knowledge map to pint staff in the direction of the knowledge they seek. The other 11% reported that this is beneficial. On the other hand, 21% of the respondents reported that this is completely implemented, 26% partially implemented, and 47% plan to implement.

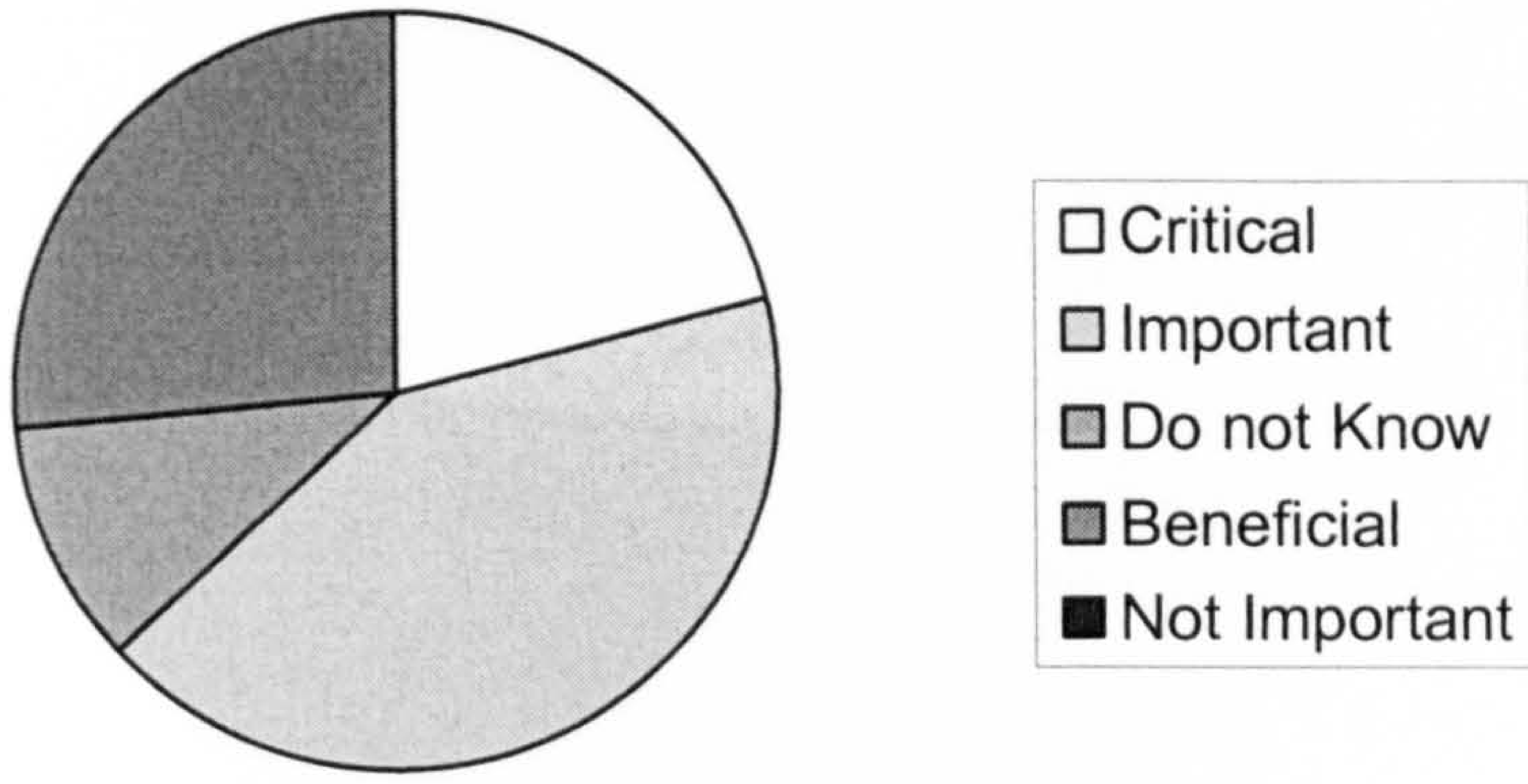
Question: D2. Formal networks and cross-functional teams exist to facilitate the dissemination of knowledge.

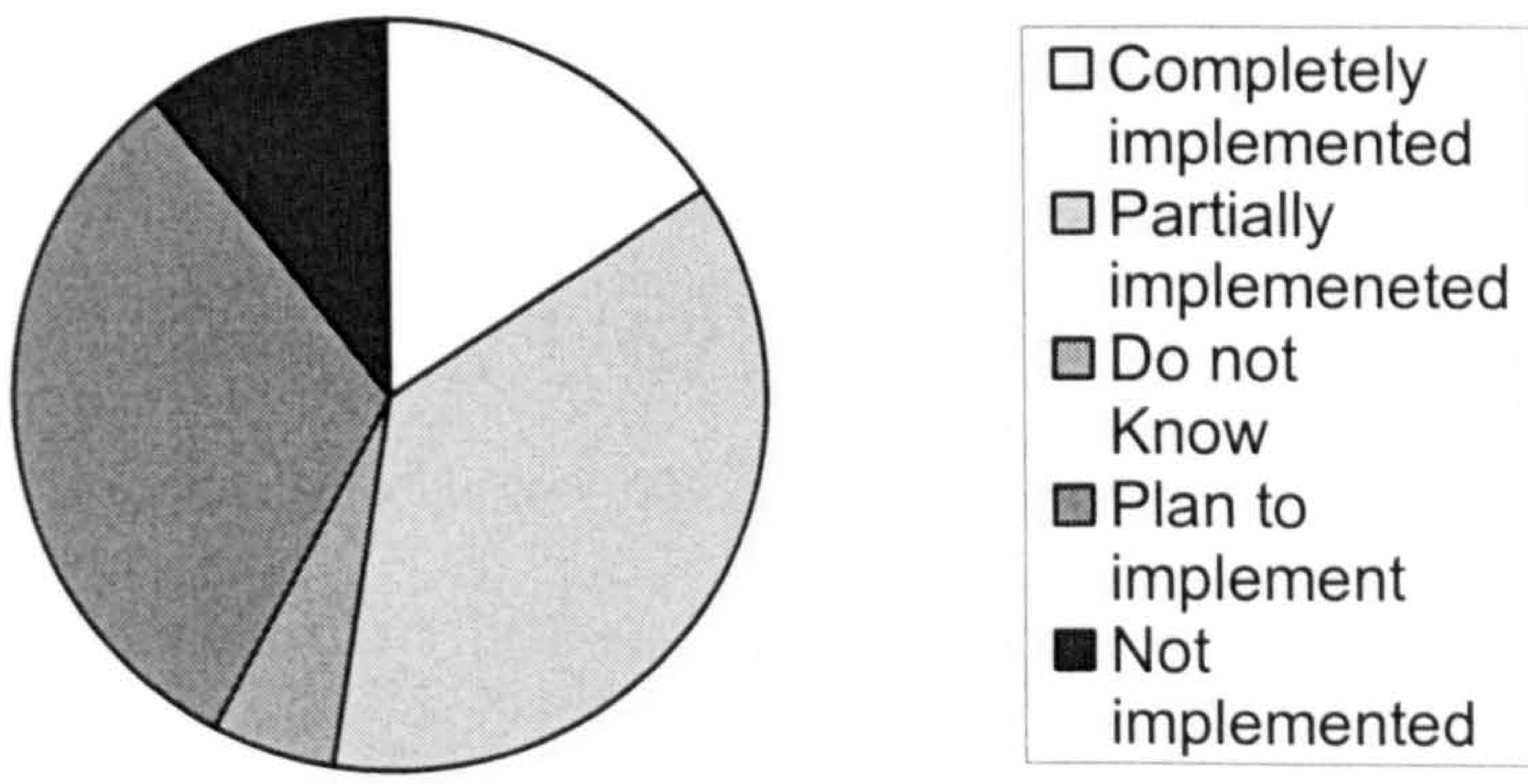




Finding: 89% of the respondents reported that it is critical or important to have formal networks and cross-functional teams to facilitate the dissemination of knowledge. The other 11% reported that this is beneficial. On the other hand, 26% of the respondents reported that this is completely implemented, 32% partially implemented, and 37% plan to implement.

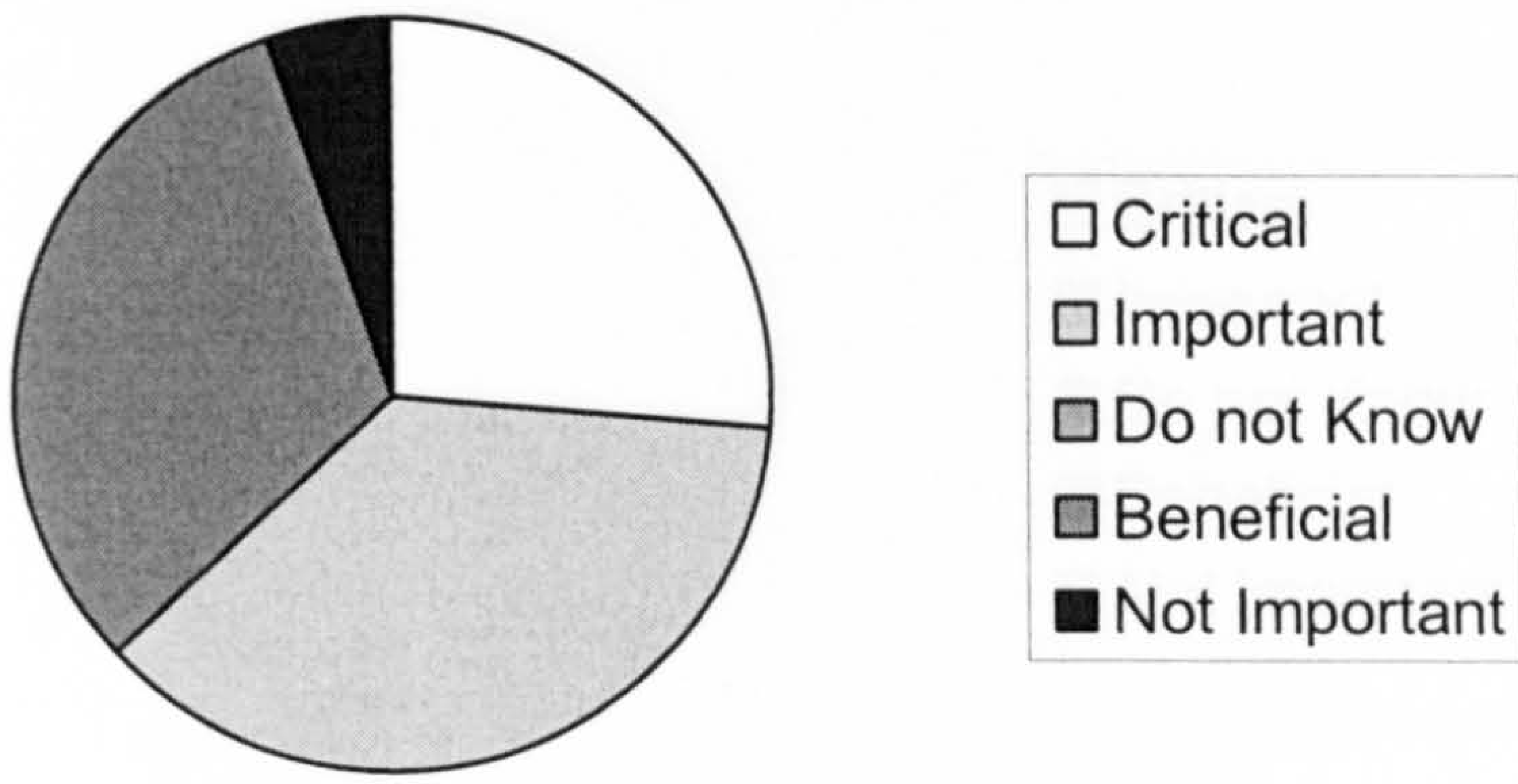
Question: D3. Informal networks across the organization are encouraged, in fact management meetings often discuss our communities of practice.

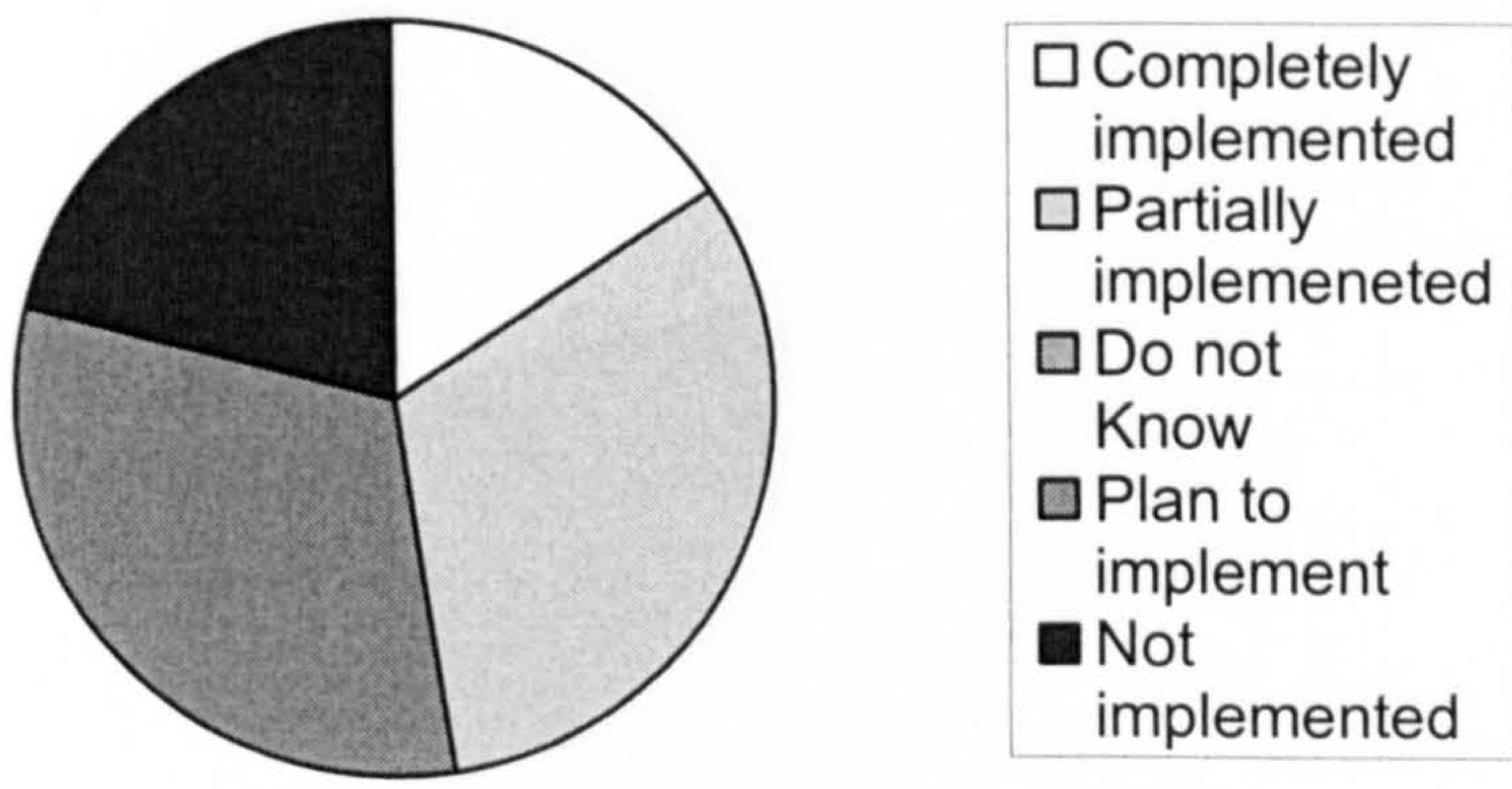




Finding: 63% of the respondents reported that it is critical or important to encourage informal networks and communities of practice. 26% reported that this is beneficial. On the other hand, 16% of the respondents reported that this is completely implemented, 37% partially implemented, and 32% plan to implement.

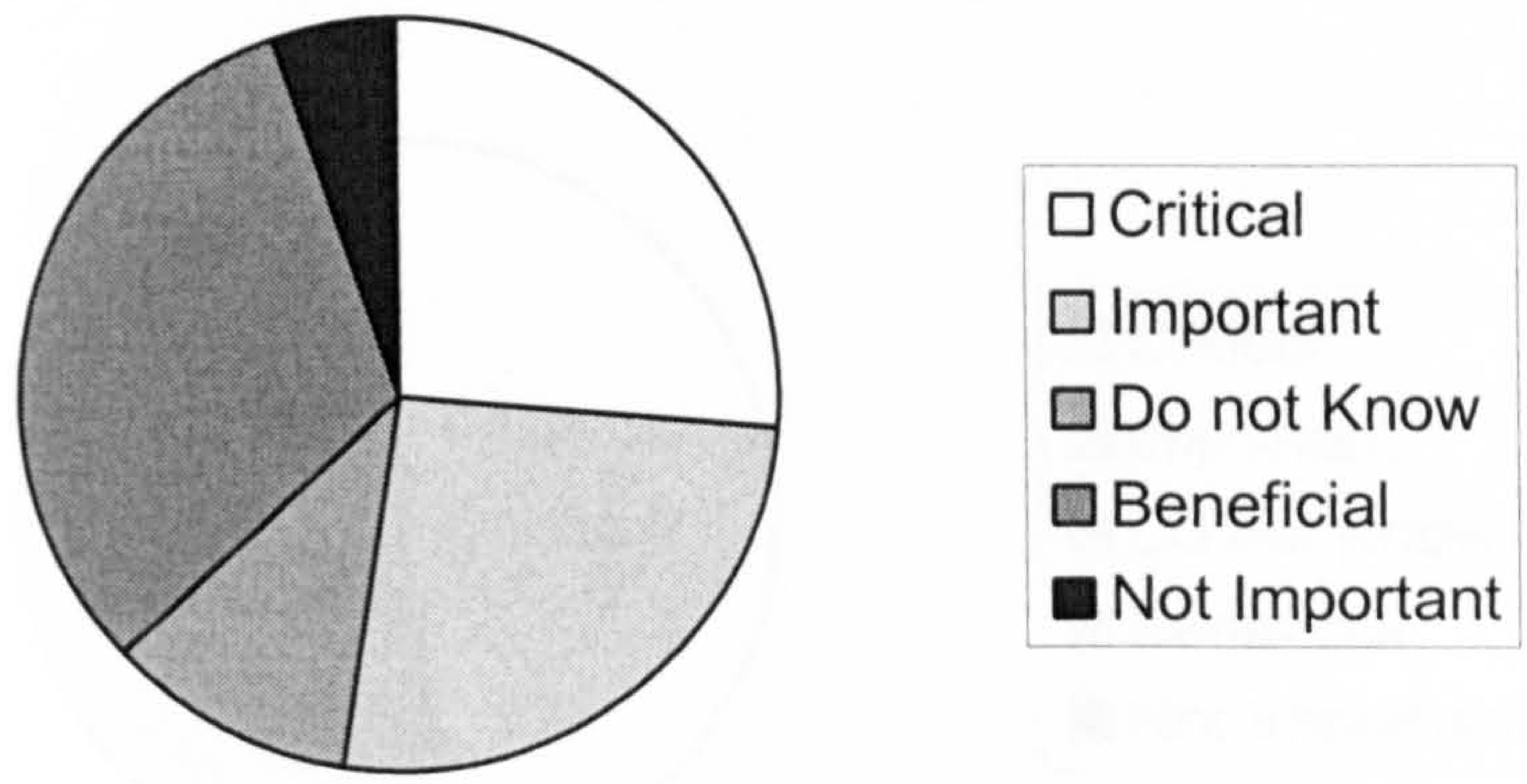
Question: D4. Staff are rotated to spread best practice ideas or natural staff turnover is positively used to assist with the dissemination of best practice.

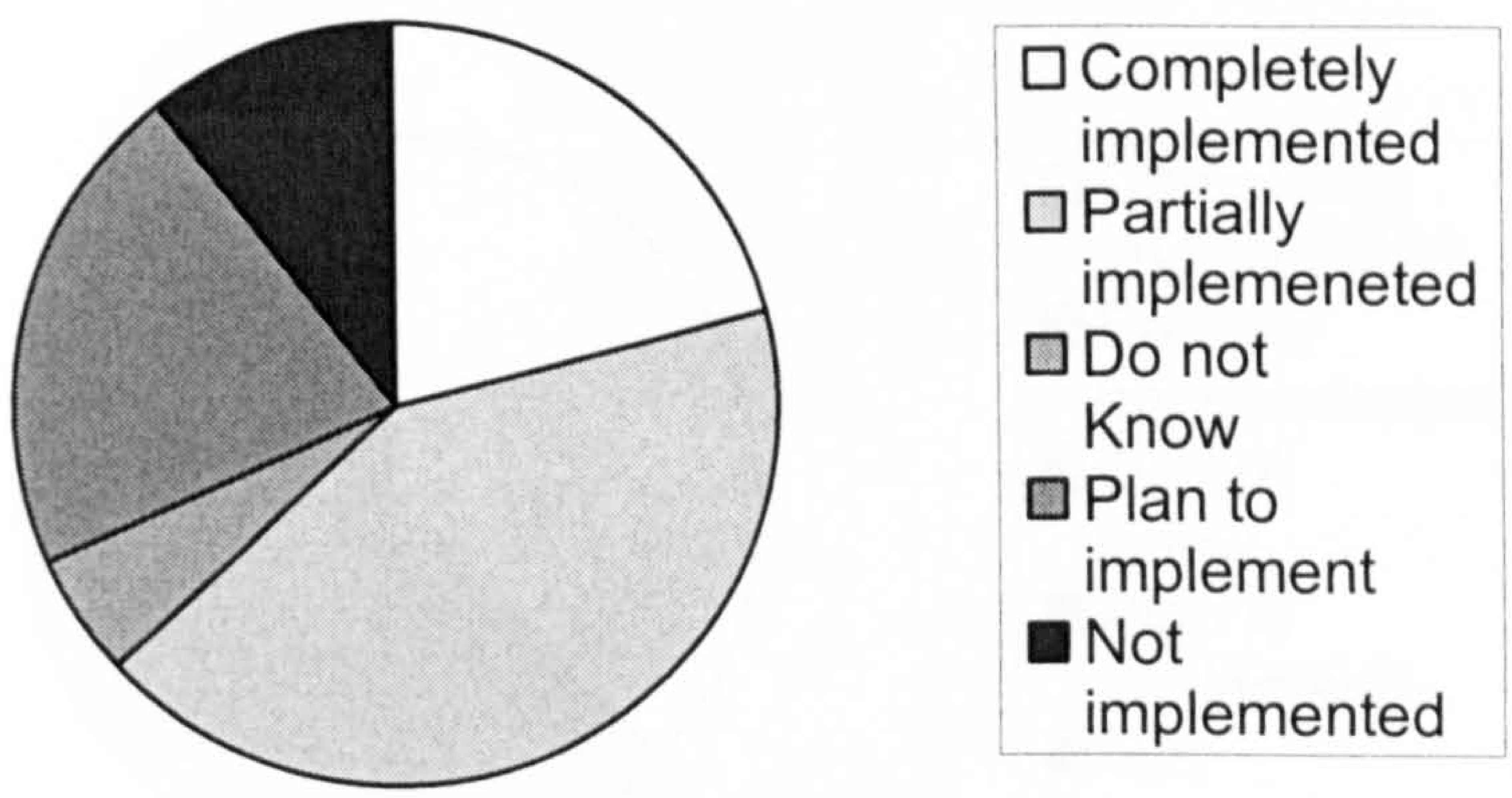




Finding: 63% of the respondents reported that it is critical or important to rotate staff in the organization to spread best practices. 32% reported that this is beneficial. On the other hand, 16% of the respondents reported that this is completely implemented, 32% partially implemented, 32% plan to implement, and 21% not implemented.

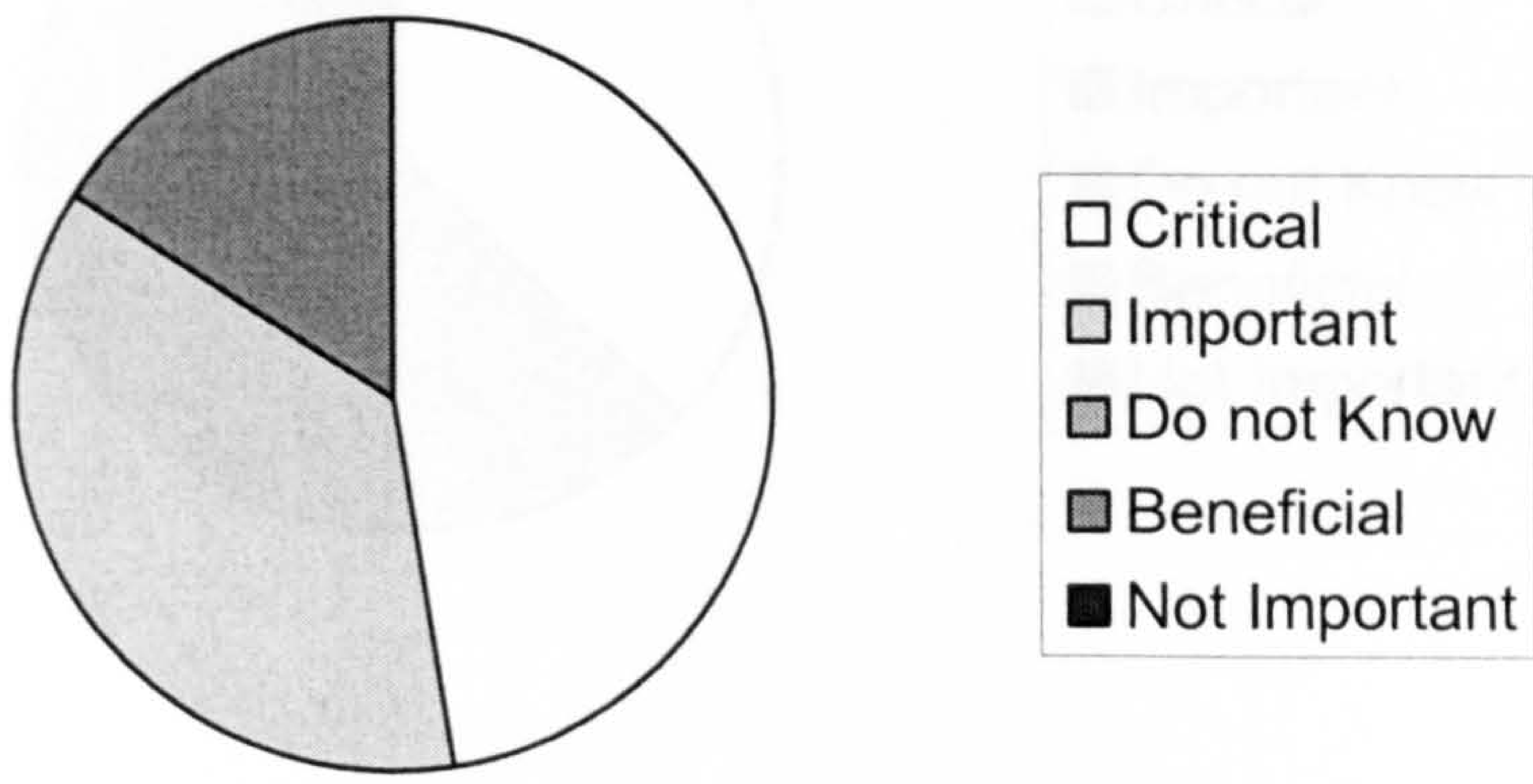
Question: D5. We are connected to external networks and knowledge sources which cause us constantly to re-examine what we are doing.

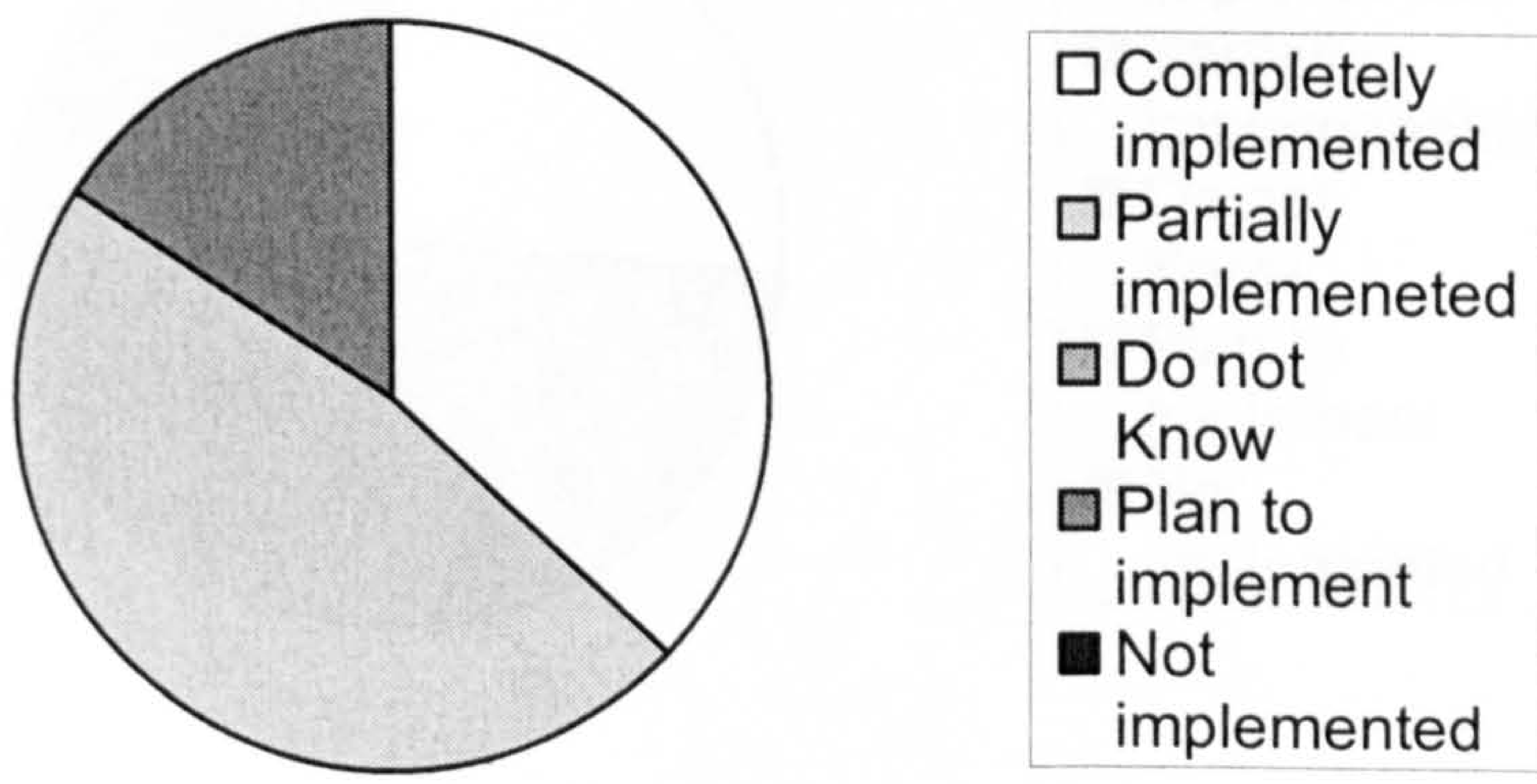




Finding: 53% of the respondents reported that it is critical or important to be connected to external networks and knowledge sources. 32% reported that this is beneficial. On the other hand, 21% of the respondents reported that this is completely implemented, 42% partially implemented, 21% plan to implement, and 11% not implemented.

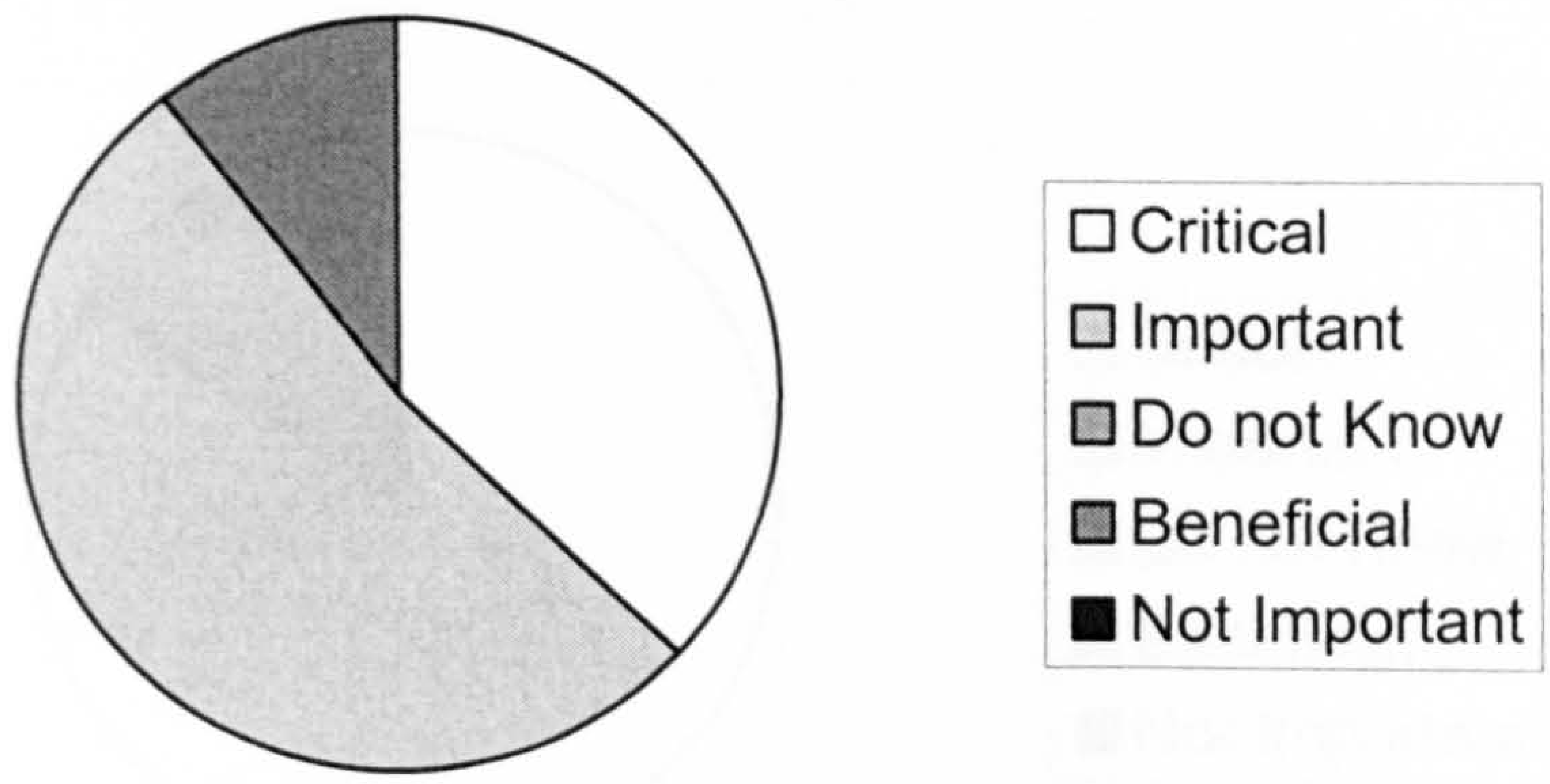
Question: E1. Middle managers play a major role in transferring the organization's KM strategy into specific plans, actions, processes and defined KM roles.

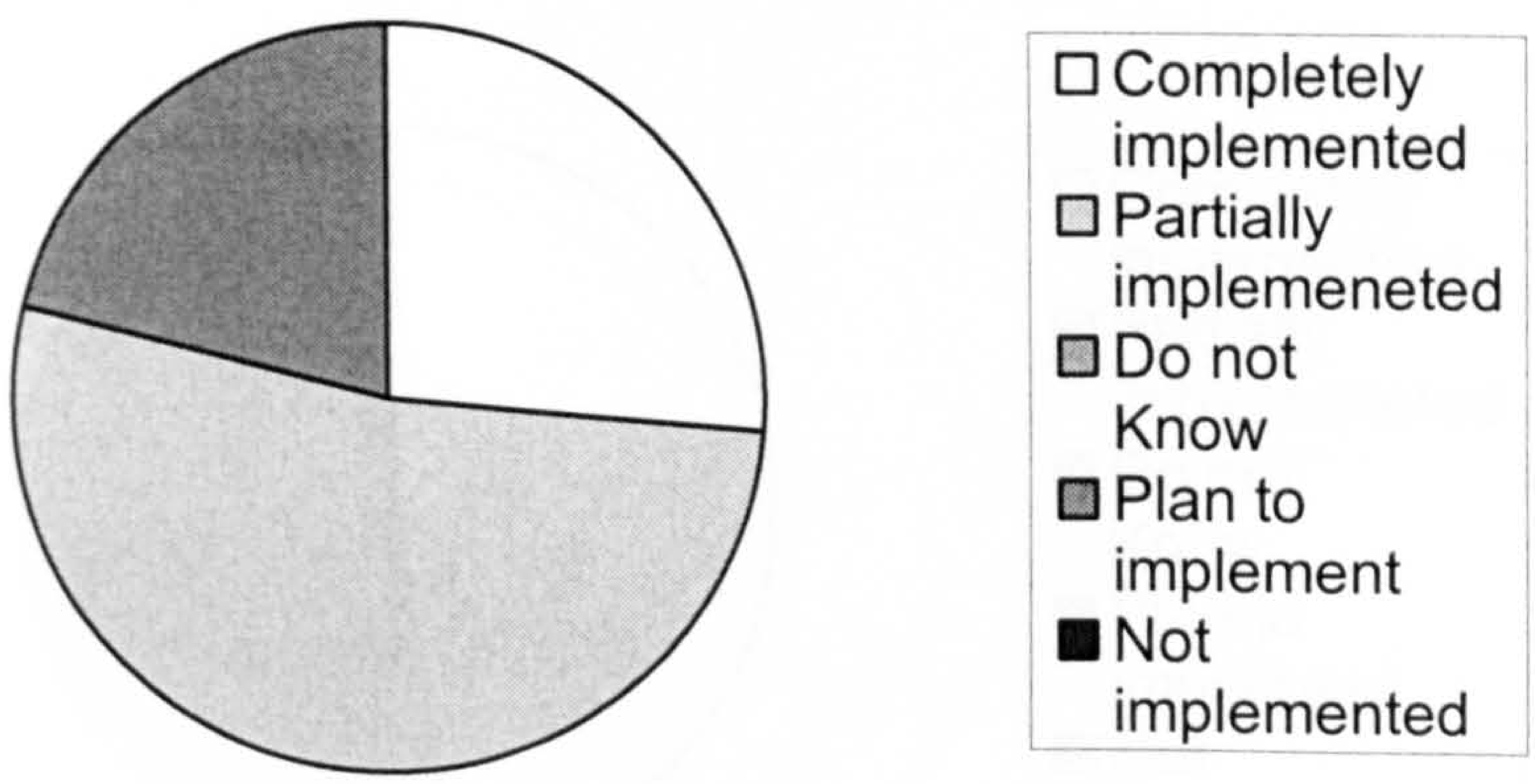




Finding: 84% of the respondents reported that it is critical or important for middle managers to play a major role in realizing the organization's KM strategy. The other 16% reported that this is beneficial. On the other hand, 37% of the respondents reported that this is completely implemented, 47% partially implemented, and 21% plan to implement.

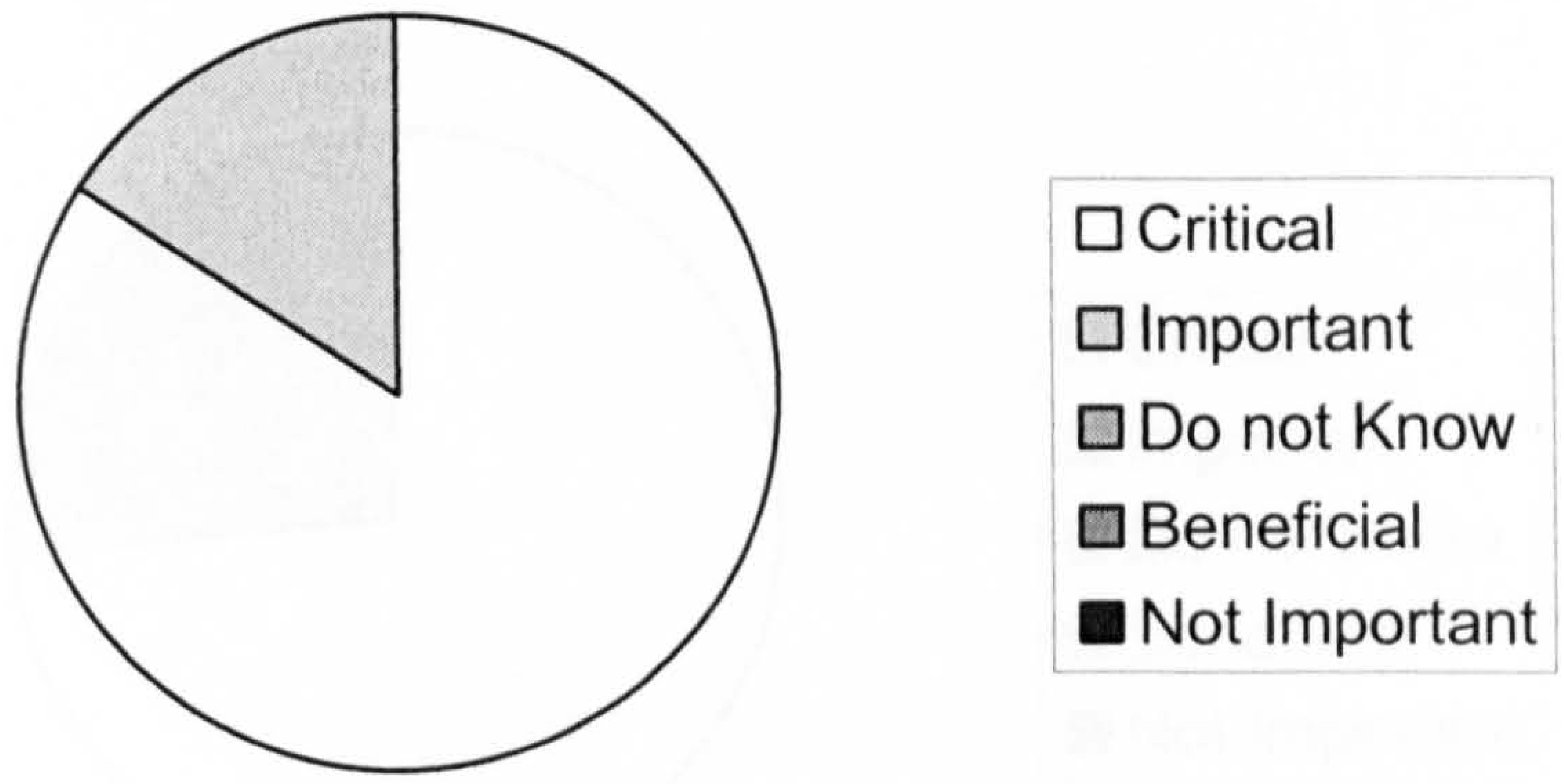
Question: E2. Managers scan the organization to identify knowledge needs.

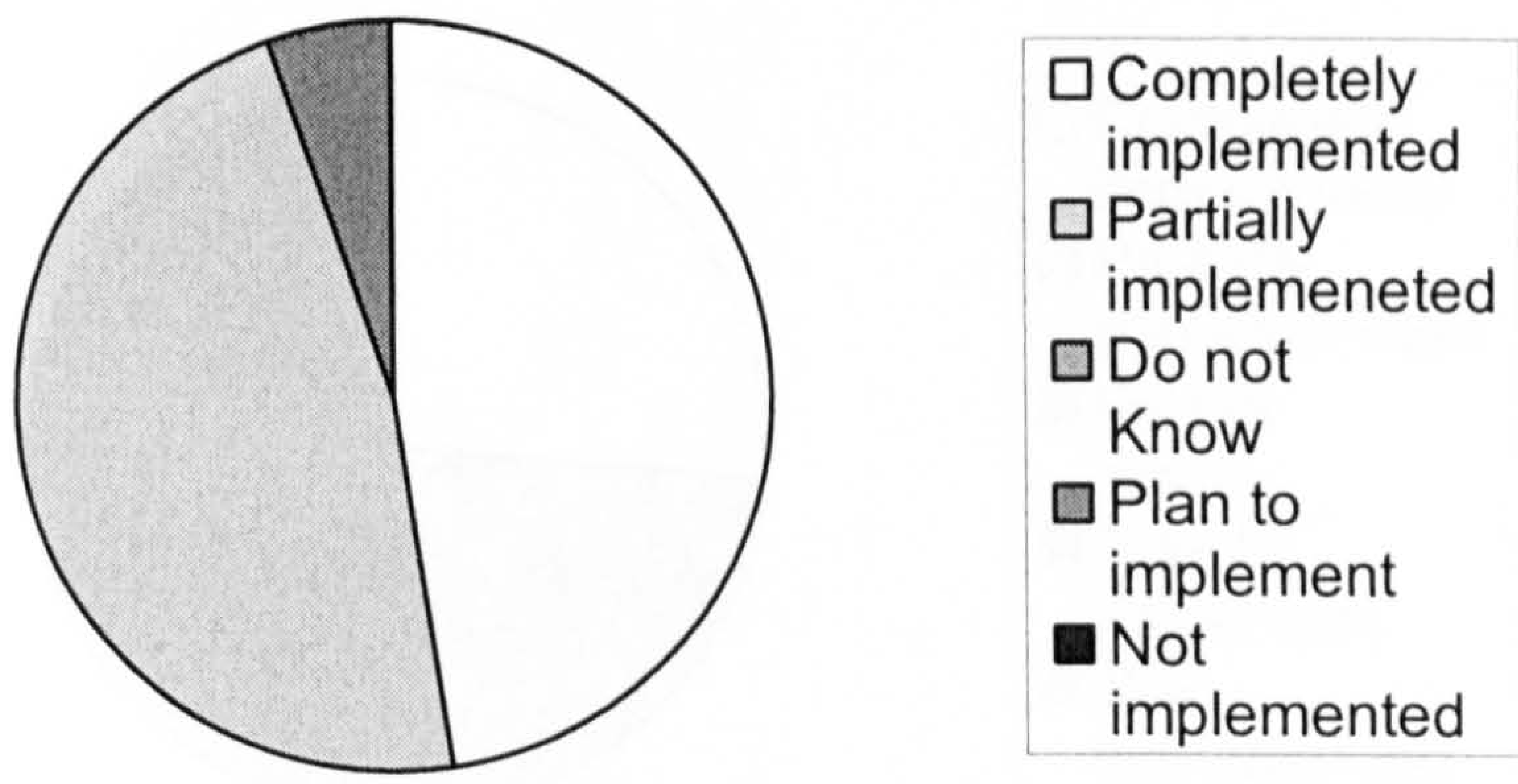




Finding: 89% of the respondents reported that it is critical or important for managers to scan the organization and identify needed knowledge. The other 11% reported that this is beneficial. On the other hand, 26% of the respondents reported that this is completely implemented, 53% partially implemented, and 21% plan to implement.

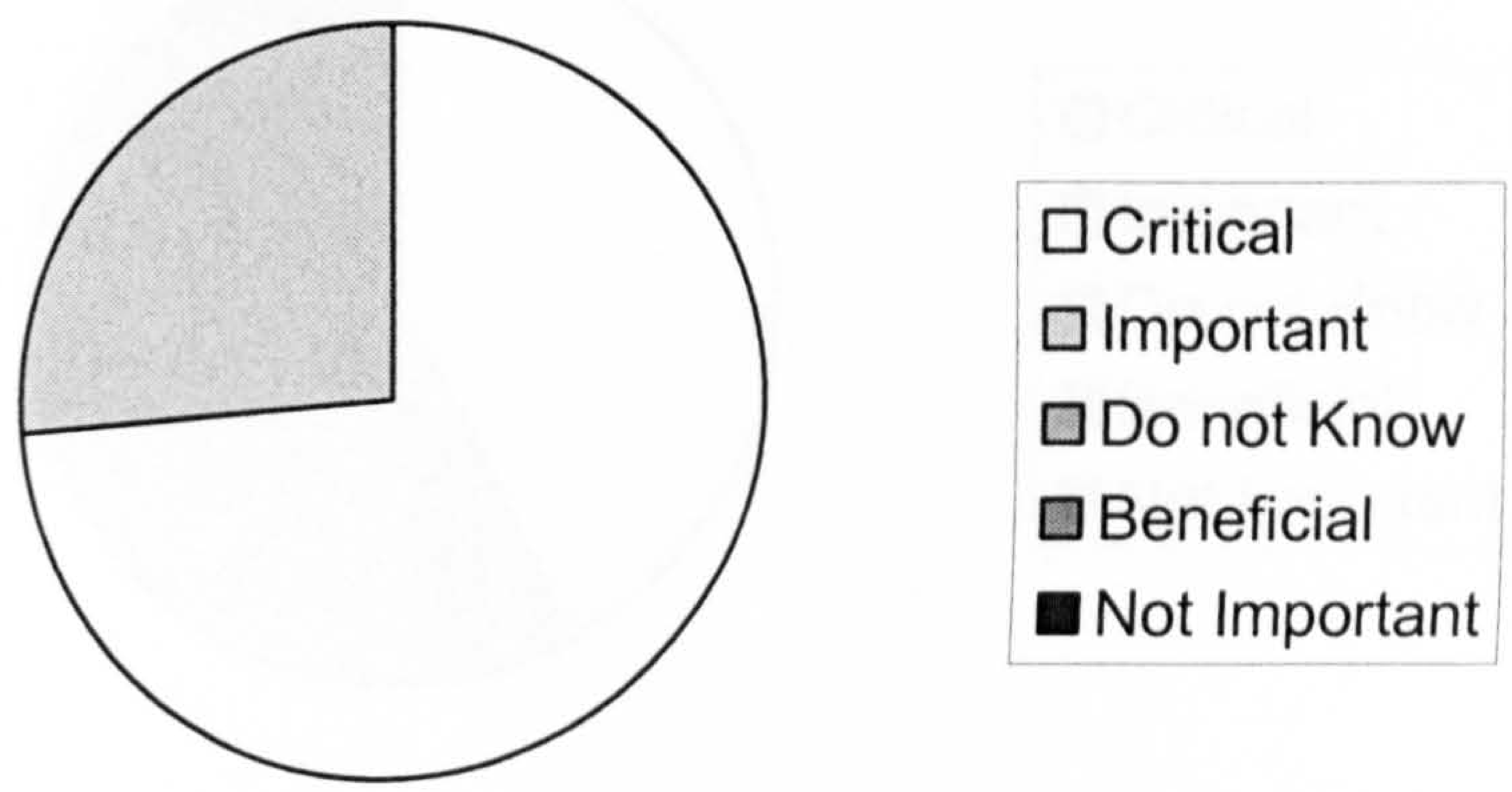
Question: E3. Knowledge sharing is seen as strength. Managers are responsible for motivating, mentoring and coaching their employees.

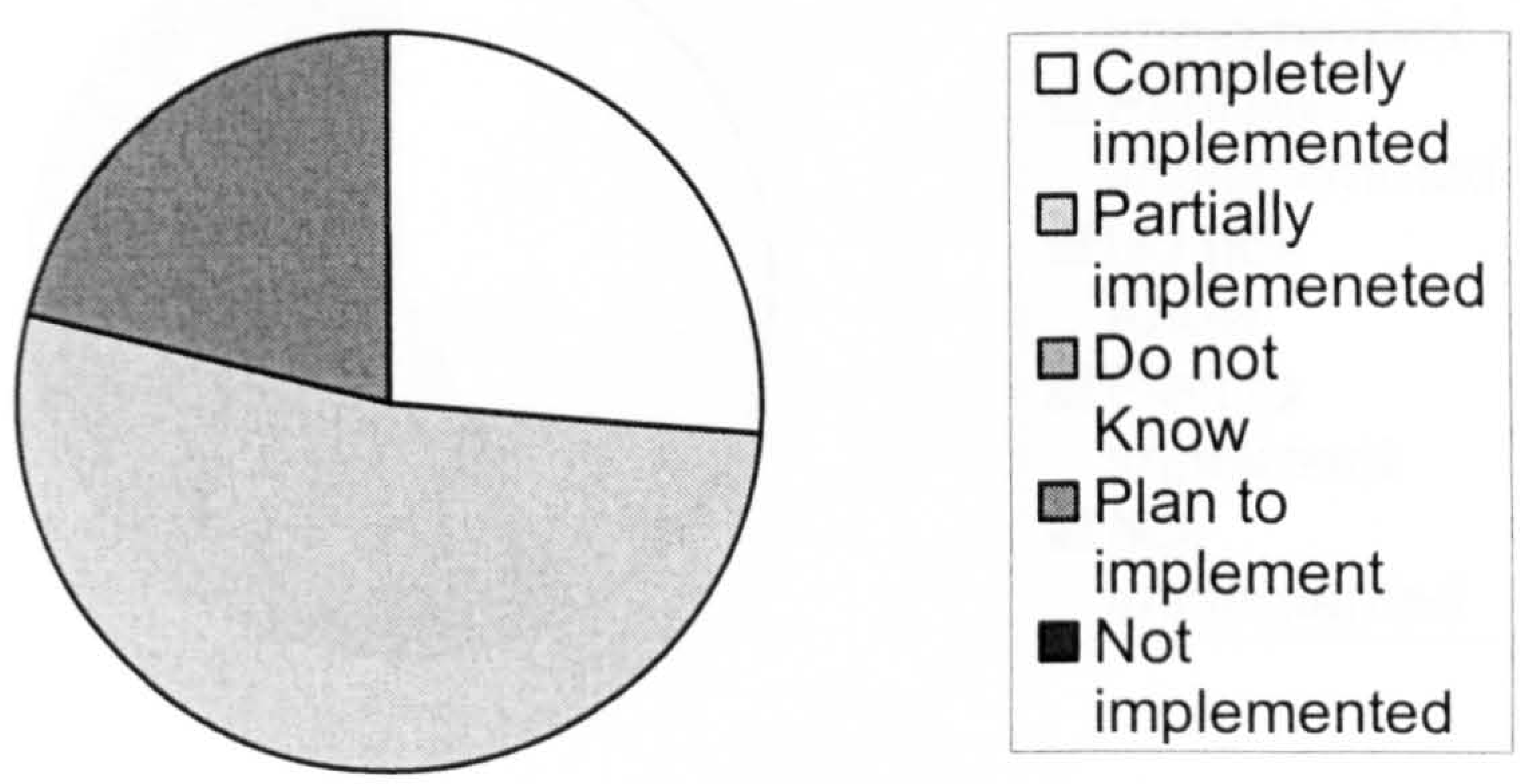




Finding: 84% of the respondents reported that it is critical that managers be responsible for motivating, mentoring, and coaching their employees. The other 16% reported that this is important. On the other hand, 47% of the respondents reported that this is completely implemented, 47% partially implemented, and 5% plan to implement.

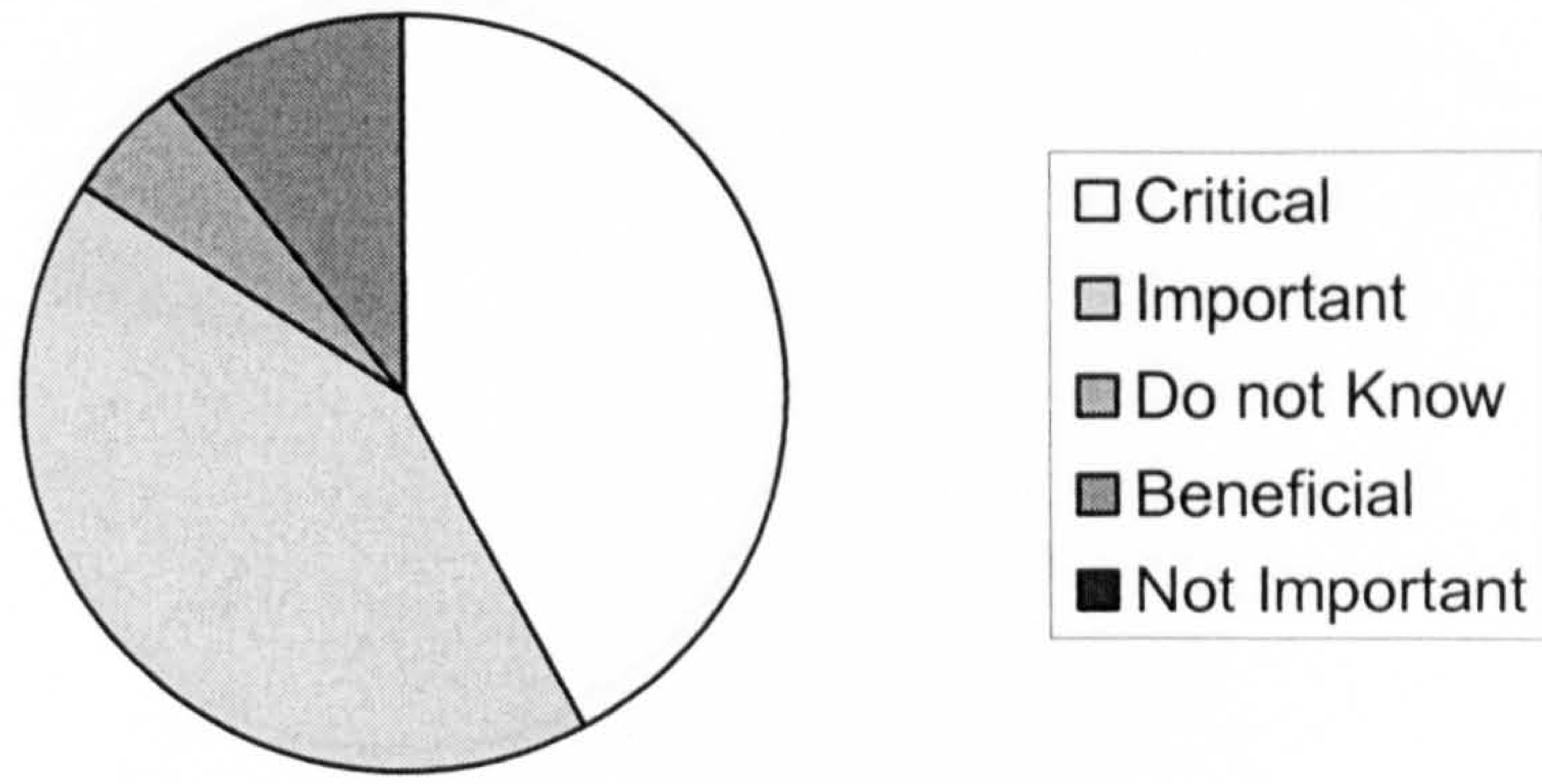
Question: E4. We know who our leading experts are in all areas of activity. We take active steps to ensure that they share knowledge and do not leave without leaving their knowledge in the organization.

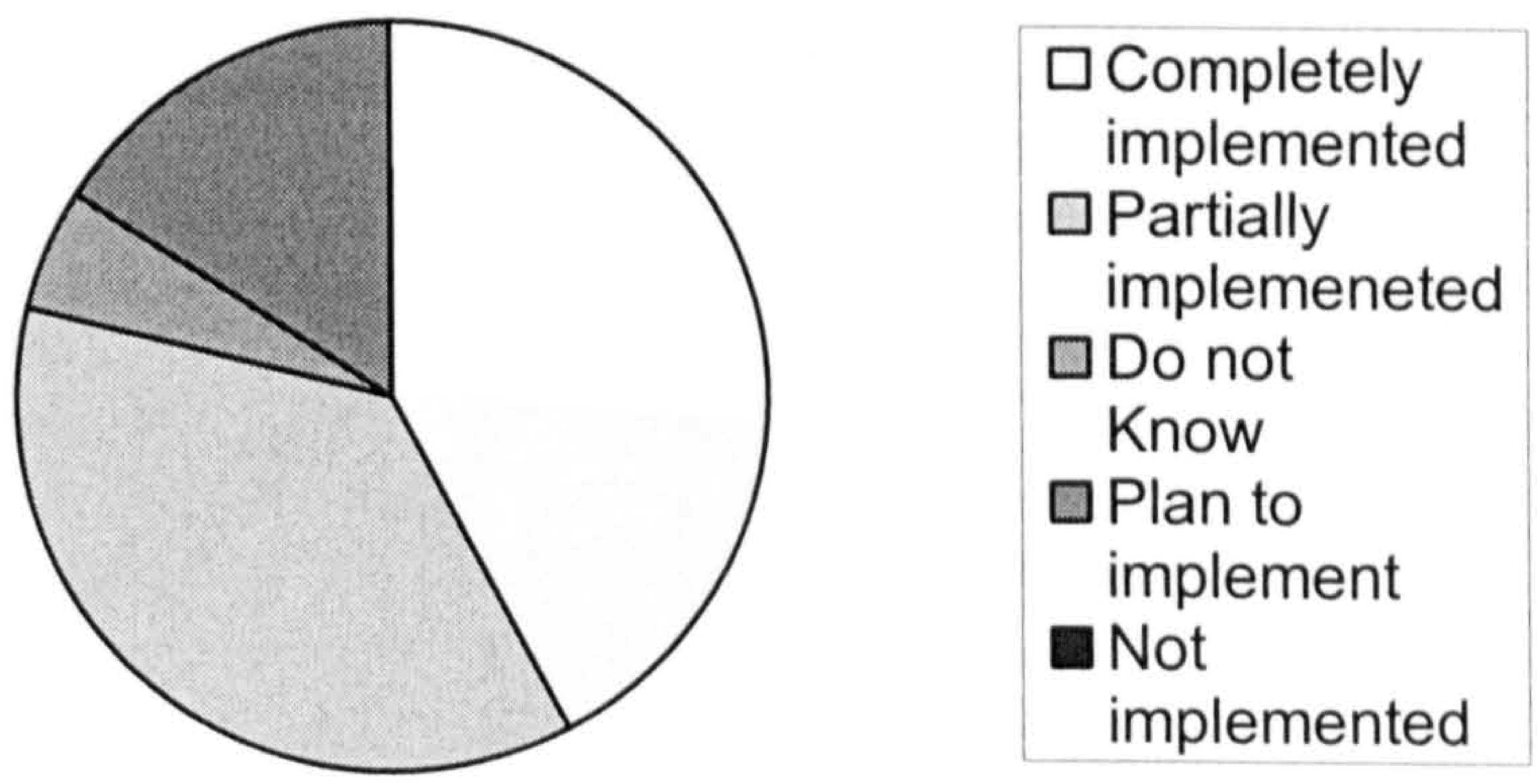




Finding: 100% of the respondents reported that it is critical or important to know leading experts in a company and take active steps to ensure that they share their knowledge and do not leave without leaving their knowledge in the organization. On the other hand, 26% of the respondents reported that this is completely implemented, 53% partially implemented, and 21% plan to implement.

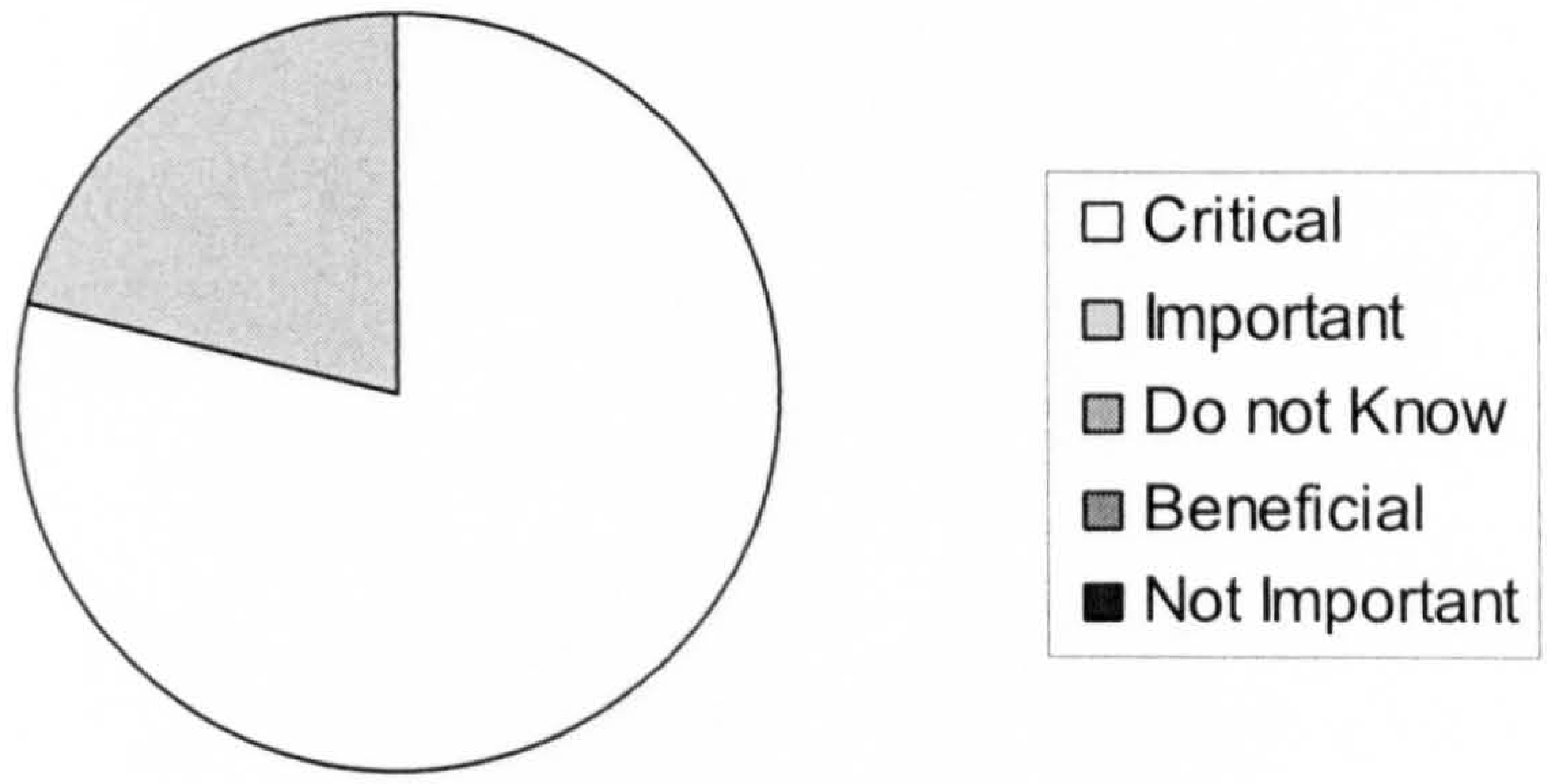
Question: E5. Managers give considerable attention to creating the right mix of people when forming teams.

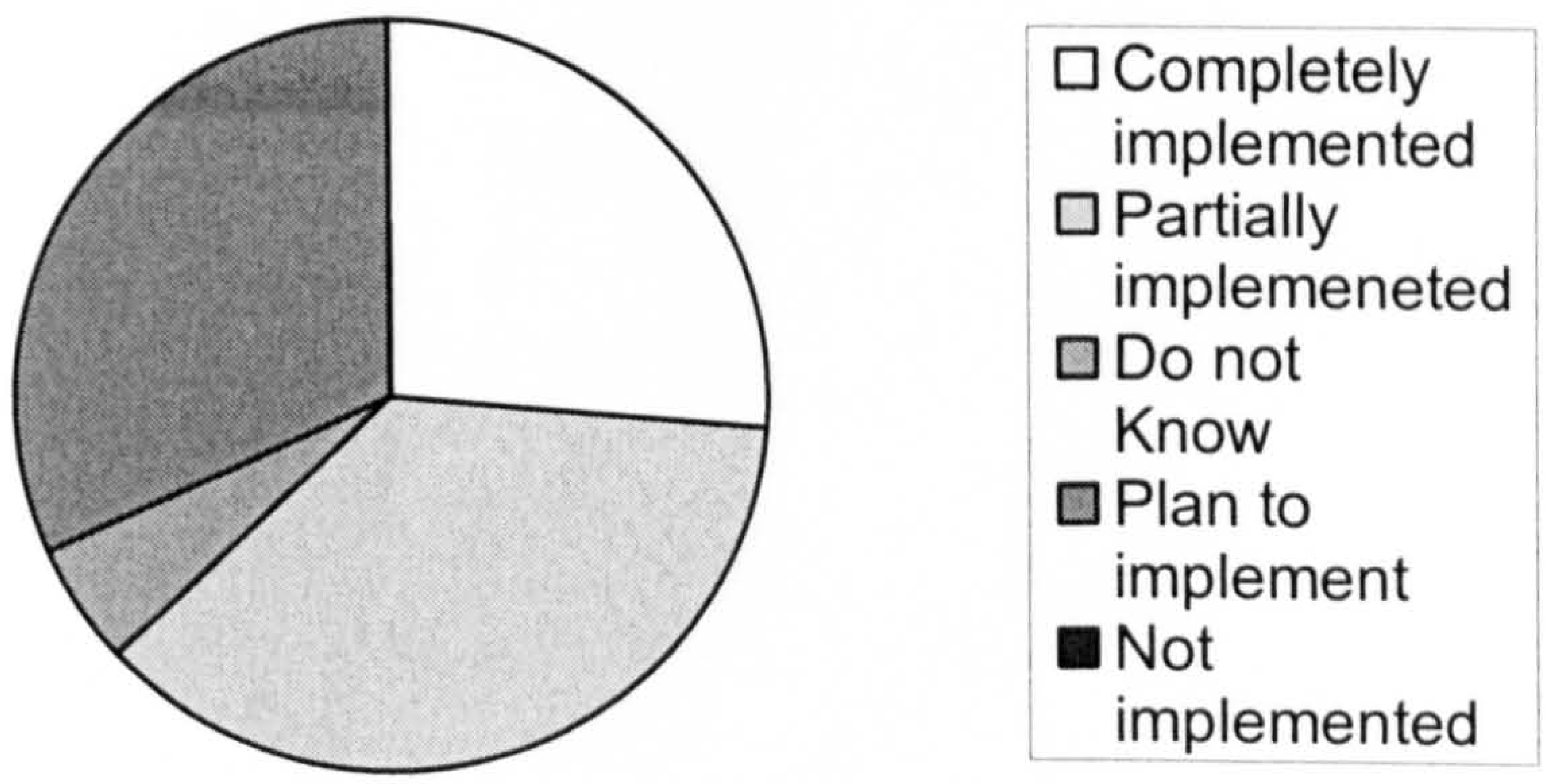




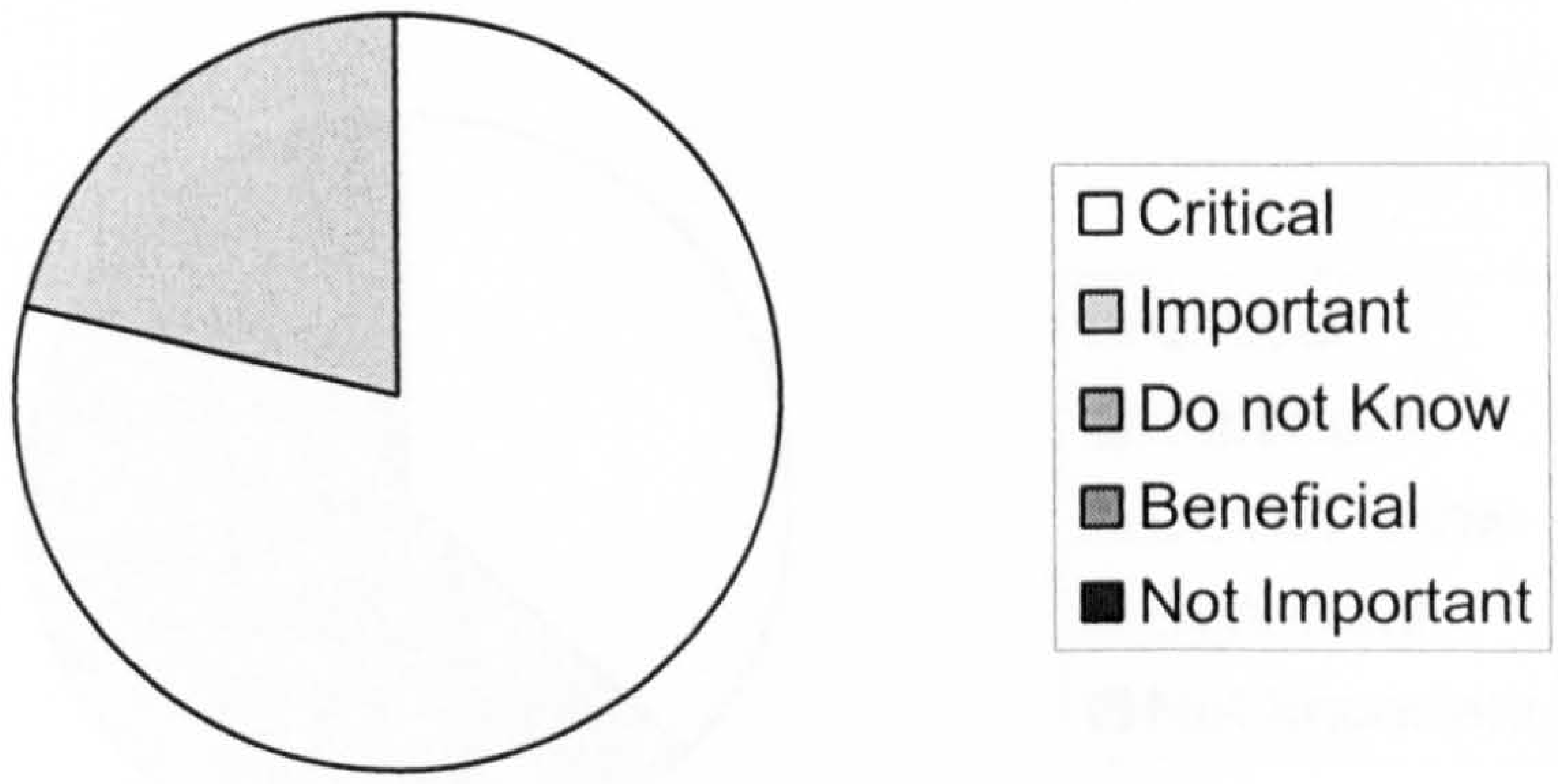
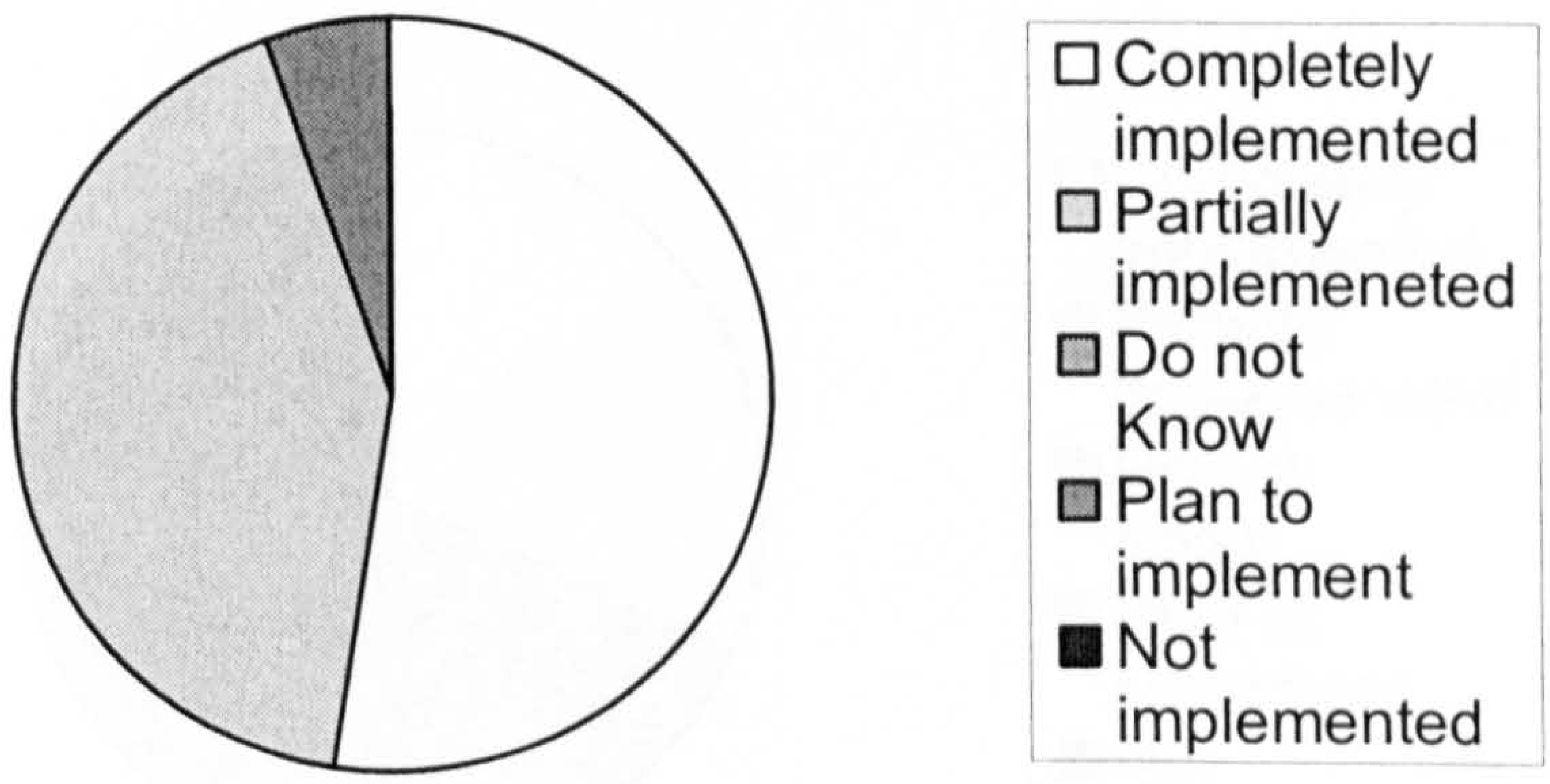
Finding: 84% of the respondents reported that it is critical or important that managers give considerable attention to forming teams. 11% reported that it is beneficial. On the other hand, 42% of the respondents reported that this is completely implemented, 37% partially implemented, and 16% plan to implement.

Question: E6. Everyone is willing to give advice or help on request to anyone else in the company.

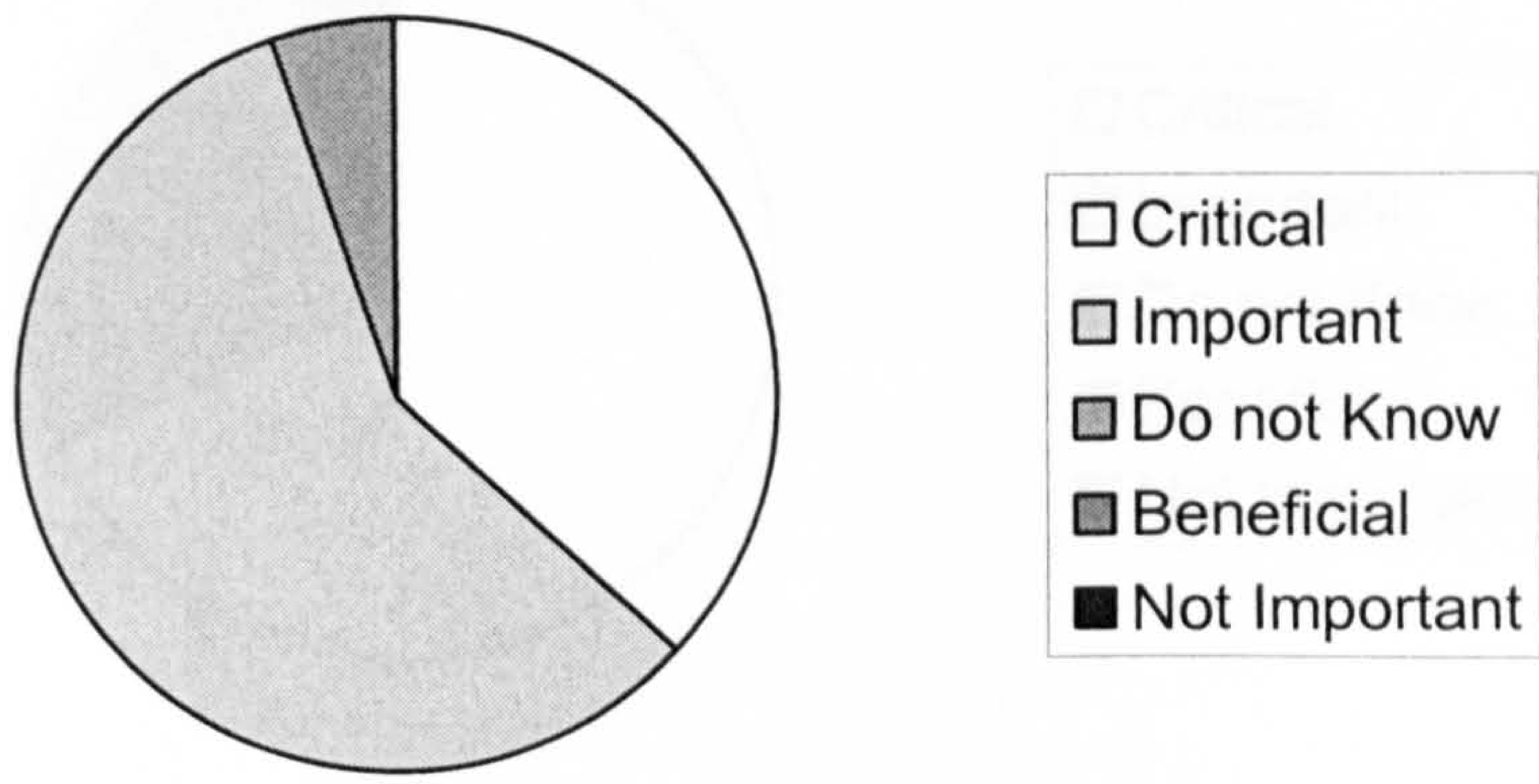


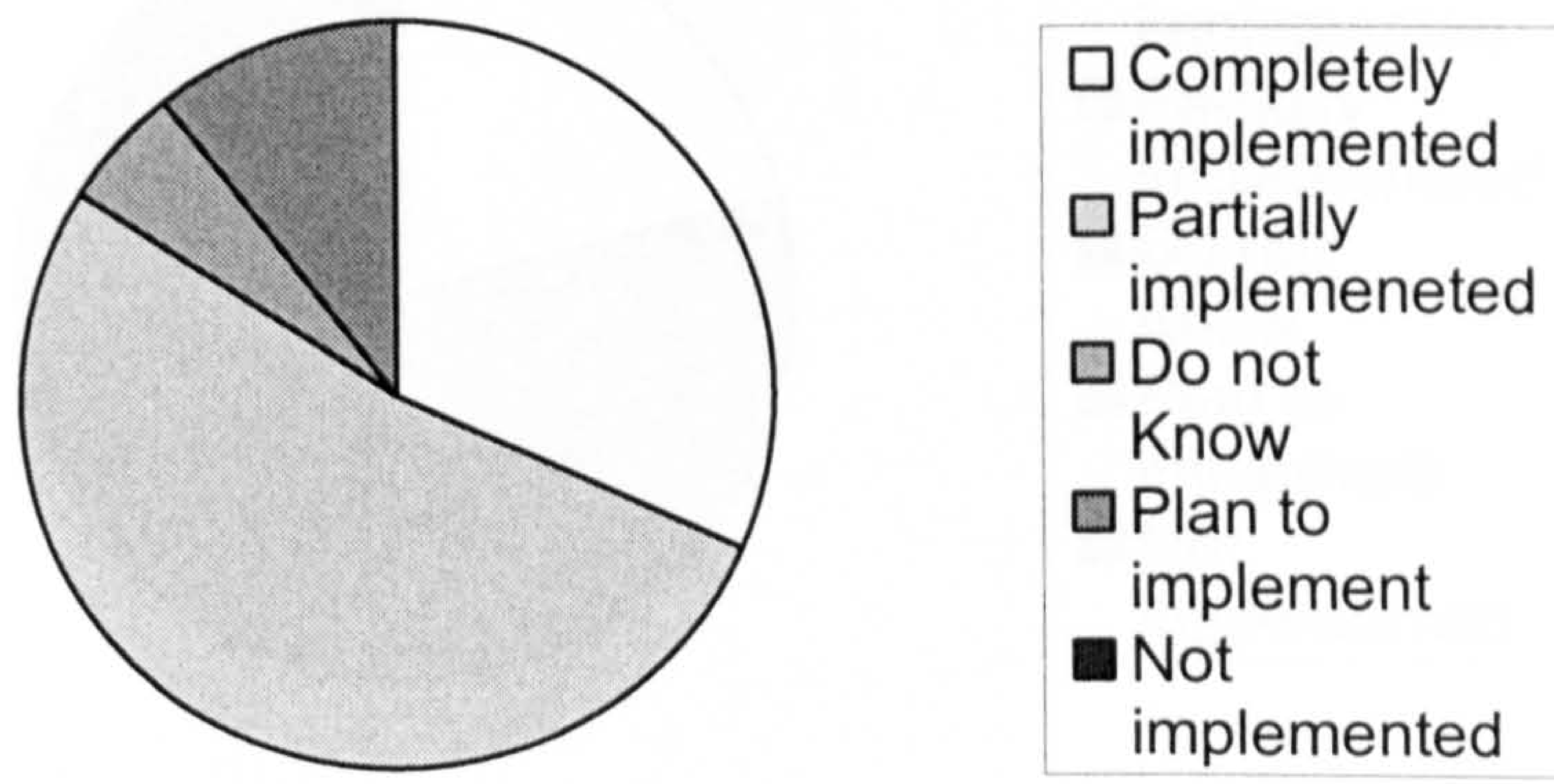


Finding: 79% of the respondents reported that it is critical that everyone is willing to give advice or help on request to anyone else in the company. The other 21% reported that this is important. On the other hand, 26% of the respondents reported that this is completely implemented, 37% partially implemented, and 32% plan to implement.

Question: E7. Training and development programs in KM behaviour and procedures are encouraged from recruitment onwards.
 
Finding: 100% of the respondents reported that it is critical or important to provide and encourage training and development programs in KM behaviour and procedures. On the other hand, 53% of the respondents reported that this is completely implemented, 42% partially implemented, and 5% plan to implement.

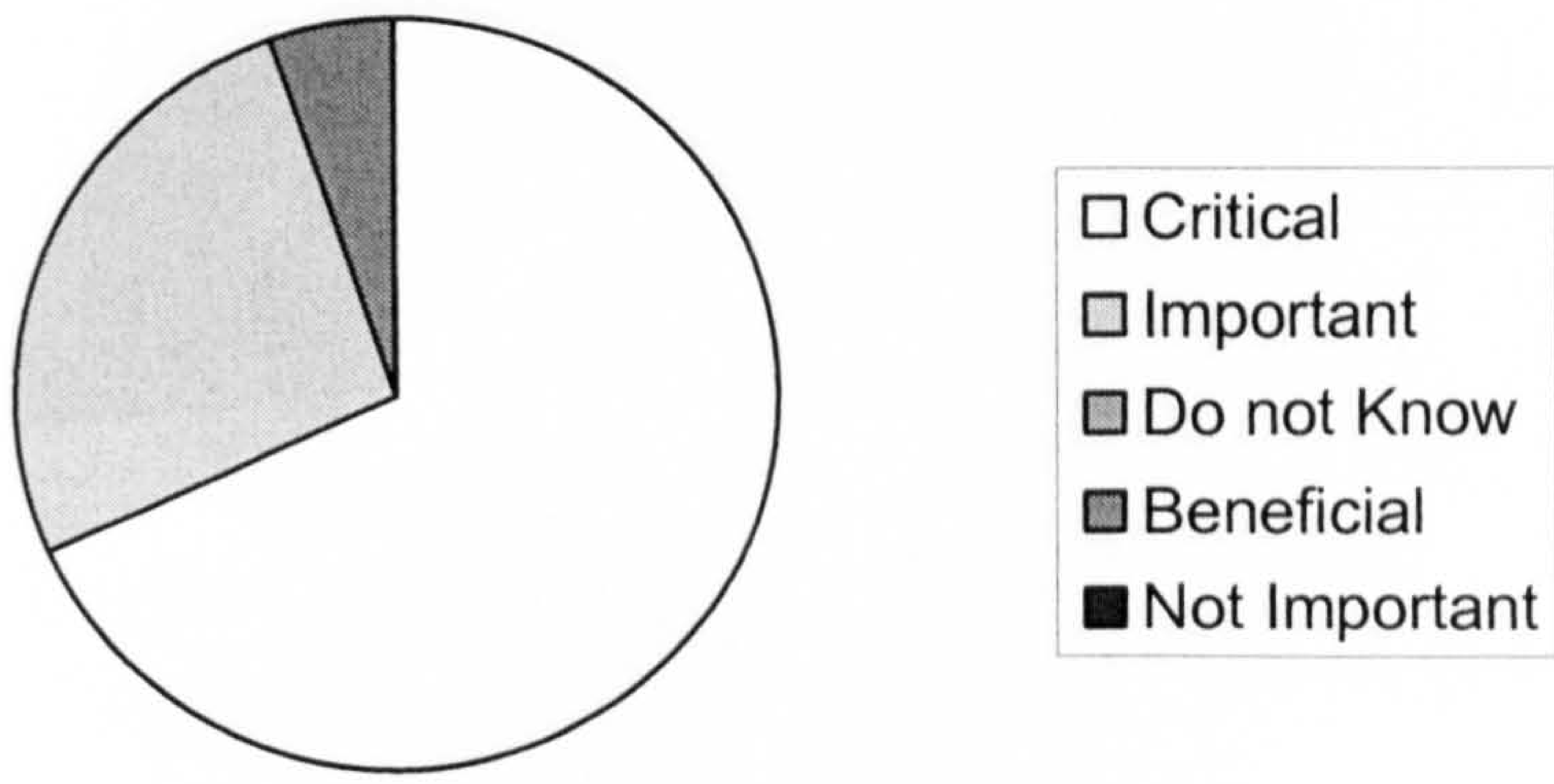
Question: <u>E8</u>. We have a number of people who are assigned the responsibility of ensuring that knowledge is transferred internally and externally.

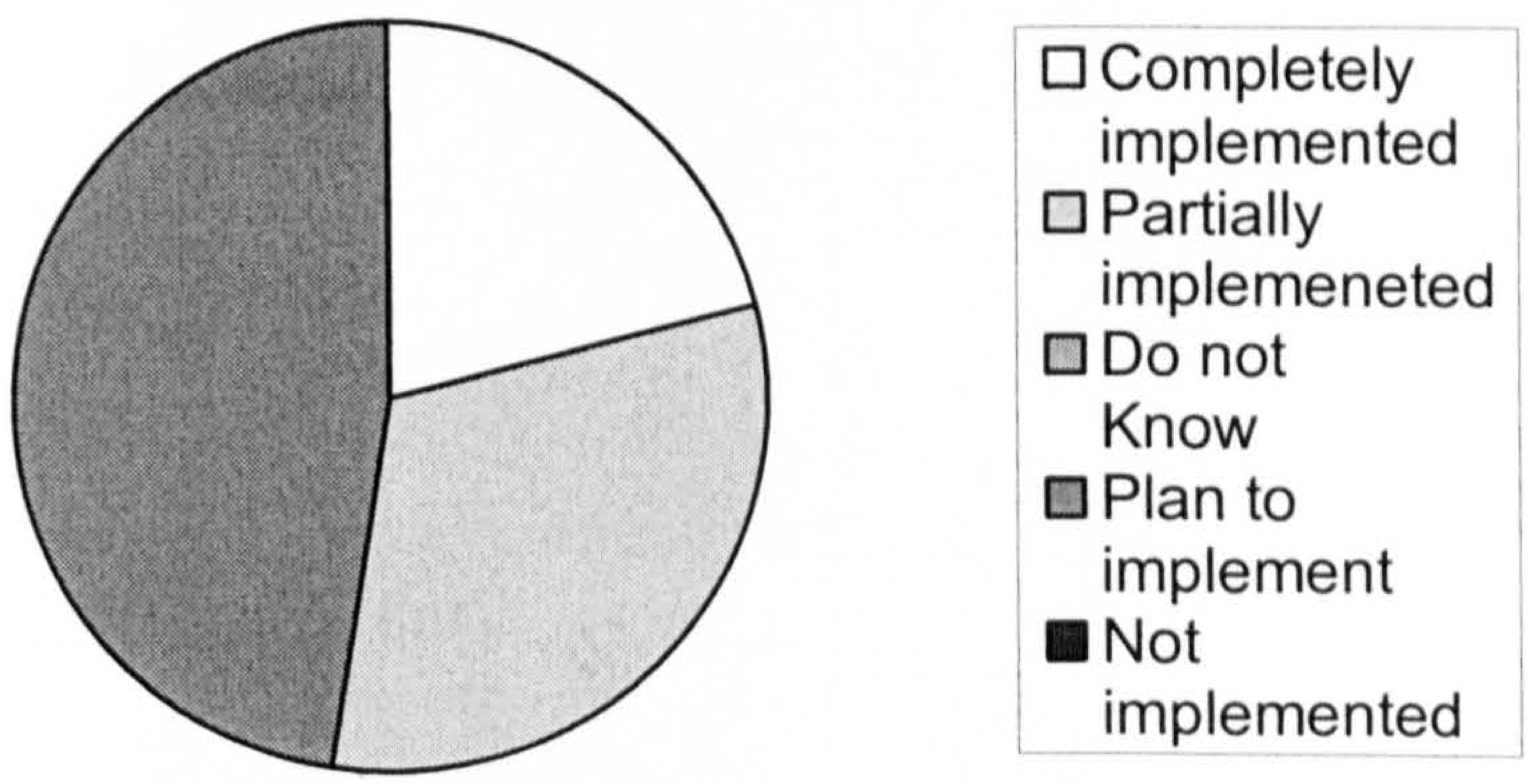




Finding: 95% of the respondents reported that it is critical or important to have people who are responsible to ensure transferring knowledge internally and externally. On the other hand, 32% of the respondents reported that this is completely implemented, 53% partially implemented, and 11% plan to implement.

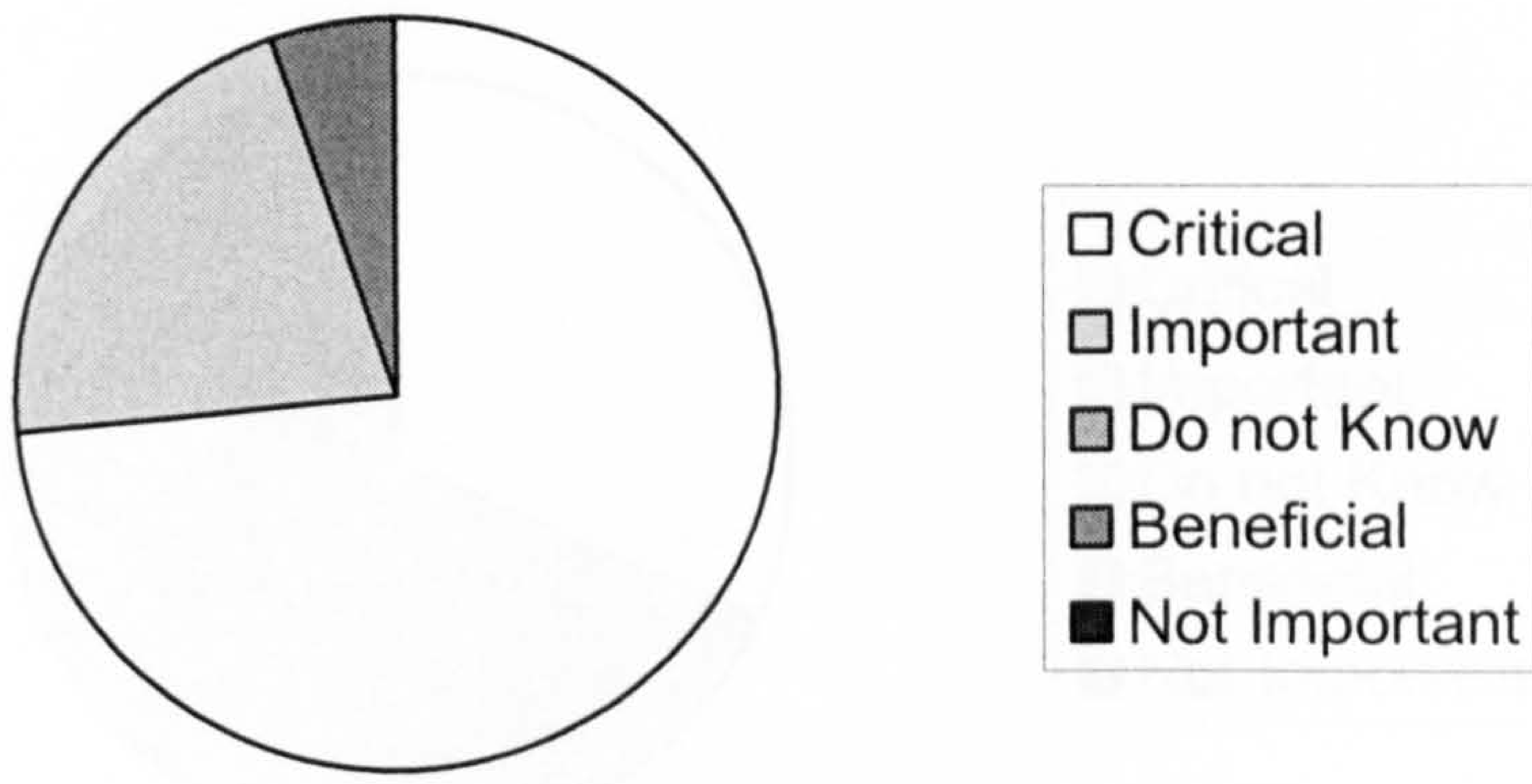
Question: <u>E9</u>. Specialized teams are assigned the responsibility of storing and maintaining knowledge.

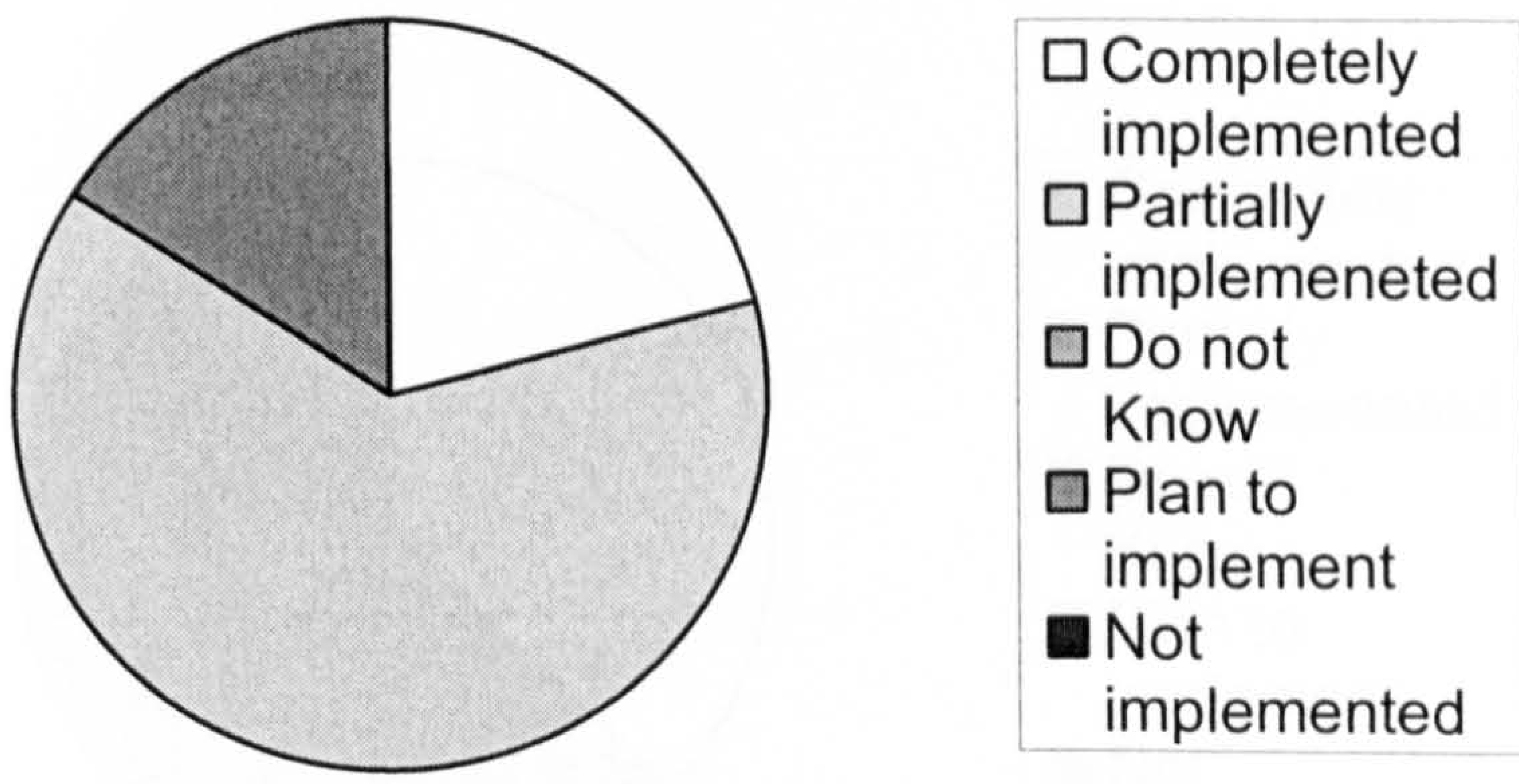




Finding: 95% of the respondents reported that it is critical or important to assign specialized teams the responsibility of storing and maintaining knowledge. The other 5% reported that this is beneficial. On the other hand, 21% of the respondents reported that this is completely implemented, 32% partially implemented, and 47% plan to implement.

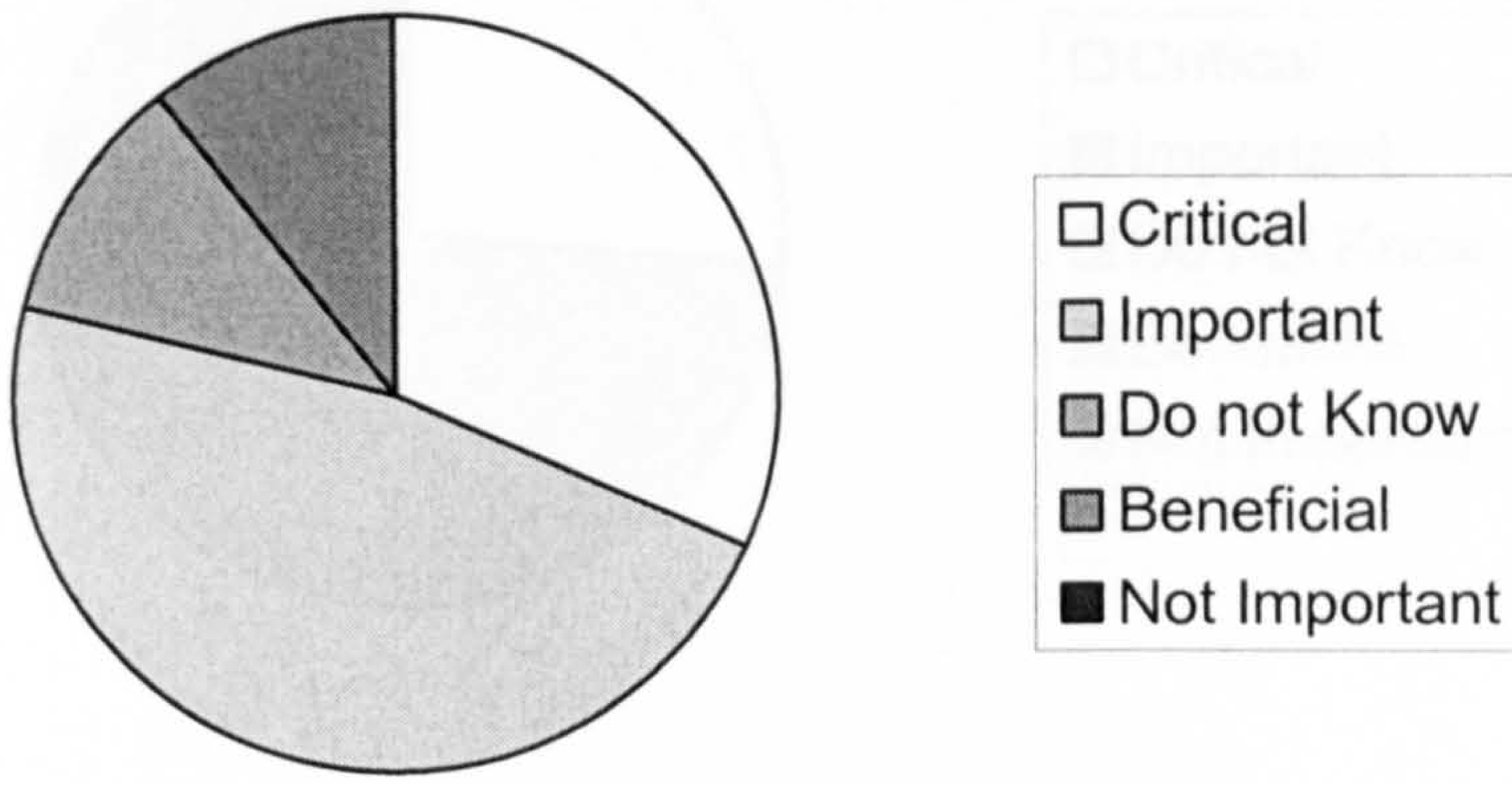
Question: F1. Technology is a key enabler in ensuring the right information is available to the right people at the right time.

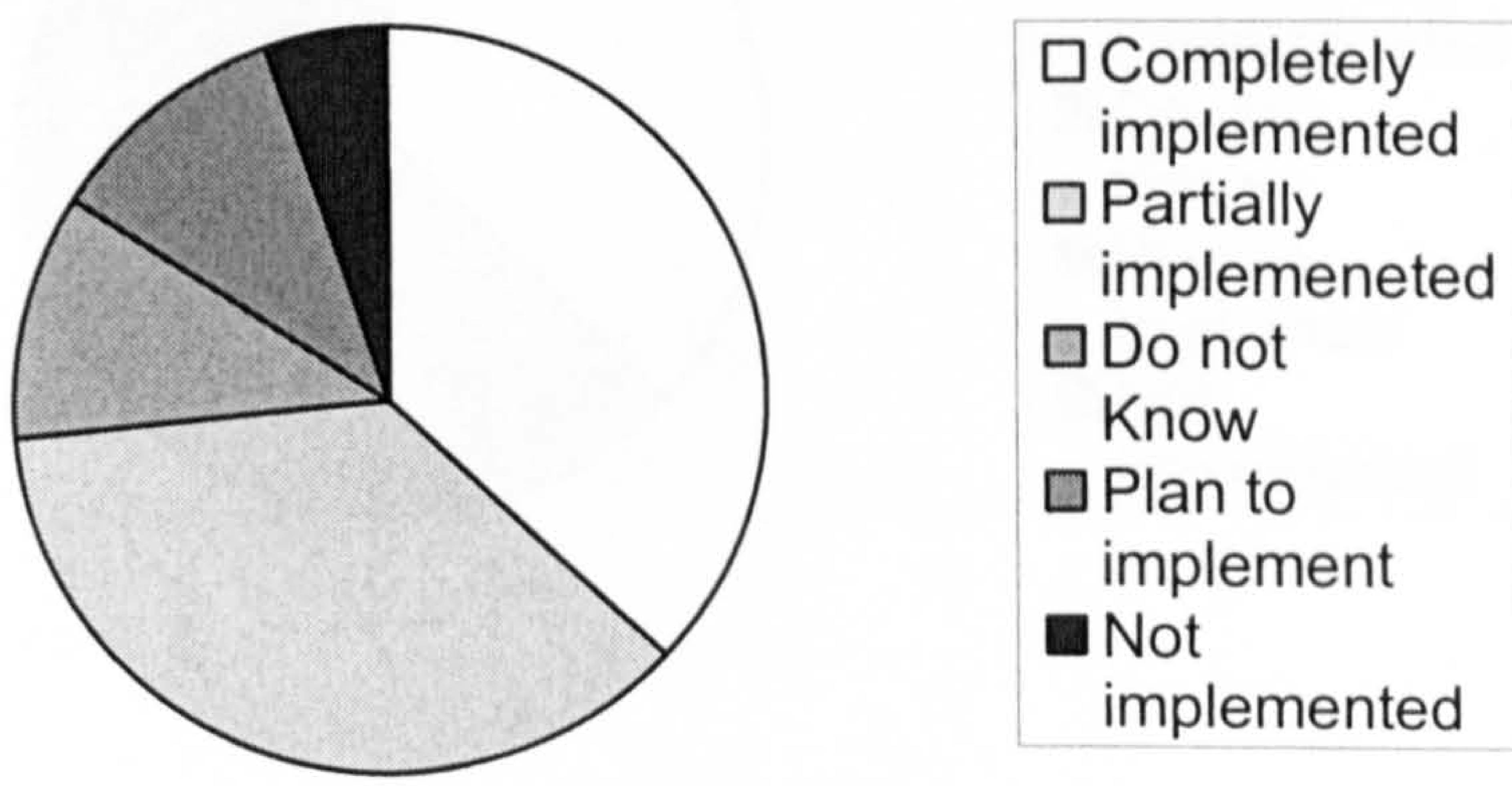




Finding: 95% of the respondents reported that it is critical or important for technology to be a key enabler in ensuring the right information is available to the right people at the right time. The other 5% reported that it is beneficial. On the other hand, 21% of the respondents reported that this is completely implemented, 53% partially implemented, and 16% plan to implement.

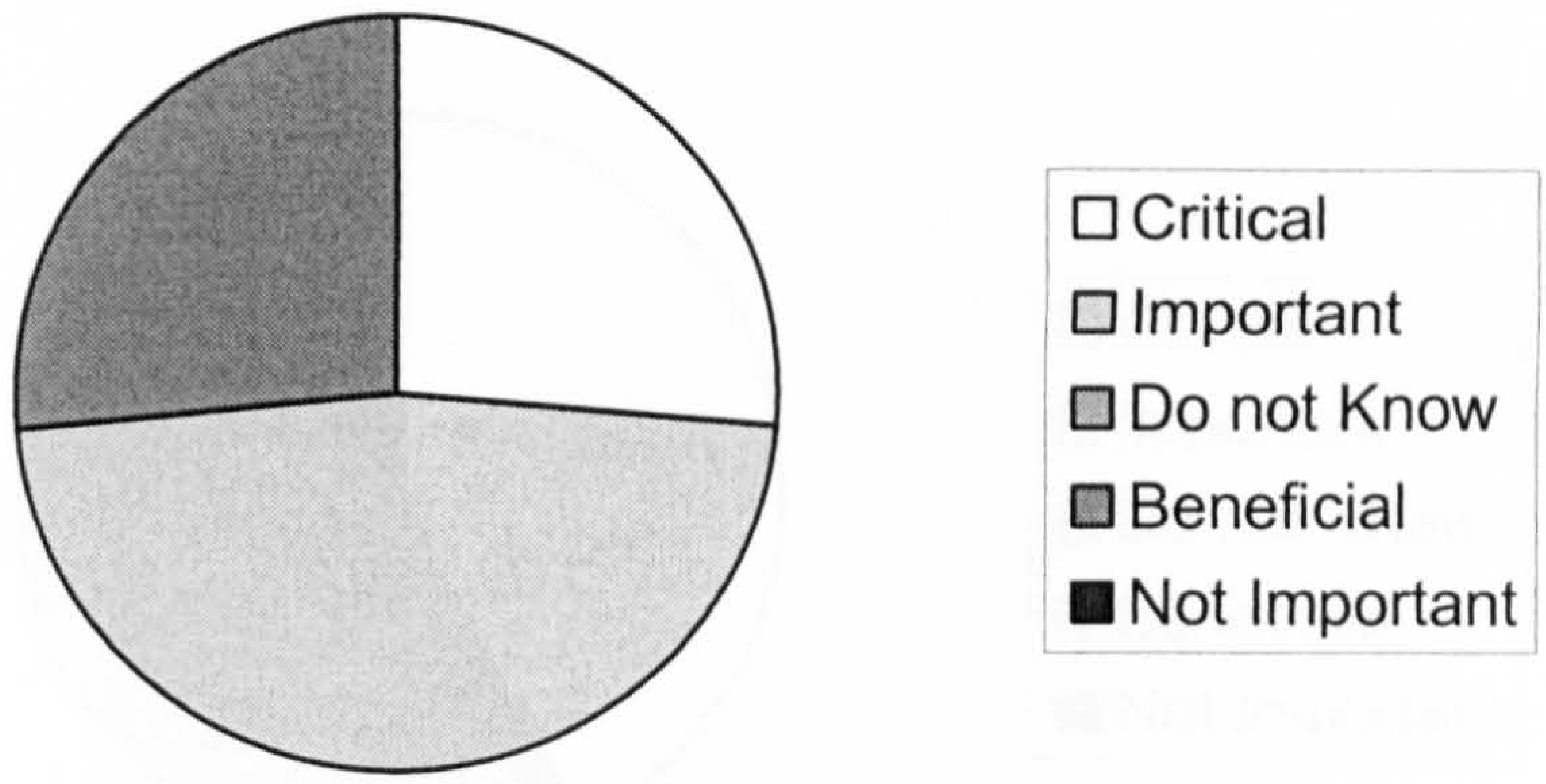
Question: F2. The information services team are constantly checking to ensure that our IT support our knowledge needs.

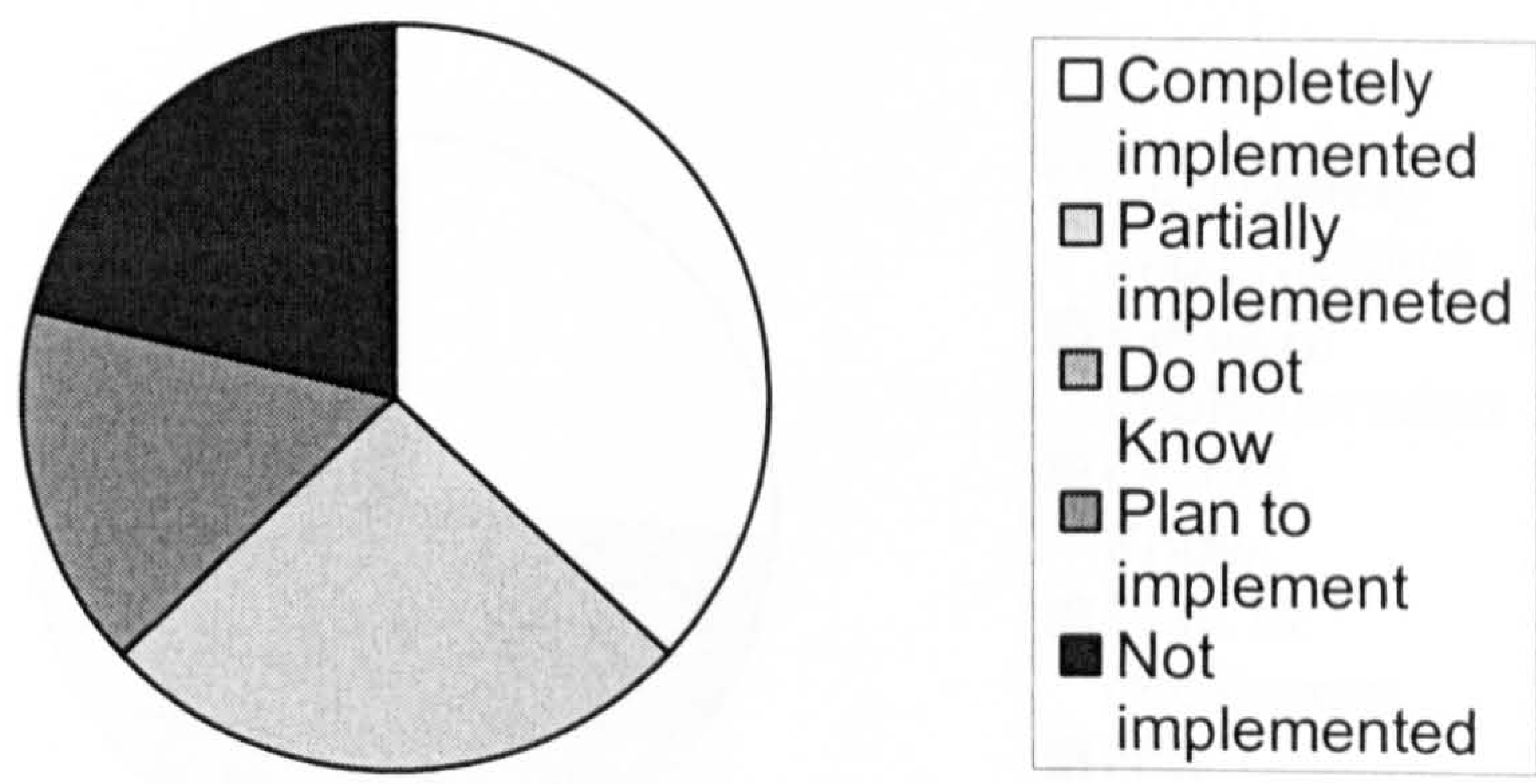




Finding: 79% of the respondents reported that it is critical or important to ensure that IT supports the organization's knowledge needs. 11% reported that it is beneficial. On the other hand, 37% of the respondents reported that this is completely implemented, 37% partially implemented, and 11% plan to implement.

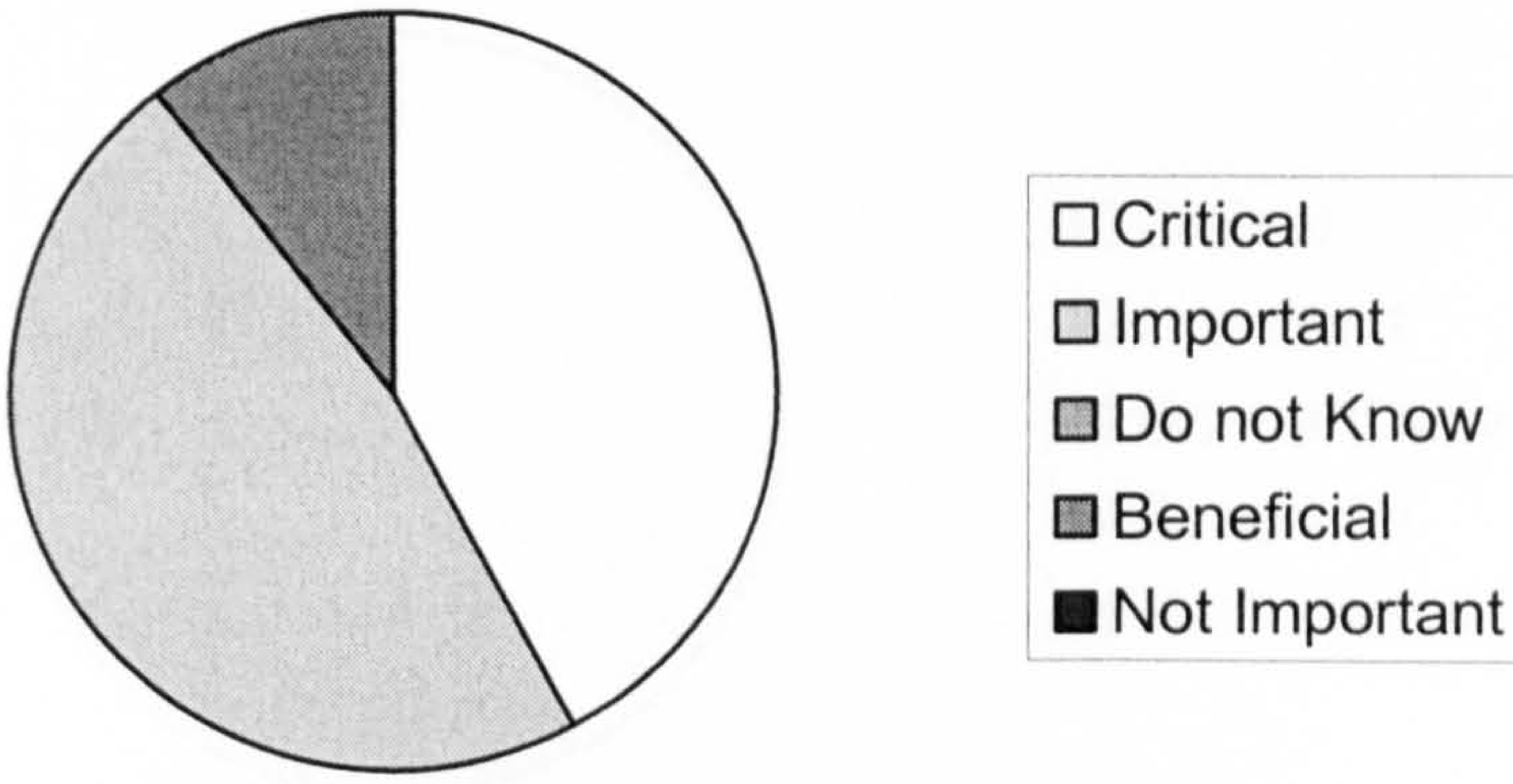
Question: F3. Internet and a local intranet are available to support KM.

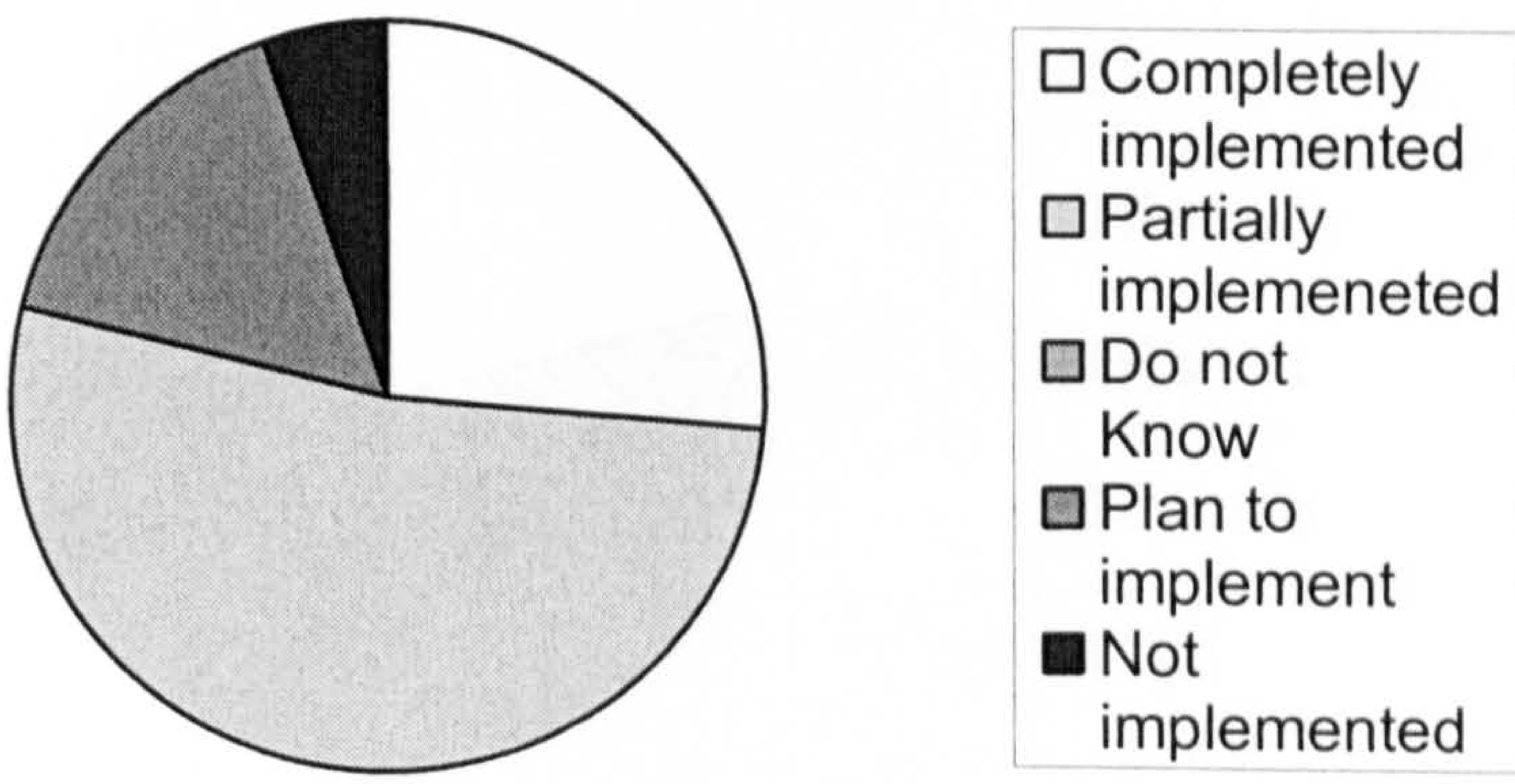




Finding: 74% of the respondents reported that it is critical or important to support KM with the Internet and a local intranet. The other 26% reported that it is beneficial. On the other hand, 37% of the respondents reported that this is completely implemented, 26% partially implemented, 16% plan to implement, and 21% not implemented.

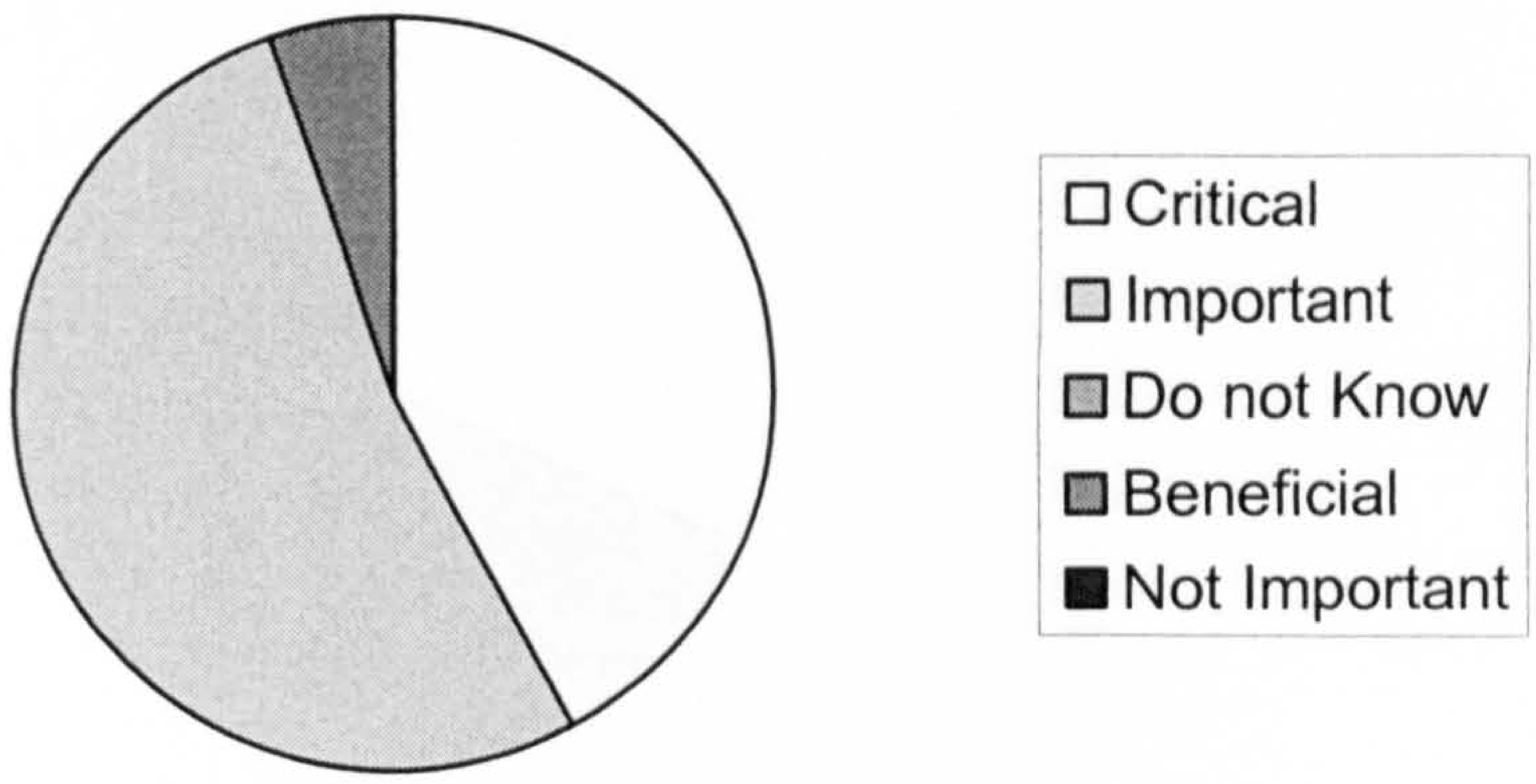
Question: F4. Organization policies, standards and manuals are stored in databases and made available to employees.

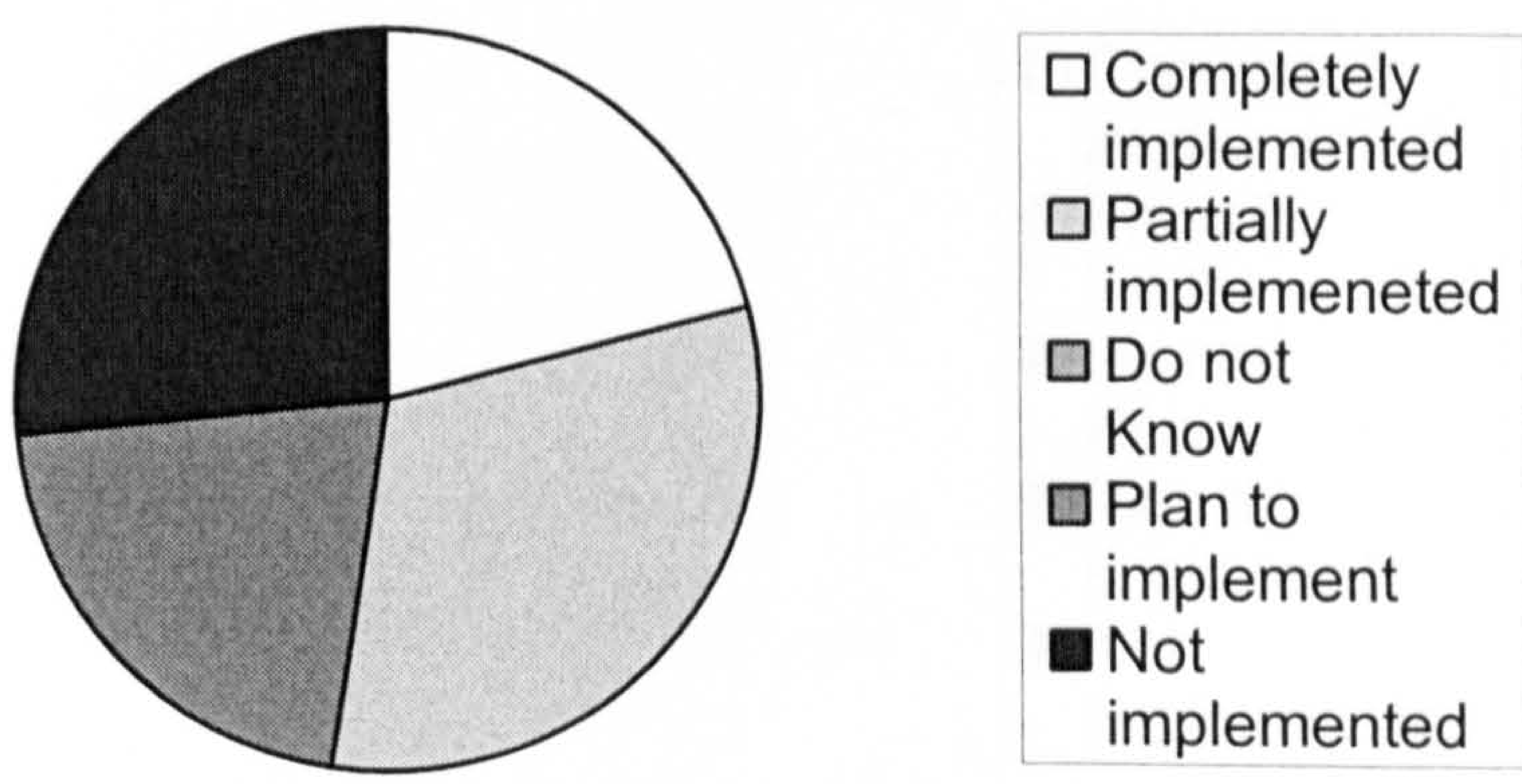




Finding: 90% of the respondents reported it that it is critical or important to have organizations' policies, standards, and manuals stored in databases and made available to employees. The other 10% reported that it is beneficial. On the other hand, 26% of the respondents reported that this is completely implemented, 53% partially implemented, 16% plan to implement, and 5% not implemented.

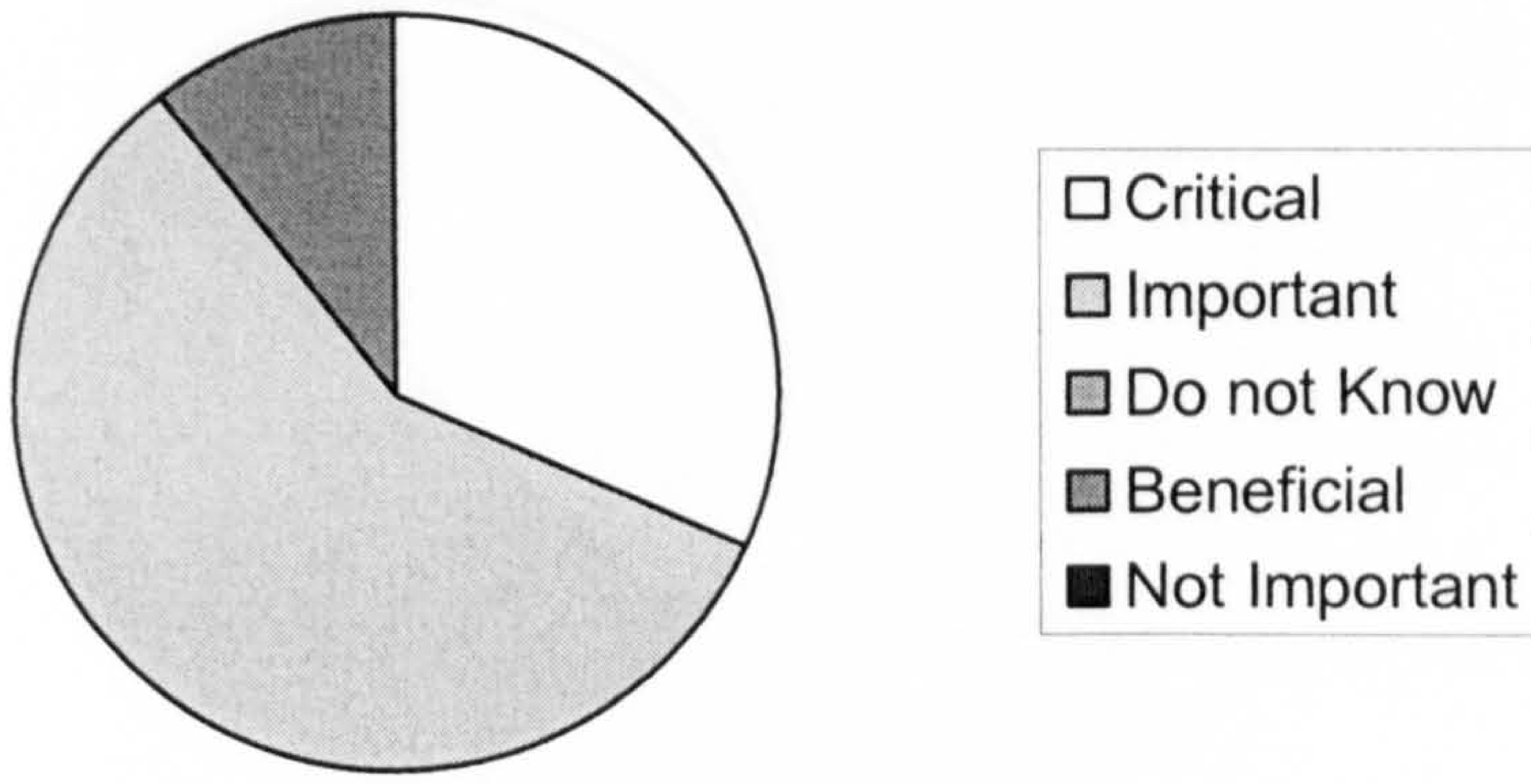
Question: F5. Procedures and lessons-learned from experience are documented and stored in databases.

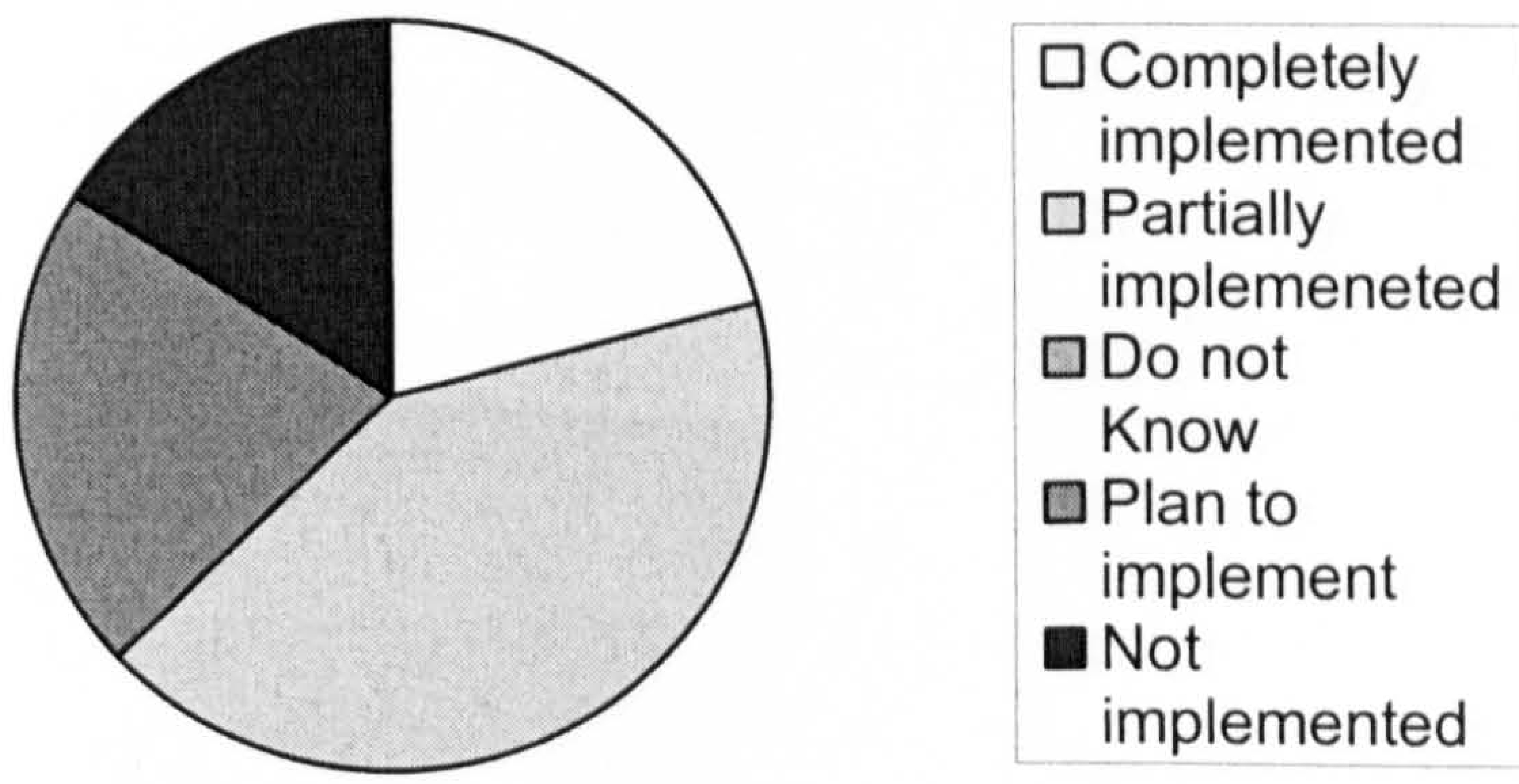




Finding: 95% of the respondents reported that it is critical or important to document and store procedures and lessons learned from experience in databases. As far as the current status in their organizations, respondents reported as follows: 21% completely implemented, 32% partially implemented, 21% plan to implement, and 26% not implemented.

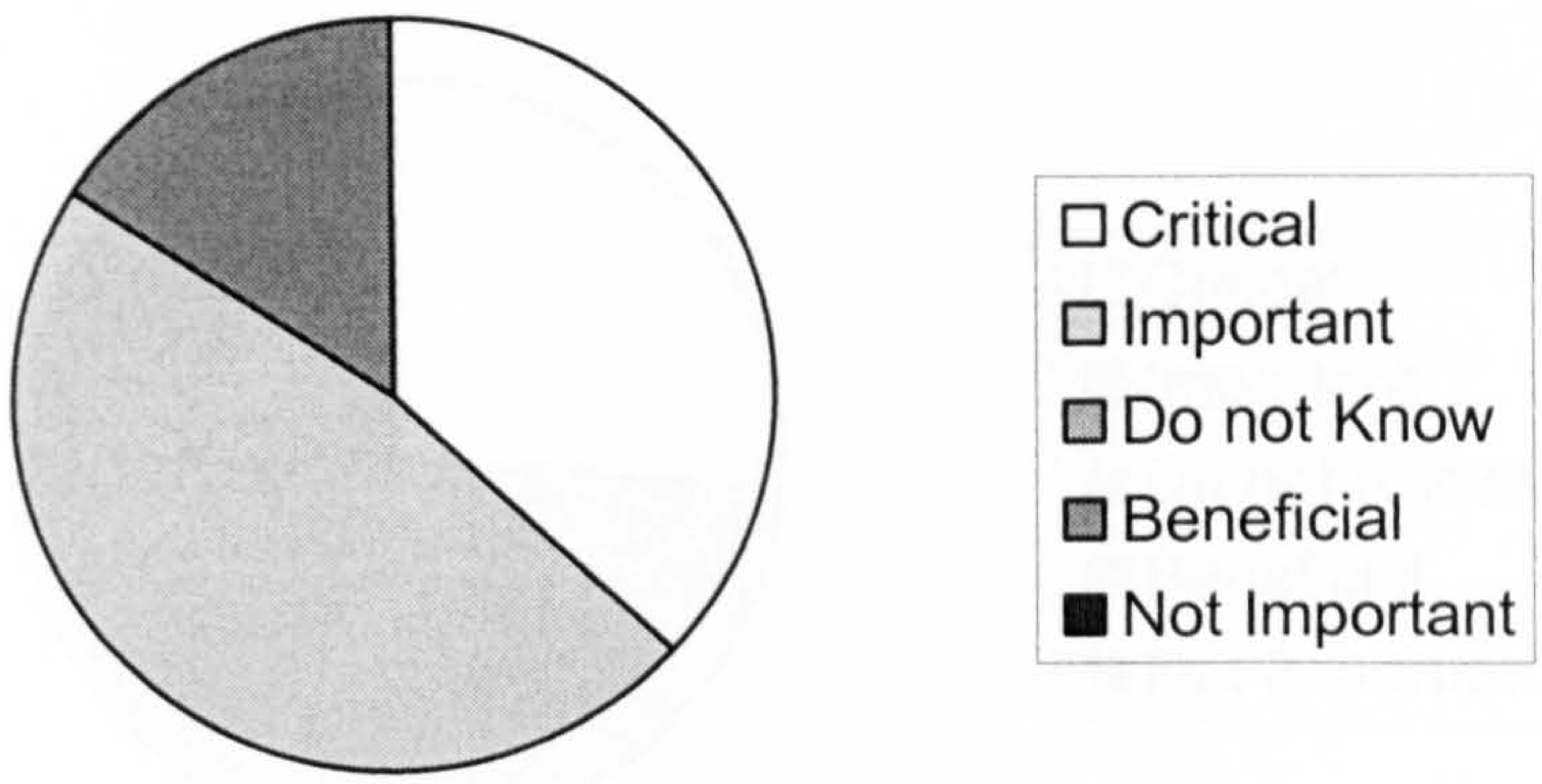
Question: **F6.** IT makes the search for information much easier. It is supported by search engines and document management systems.

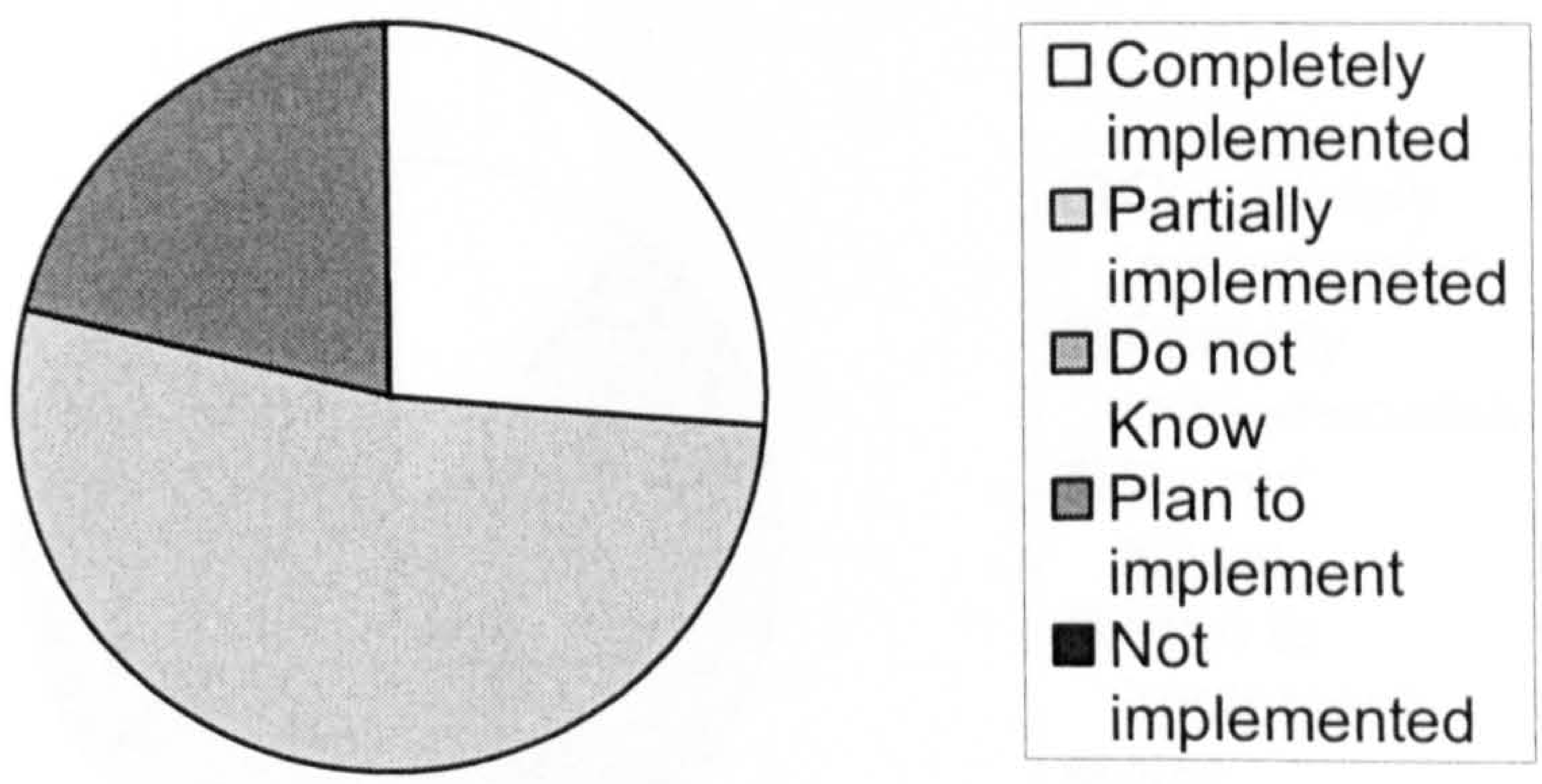




Finding: 89% of the respondents reported that it is critical or important for IT to make the search for knowledge easier. The other 11% reported that it is beneficial. As far as the current status in their organizations, respondents reported as follows: 21% completely implemented, 42% partially implemented, 21% plan to implement, and 16% not implemented.

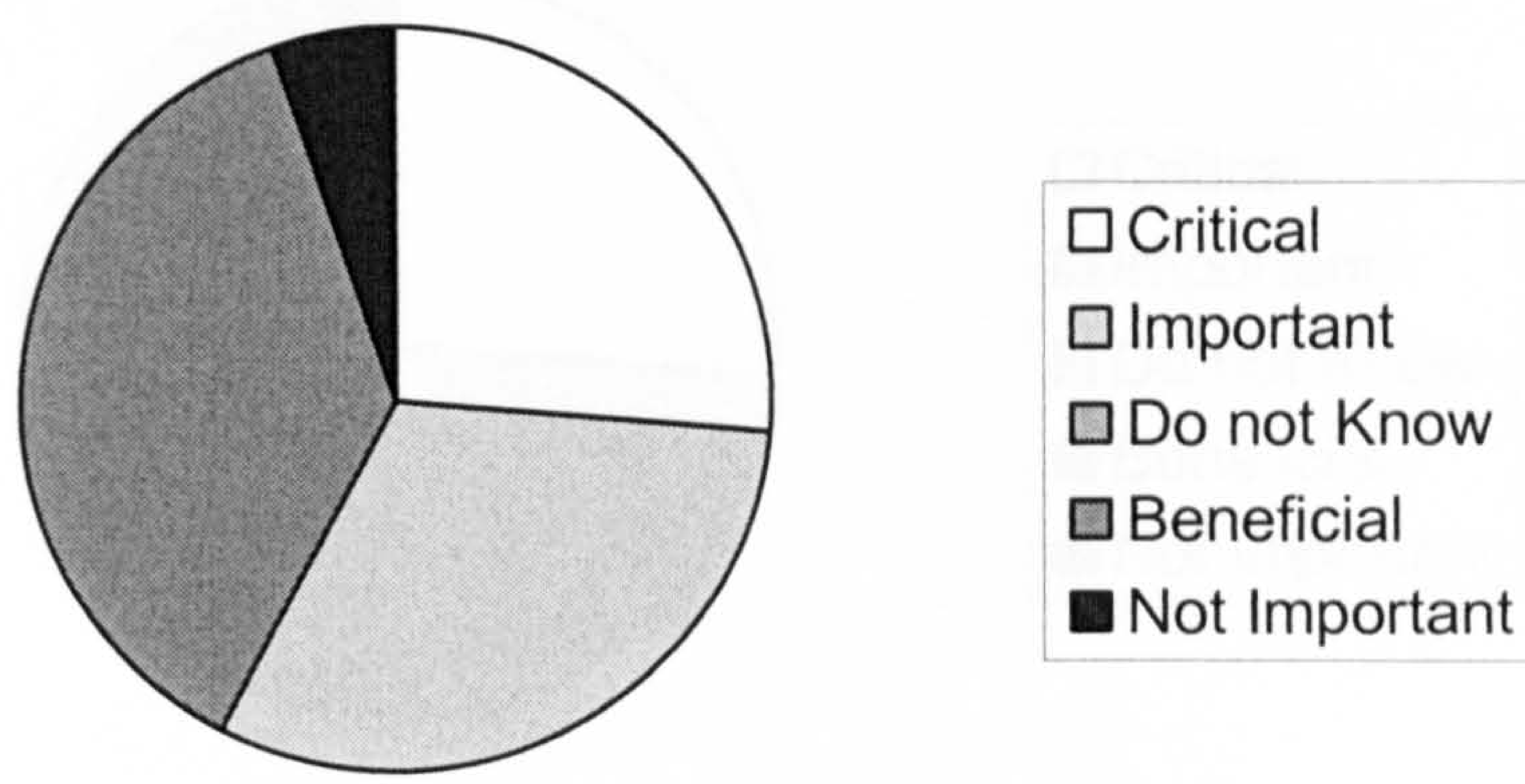
Question: F7. IT network is integrated with the specialized business software tools. For example, CAD/CAM and project management tools.

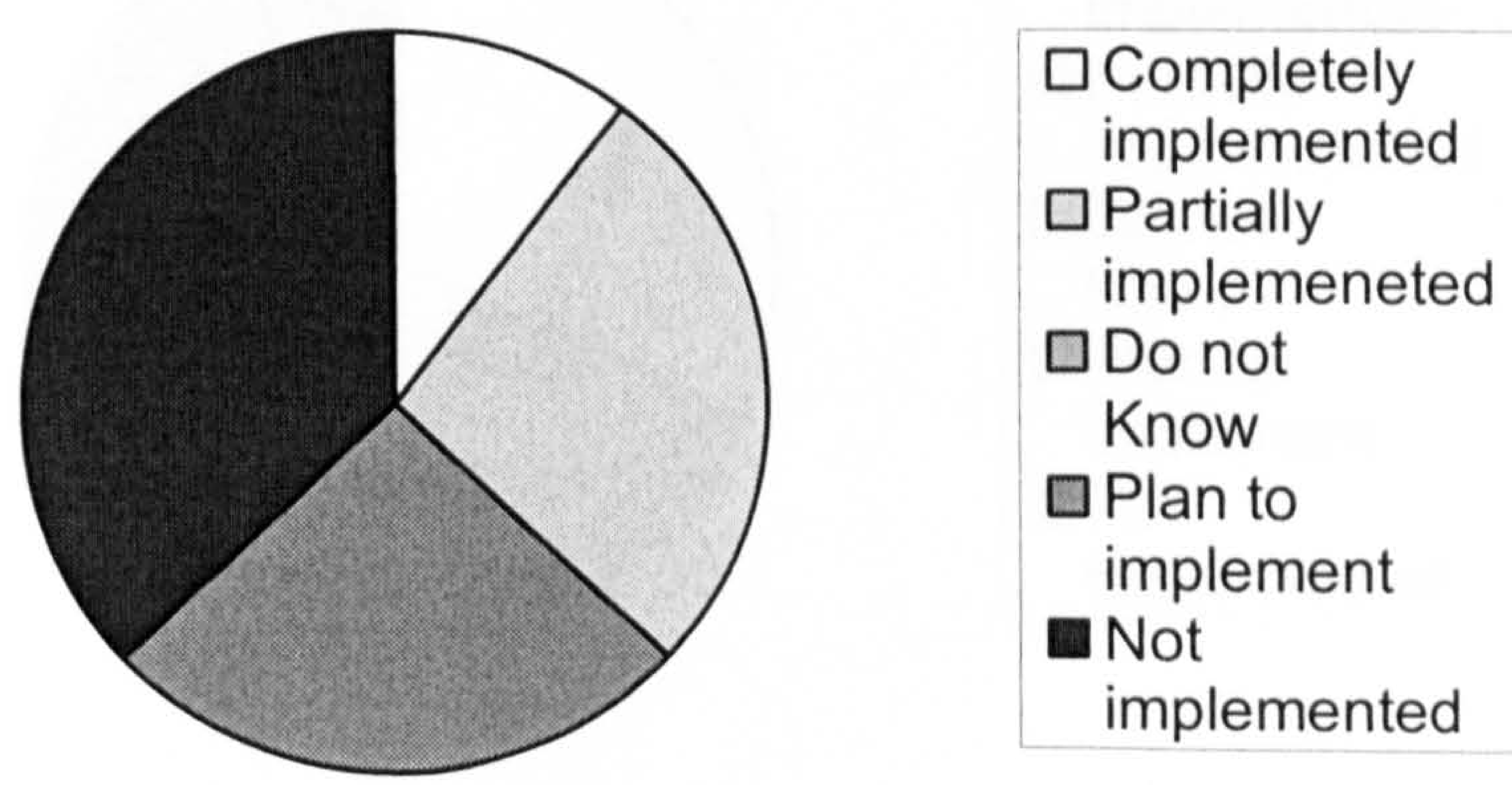




Finding: 84% of the respondents reported it that it is critical or important to integrate IT with specialized software tools. The other 16% reported that it is beneficial. On the other hand, 26% of the respondents reported that this is completely implemented, 53% partially implemented, and 21% plan to implement.

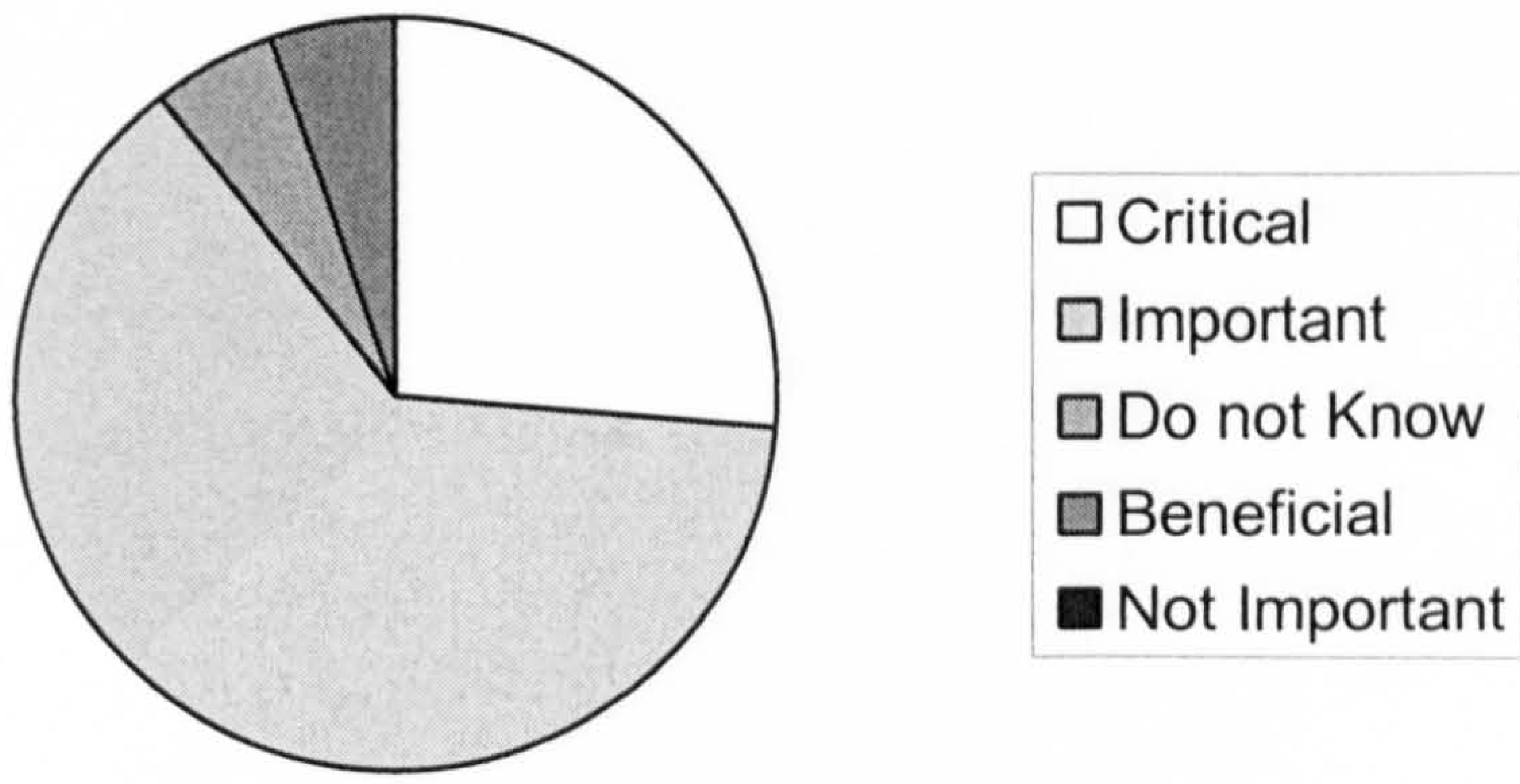
Question: F8. Modelling systems, decision support systems and artificial intelligence are in use.

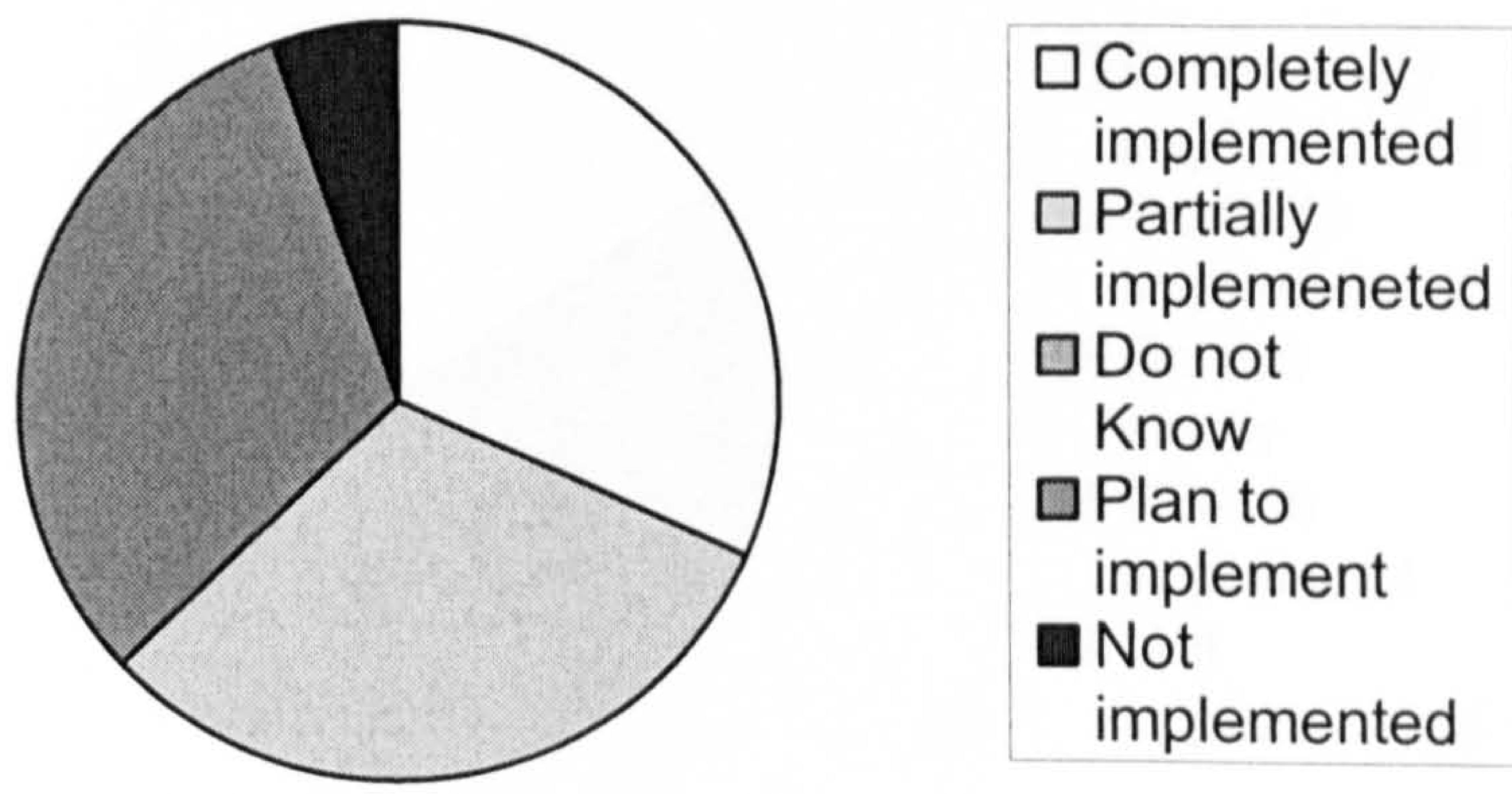




Finding: 59% of the respondents reported it that it is critical or important to use decision support systems and artificial intelligence. 37% reported that it is beneficial. On the other hand, 11% of the respondents reported that this is completely implemented, 21% partially implemented, 21% plan to implement, and 37% not implemented.

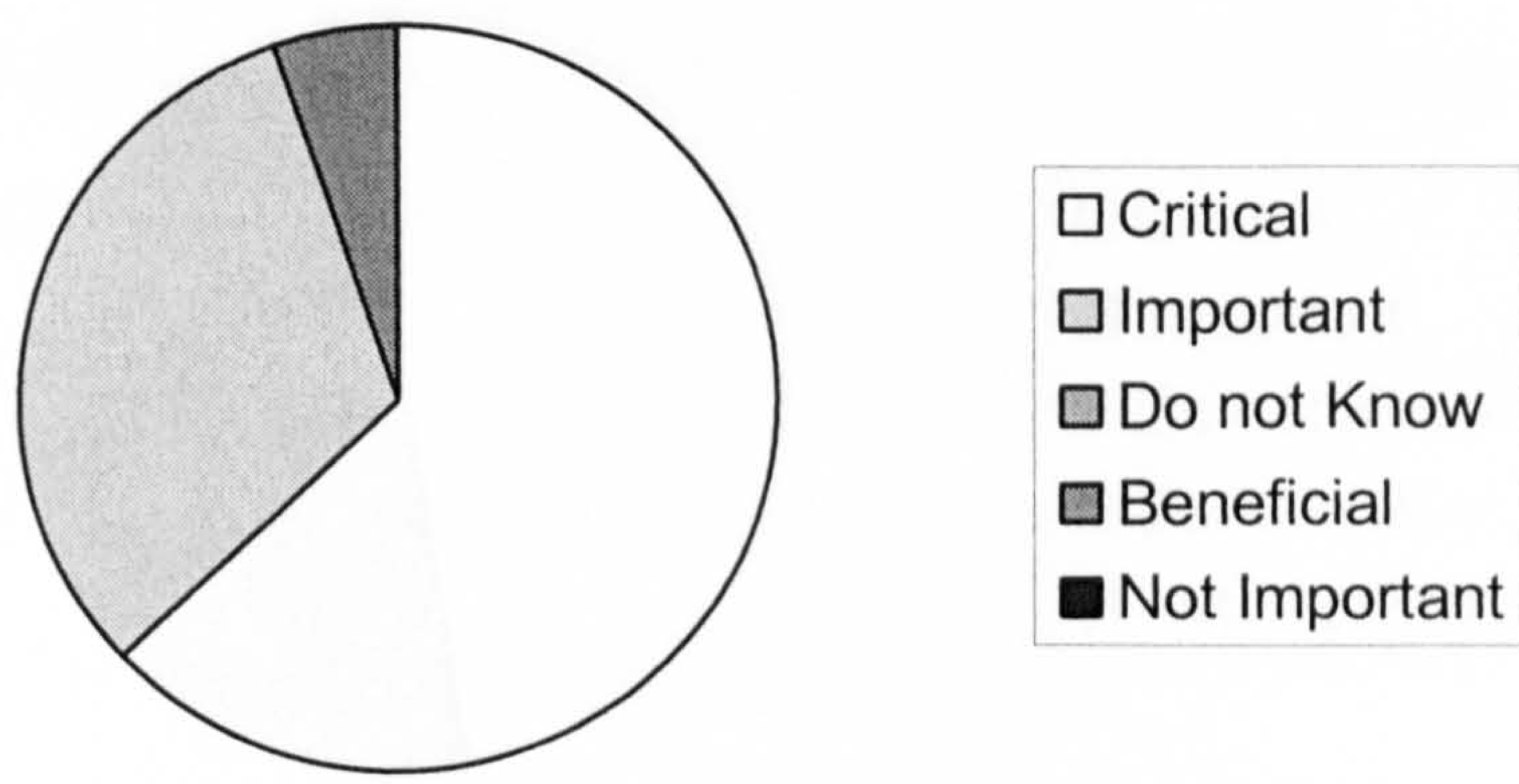
Question: F9. IT allows effective communication across boundaries and even time zones aided by massaging systems and conference tools.

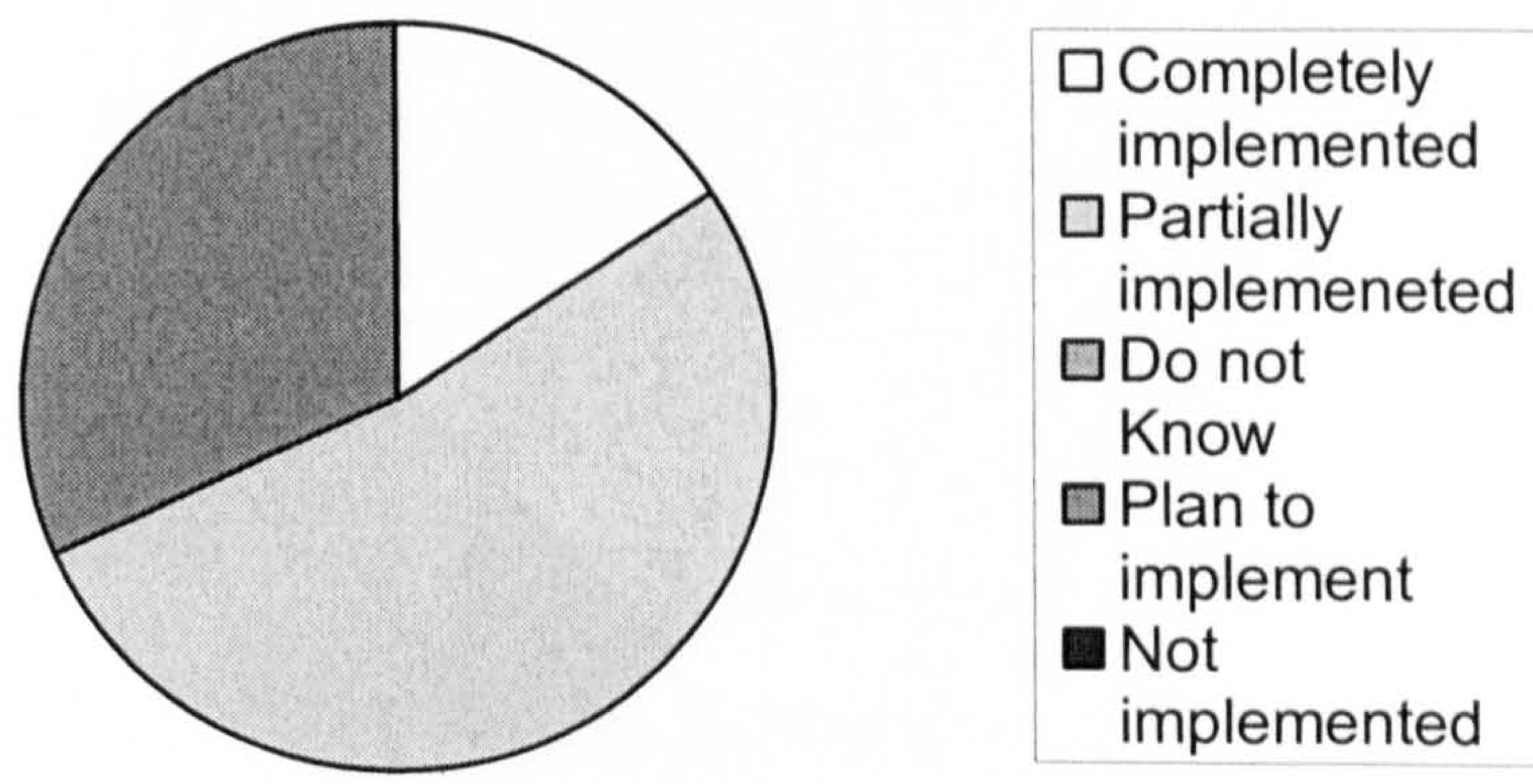




Finding: 90% of the respondents reported that it is critical or important to utilize IT such as massaging systems and conference tools, to allow effective communication across boundaries and time zones. 5% reported that it is beneficial. On the other hand, 32% of the respondents reported that this is completely implemented, 32% partially implemented, 32% plan to implement, and 5% not implemented.

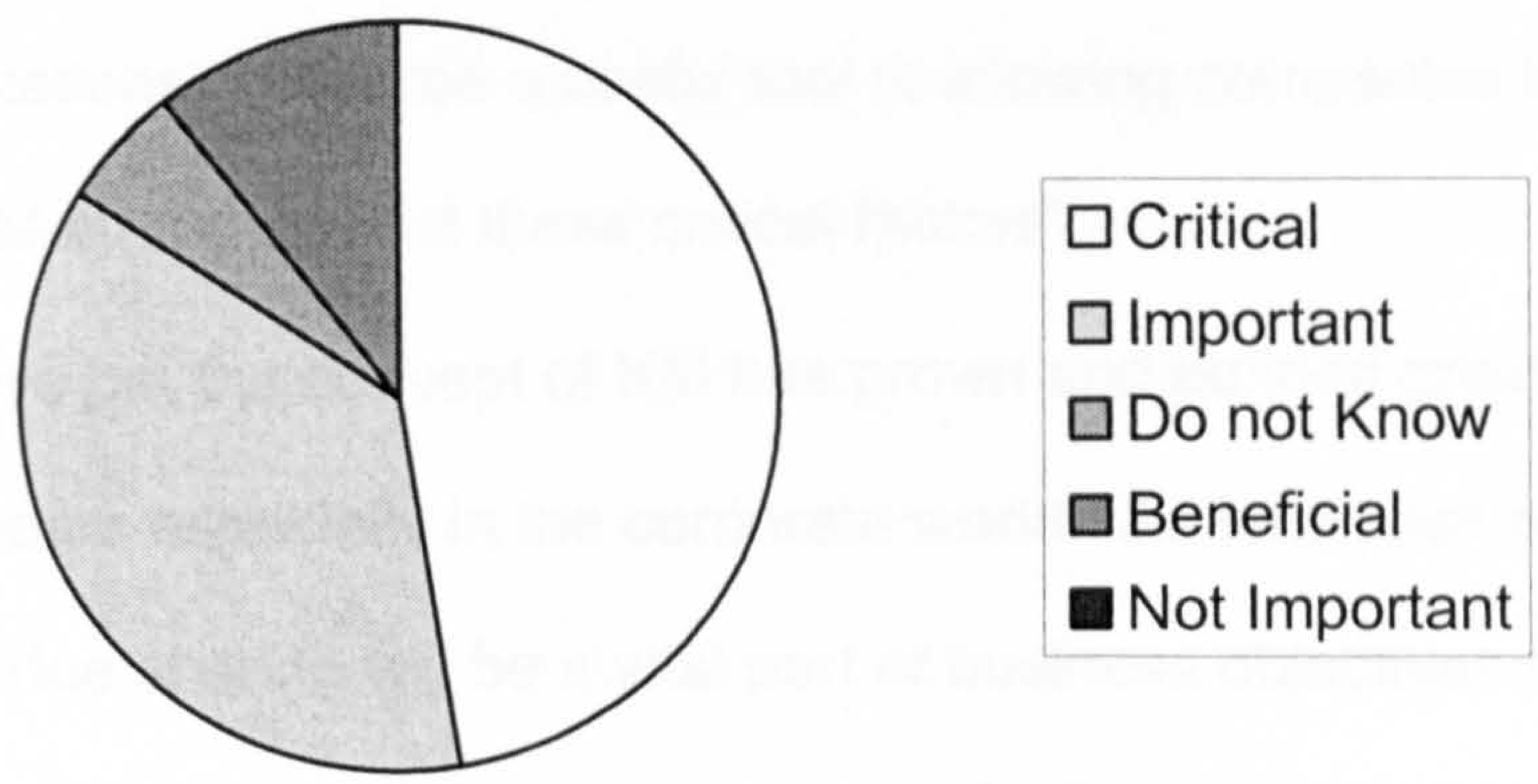
Question: F10. Directories of staff indicating their field of expertise and their contacts are available for easy identification.

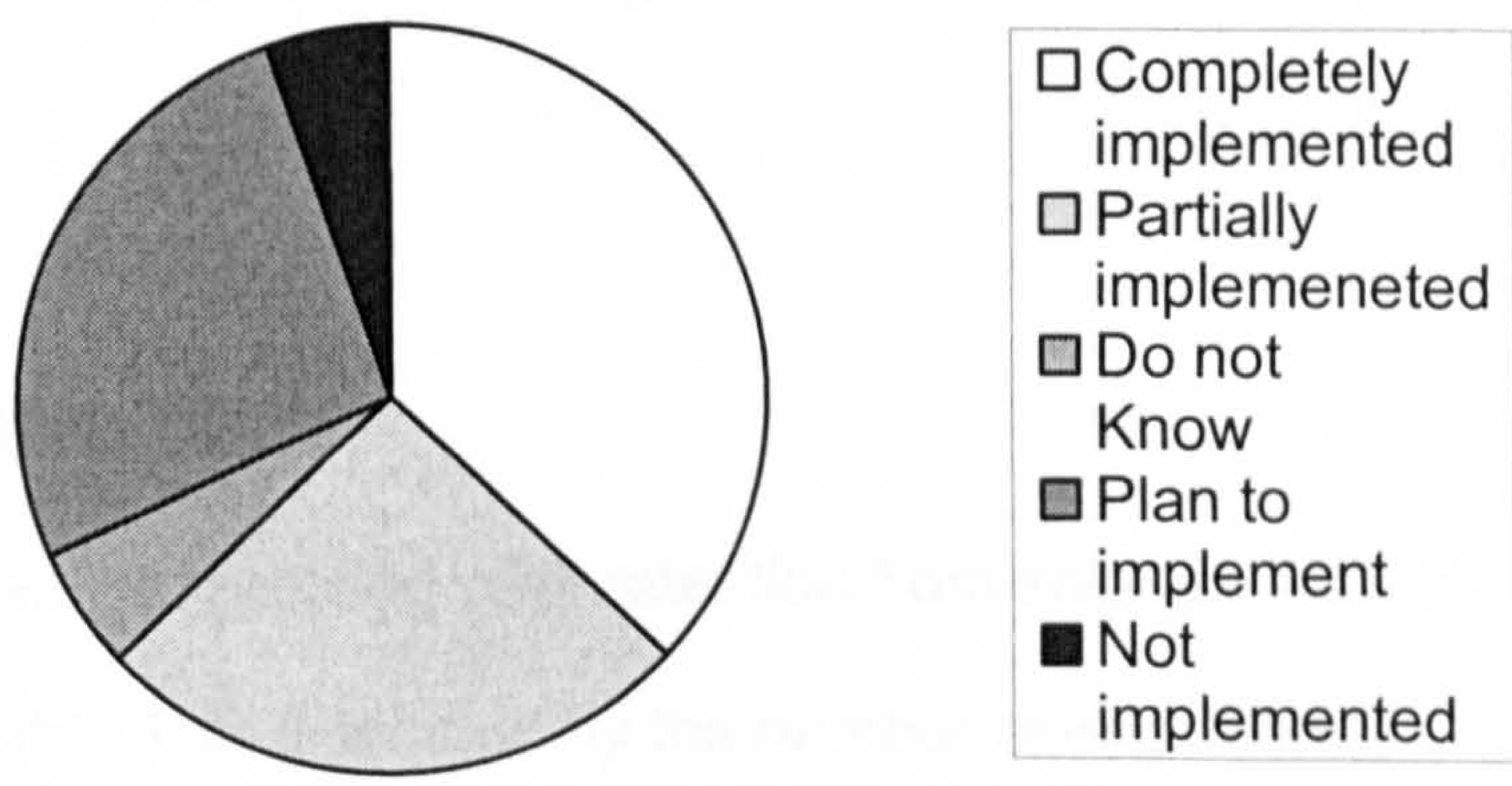




Finding: 95% of the respondents reported that it is critical or important to have directories of staff indicating their field of expertise and their contacts for easy identification. The other 5% reported that it is beneficial. On the other hand, 16% of the respondents reported that this is completely implemented, 53% partially implemented, and 32% plan to implement.

Question: F11. Our hardware and software are updated routinely without significant debate.





Finding: 84% of the respondents reported that it is critical or important to routinely update the organization's hardware and software. 11% reported that it is beneficial. On the other hand, 37% of the respondents reported that this is completely implemented, 26% partially implemented, 26% plan to implement, and 5% not implemented.

The following comments were also received form respondents in their completed KM questionnaires:

- "This questionnaire identifies critical factors that support KM in organizations. It can be a useful tool in allowing companies to compare their KM status against these critical factors".
- "I believe hat the concept of KM has grown and defined greatly in the last three years especially in the corporate world. As time pass by, KM and knowledge sharing will be a vital part of business objectives and practice. Technology will play an important role in facilitating and improving this concept for both managers and employees".
- "It will take more than technology to succeed in managing knowledge. This questionnaire outlines important factors that can aid in facilitating KM".

7.5 Discussion

It is clear that KM is receiving wide attention from engineering organizations around the world. This is evident by the number of engineering organizations which were identified for the purpose of the KM questionnaire. 426 engineering organizations which are involved with KM practice at different levels were identified in different countries around the world. Some of these organizations have a wide approach to KM with detailed KM strategy that produces detailed plans, KM officer at the management level, and a number of KM initiatives. Other organizations have a smaller and more limited approach to KM focusing on cretin elements such as people and technology.

The findings of the KM questionnaire which are presented in the previous section indicate a general agreement among practitioners in engineering organizations on the importance of the various factors described by the model and their role in facilitating KM. Managers agreed on the importance of developing KM awareness in organizations to succeed in managing knowledge which is in agreement with the experience of the KM team at BP, presented in Chapter 3, where the team first stage of implementing KM was to develop awareness among employees. However, most organizations reported that this is not completely achieved yet.

Managers recognized the importance of strategic management in facilitating KM which has recently been emphasized by researchers (McAdam, 2000; Meso et al., 2002; Shankar et al., 2003). They reported that it is critical or important to see KM as a vital element of business strategy and to recognize knowledge as the basis of a company's competitive advantage. It is also important to have defined responsibilities and a budget set for KM as well as key performance indicators for KM in place. On the other hand, most organizations reported that they are yet to completely implement a KM strategy.

It was also evident that there is a general agreement among respondents on the importance of having a knowledge friendly culture to facilitate KM. This is in line with the views of a number of researchers who have emphasized the important role of organizational culture in facilitating KM (Davenport, 1995; Scarbrough et al., 1999; Agresti, 2000; Meso and Smith, 2000; Bhatt, 2001). Such a culture is characterized by love, trust, discouraging holding of knowledge, encouraging sharing knowledge and providing the physical space to support knowledge development and sharing as well as rewarding team and knowledge sharing. Based on the responses received, it is apparent that more organizations are trying to create such a knowledge friendly culture. Additionally, there is an agreement that a flat organizational structure can be important or beneficial to supporting KM.

The responses also indicated a general agreement among respondents on the important role of managers in facilitating KM. This is in the form of management commitment to support knowledge sharing, learning and other KM desired behaviours as well as motivating, mentoring, and motivating employees. Additionally, respondents reported that it is important to assign specialized teams the responsibility of storing and maintaining knowledge. This was seen to be effective in the cases of Ollco and Compco presented in Chapter 6.

It was also agreed that KM is important for seeking best practices and reusing existing projects and knowledge. Additionally, technology, both hardware and software, was recognized as a main enabler in facilitating the management of both tacit and explicit knowledge as well as improving communication. This has been long argued in the literature by researchers and practitioners (Ruggles, 1997; Frappaolo, 1998; Wiig, 1999a; Davenport and Prusak, 2000; Chourides et al., 2003).

As far as the current status in the organizations is concerned, the findings indicate that individual organizations have strong as well as week elements. It is apparent that in general not all the key factors that are considered important by the organizations to ensure success in managing their knowledge are being completely and effectively developed to support and enhance KM. A knowledge gap seems to exist in most of the organizations. Finally, some of the managers have suggested that the KM questionnaire is a useful tool in identifying KM key factors and can be used as a starting point to towards successfully implementing KM.

7.6 Summary

This chapter introduced the questionnaire used in this research to further validate and generalize the proposed "SCPTS" three-layer KM model. A description of the development of the questionnaire as well as the survey conduction method was presented. The Chapter then introduced details of the KM questionnaire and its findings. The KM questionnaire investigated the responses of managers in engineering organizations regarding the importance of the elements described by the model as well as the current status in their organizations. The findings indicate a general agreement among practitioners on the importance of the various factors described by the model and their role in facilitating KM. The findings also indicate that organizations seem to have strong as well as week elements facilitating KM.

CHAPTER 8

SUMMARY AND CONCLUSIONS

8.1 Introduction

This chapter presents an overall summary of this study along with the major conclusions and findings. It also presents the contributions of the research. The Chapter then provides a methodology for implementing the proposed KM model. It also outlines future research directions, which have emerged from this study.

8.2 Summary

In this age of international markets and increased worldwide competition, many companies are looking for new ways to gain and keep competitive advantage. In doing this they will try to use their intellectual capital to the full (Winch, 1999). KM is an emerging discipline that promises to capitalize on organizations' intellectual capital. In recent years, knowledge management has become a critical subject of discussion in the business literature. Both business and academic communities believe that by leveraging knowledge, an organization can sustain its long-term competitive advantages (Bhatt, 2001). KM deals with the process of creating value from an organization's intangible assets. These assets, or knowledge, can be classified as either tacit or explicit, explicit knowledge is that which have been codified and expressed in formal language (Nonaka, 1991, 1994). It can be easily represented, stored, shared, and effectively applied. Tacit knowledge is knowledge that is difficult to express, represent, and communicate (Nonaka, 1991, 1994). The distinction between types of knowledge is relevant because each type must be managed differently.

Knowledge management is still a young field with almost as many definitions to the term than there are approaches or "schools" of authors contributing to the field. These definitions of KM are arising form differently focused studies (Shankar et al., 2003). However, most working definitions in the literature point to fundamentally the common idea that KM incorporates facilitating the process of identifying, capturing, developing, distributing, and effectively using both tacit and explicit knowledge within an organization to achieve its business objectives.

Researchers and academics have taken different perspectives on KM, ranging from technological solutions to cultural approaches and the use of communities of practice. However, more recently an increased number of researchers have recognized and propagated the need for an interaction between the various approaches for successful implementation of KM, and a "socio-technical" approach emerged (Offsey, 1997; Meso and Smith, 2000; Bollinger and Smith, 2001; Koch, 2003; Chourides et al., 2003; Shankar et al., 2003; Maier and Remus, 2003). In spite of this theoretical dispute, there are already a large number of KM activities implemented in organizations.

Engineering organizations embrace vast amounts of knowledge in various areas that are critical to achieve business goals, such as knowledge related to product development and process integration. Managing this knowledge effectively can help engineering organizations in deceasing production time and cost, increasing quality, making better decisions as well as improve organizations' performance and provide a competitive advantage (Rus and Lindvall, 2002; Shankar et al., 2003; Koch, 2002, 2003; Disterer, 2002; Lytras and Pouloudi, 2003; Szymczak and Walker, 2003). Realizing the potential of KM, engineering organizations led the way in KM initiatives. Although some engineering organizations such as Booz Allen, Buckman Labs, and BP reported early KM success (Lucier and Torsilieri, 2001), other organizations have tried and failed to implement KM (Scarbrough and Swan, 1999). These failures have been linked to the lack of a generally accepted framework and methodology to guide successful implementation of KM in organizations (Rubenstein et al., 2001a, 2001b; Beckman, 1998; Maier and Remus, 2003).

A number of KM frameworks and methodologies have been suggested in the literature to provide organizations with guidance and direction of how KM should be done (Chase, 2000; Wiig, 1999b; Wiig et al., 1997; Junnakar, 1999; Dataware Technologies, 1998; Xerox cooperation, 1999; Liebowitz, 1999; Rubenstein et al., 2001b). However, many of these frameworks and methodologies have been criticized in the literature for suffering shortcomings; hence, there is neither a universally accepted KM framework nor methodology (Rubenstein et al., 2001a, 2001b; Beckman, 1998; Maier and Remus, 2003).

To contribute to the resolution of the shortcomings in the frameworks and methodologies supporting KM implementation, this study introduced a novel model for the successful implementation of KM in engineering organizations which integrates the various approaches to KM and the key factors affecting its implementation. The "SCPTS" three-layer KM model provides a framework that identifies the different types of knowledge available in engineering organizations, the KM life-cycle which is needed to manage this knowledge, and the key factors that facilitate the KM life-cycle. The "SCPTS" KM model provides management in organizations with a tool that highlights the various aspects affecting KM implementation. Such a tool would assist organizations in identifying their knowledge needs as well as the current status of the various key factors affecting the successful implementation of KM in their organizations. These are: strategy, organizational culture, people, technology, and organizational structure. This provides management with effective guidance that contributes to meeting their business objectives by achieving the critical success factors (Rockart, 1979). Management would then be in a better position to develop plans for KM implementation focusing on the weak areas and according to the organization's knowledge needs; thus, increasing the likelihood of KM success.

After the introduction of the "SCPTS" three-layer KM model, three case studies were conducted. The use of case studies in this research aims to test and validate the "SCPTS" KM model in as close to a "real life" situation as possible. While the elements and issues described by the model are "logical" and supported by the literature, it was important to experience the actual implementation of the model in a real organizational setting as much as possible. In addition, to solicit the opinions of the people involved with knowledge management in organizations regarding the usefulness and practicality of the model in these real situations. The three case studies were conducted in three different engineering organizations based in the Middle East and are characterized under different sizes, sectors, and levels of knowledge management implementation, applications, and initiatives. These companies are: a major joint government-private oil company (Oilco), a computer solutions and network provider (Compco), and a consulting company (Consultco).

Following the completion of the case studies and the development of the "SCPTS" three-layer KM model, a questionnaire was used in an effort to enable the triangulation of the findings from the case studies, i.e. further validate and generalize the findings from the case study phase. This is achieved through surveying the opinions of managers involved with KM in engineering organizations regarding the importance of the various elements described by the model as well as investigating the current status of these elements in their organizations. The KM questionnaire is categorized into six sections following the background information section. These are: awareness and commitment, strategy, culture, structure, people, and technology. Each section contains a number of questions; these vary from five to eleven questions. The questionnaire was sent through email to general managers and knowledge officers in 426 engineering companies. Companies selected were of various sectors, type of engineering business, and were located in the Middle East, USA, UK, and Europe. The only prerequisite that was required for the company to be selected is to be engaged with KM practice at any level. At the end of the reply period, 19 questionnaires were returned completed.

8.3 Main Conclusions and Findings

- The field of KM have been influenced and informed by a variety of disciplines. These are: cognitive science (in understanding of knowledge workers); social science (understanding motivation, people, interactions, culture, and environment); management science (building knowledge-related capabilities); knowledge engineering (eliciting and codifying knowledge); artificial intelligence (automating routine and knowledge-intensive work) and economics (determining priorities).

- Organizations are interested in KM to achieve critical business objectives. These include improving an organization's performance, obtaining higher quality, sustaining competitive advantage, sustaining preservation and leverage of knowledge to develop a learning organization, and striving towards operational excellence.

- The interest of engineering organizations in KM to achieve business goals is evident through their contribution to the field. Engineering organizations have led the way in KM initiatives and practice. Currently, an increased number of engineering organizations around the world are engaged in KM practice.

- The research field of KM is still inconclusive, especially in guiding the implementation of KM in organizations. Many of the frameworks and methodologies suggested in the literature have been criticized for suffering serious shortcomings. In fact, researchers have linked many

KM failures to the lack of a generally accepted framework and methodology to guide successful implementation of KM in organizations.

- It was found that many of the existing KM frameworks and methodologies do not adequately address all of the requirements for effective knowledge management implementation or do not provide sufficient details. It was necessary to explore the various approaches to KM and identify all the key factors and issues that affect the successful implementation of KM in engineering organizations.

- The following factors and attributes were found to affect the successful implementation of KM in engineering organizations:
    - The types of knowledge available in engineering organizations,
    - The steps which are needed to manage the different types of engineering knowledge,
    - Management commitment and support to KM,
    - Strategic planning,
    - Organizational culture,
    - Managers' role,
    - Employees skills and expertise,
    - Employees' willingness to share their knowledge,
    - Information and communication technologies (hardware and software),
    - Organizational structure, and
    - Performance measurement.

- The failure of KM practice in several organizations has been linked to the focus on tools and technologies; mostly information technology, and the negligence of people management issues. Many researchers have recently recognized and emphasized the need to integrate the various approaches to KM to ensure successful implementation.

- It became apparent that there was a need for a tool that can assist management in engineering organizations in successfully implementing KM. However, the KM research field was still lacking a generally accepted tool that addresses all the key KM factors that affect the successful implementation of KM. Such a tool would highlight the various aspects affecting KM implementation. It would also assist organizations in identifying their knowledge needs as well as the current status of the various key factors affecting the successful implementation of KM in their organization. This provides management with effective guidance that contributes to meeting their business objectives. Management would then be in a better position to develop plans for KM implementation focusing on the weak areas and according to an organization's knowledge needs; thus, increasing the likelihood of KM success.

- This research has produced a novel KM model for the successful implementation of KM in engineering organizations which integrates the various approaches and key factors to implementing KM. The proposed "SCPTS" three-layer KM model consists of the following three layers:

- The first layer classifies engineering knowledge according to their knowledge processing requirements and places them in three categories:
  - electronic library which contains an organization's explicit knowledge that is easily codified;
  - documented procedures and lessons learned which represent tacit knowledge that has been transferred into explicit knowledge; and
  - experience and know-how which refer to tacit knowledge that employees gain through their work experiences and is not easily codified.
- The second layer includes the steps needed to manage the elements of the first layer. This layer constitutes the KM life-cycle composed of:
  - knowledge identification;
  - knowledge acquisition and development;
  - knowledge distribution; and
  - knowledge measurement and review.
- The third layer includes the facilitators and infrastructure that support the elements of the second layer. These are:
  - strategy;
  - organizational culture;
  - people;
  - technology; and
  - organizational structure.

- This research has produced the needed model to guide the implementation of KM in engineering organizations. This model provides management in engineering organizations with a tool that assist them in identifying their KM requirements and developing effective plans to implement KM according to their business goals. This approach is hoped to increase the likelihood of the success of KM implementation in engineering organizations.

- The use of case studies in this research allowed for a close in-depth examination of the types of knowledge available in engineering organizations as well as the various factors and tools that affect the management of this knowledge, their interrelationships, and impacts. This enabled the refinement, modification and validation of the proposed model.

Cases-related findings:

- Engineering organizations have vast amounts of knowledge in various areas that are critical to achieve organizations' business goals. These goals include performance improvement, competitive advantage, and total quality.

- Engineering knowledge varies from explicit knowledge such as project documentation and drawings to tacit knowledge in the form of employees' experiences. Part of the tacit knowledge engineering organizations have and value can be successfully externalized into explicit knowledge that is more easily transferred to other employees.

- The first step in managing organizations' knowledge is to identify the needed knowledge. Organizations can then develop plans to acquire, organize, and distribute that knowledge. The acquisition and development of the needed knowledge depends on the source and form of that knowledge. Having developed the needed knowledge, it then needs to be distributed to those who need it. The distribution method depends on the type of knowledge handled.

- The ability of an organization to succeed in managing its knowledge relies on its ability to facilitate the KM life-cycle.

- The success of organizations in developing strong elements to facilitate KM is linked to their strategies. Strategies need to develop plans and objectives to achieve business goals. Strategies need also to be integrated to a measurement system to evaluate the contributions of KM to business goals and make continuous adjustments.

- It is clear that organizational culture has a critical role in facilitating knowledge development and distribution, particularly in the case of tacit knowledge. As engineering organizations rely heavily on tacit knowledge through their employees' skills and experiences, it is important to create a knowledge friendly culture to ensure successful implementation of KM.

- It is noticed that mangers have a key role in facilitating KM. Their role extends from identifying the needed knowledge to being leaders and mentors.

- It is also noticed that establishing and maintaining a skilled workforce is emphasized in engineering organizations. This is facilitated through training and development as well as recruiting.

- Technology is a main enabler of KM in engineering organizations. Various technologies are deployed to enhance communication and facilitate the management of both explicit and tacit knowledge. There is no general set of technologies that is suitable for all organizations. Firms need to employ the necessary technologies that facilitate their needs and requirements.

- It is noticed that organizational structure can facilitate or harm knowledge development and sharing.

Questionnaire-related findings:

- The field of KM is receiving wide attention from engineering organizations.

- It is important for senior management to demonstrate their commitment to KM with resources, action, guidelines, and activities. It is also important for management to support knowledge sharing, learning and other KM desired behaviors.

- It is critical to see KM as a vital element of business strategy and to recognize knowledge as the basis of a company's competitive position.

- It is important to have defined responsibilities and a budget set for KM initiatives.

- It is important to have key performance indicators for KM in place. It is also important for senior management to have ongoing review of the effectiveness of KM in the whole company.

- It is critical to have an organizational culture that facilitates KM. It is also critical that individuals be rewarded for team work and knowledge sharing.

- It is critical to constantly seek best practices and try to reuse existing projects and knowledge. It is also important to have a flexible, well-structured, up-to-date knowledge map to pint staff in the direction of the knowledge they seek.

- It is critical that managers be responsible for motivating, mentoring, and coaching their employees.

- It is important to know leading experts in a company and take active steps to ensure that they share their knowledge and do not leave without leaving their knowledge in the organization.

- It is important to provide and encourage training and development programs in KM behavior and procedures.

- It is important to assign specialized teams the responsibility of storing and maintaining knowledge.

- It is important for technology to be a key enabler in ensuring the right information is available to the right people at the right time.

- It is important to have organizations' policies, standards, and manuals stored in databases and made available to employees. It is also important to document and store procedures and lessons learned from experience in databases. In addition, it is important to utilize IT such as massaging systems and conference tools, to allow effective communication across boundaries and time zones.

- It was clear that a gap exists between what managers believed is critical or important for successful KM implementation, and the current status in their organizations.

8.4 Meeting Research Objectives

Achievement of research objectives is listed as follows:

- Carry out an extensive literature review on KM and the factors that affect its implementation in engineering organizations (Achieved in Chapters 2 and 3). This will lead to:
    a. The evaluation and classification of the different approaches to KM (Achieved in Chapter 2);
    b. Identifying the effectiveness of the different KM frameworks and methodologies suggested in the literature (Achieved in Chapter 2); and
    c. Identifying key factors and explore issues affecting the successful implementation of KM in engineering organizations (Achieved in Chapter 3).
- Propose an alternative and systematic approach to implementing KM that resolves some of the shortcomings highlighted in the literature (Achieved in Chapter 5).
- Identify the requirements to successfully manage knowledge in engineering organizations. These include categorization of the available knowledge, identifying the steps needed to manage this knowledge, and describing key factors that affect this process (Achieved in Chapter 5).
- Establish, using the literature as a guide, a model for the successful implementation of KM in engineering organizations that highlights the different elements of KM and provides organizations with effective guidance to implement KM and meet their business objectives (Achieved in Chapter 5).

- Explore, test, and validate the proposed KM model through detailed case studies and questionnaire (Achieved in Chapters 6 and 7).
- Propose a methodology for implementing the KM model (Achieved in Chapter 8).

8.5 Methodology of Implementation

The following methodology is proposed as a guide for the implementation of the "SCPTS" three-layer KM model in engineering organizations:

(1) Identify a set of goals that KM aims to achieve for an organization.

(2) Obtain top management support and commitment to KM and prepare for change.

(3) Understand the current status of KM in the organization. This includes assessing the status of the organizational culture, people, technology, and organizational structure in facilitating KM as well as the status of knowledge acquisition, development, distribution, measurement and review.

(4) Initiate a long-term KM strategy to achieve the identified goals. The KM strategy should:

- aim to identify and demarcate organizational knowledge in various areas;
- set KM priorities;
- create a KM team and/or identify roles and responsibilities;
- raise awareness of KM among employees;
- strive to create the required infrastructure to facilitate the acquisition, development, distribution, measurement, and review of the needed knowledge; and
- be associated with a top-level measurement system.

(5) Identify the needed new, internal, and external knowledge. Knowledge identification requires the combination of top-down and bottom-up approaches.

(6) Determine whether some areas need reengineering or improvements according to the organization's KM needs, for example organizational culture, employees' skills, developing explicit knowledge, distributing tacit knowledge or improving the IT infrastructure.

(7) Develop plans and objectives to improve week areas of KM. These need to be associated with Key Performance Indicators.

(8) View progress and adjust as required.

8.6 Future Research

The following is an outline of possible directions of future research which have emerged from this study:

- The model may be enhanced by the actual application in engineering organizations. This may result in linking specific organizational situations to the different factors described by the model.
- Since it was found that organizations need to deploy the technologies required to facilitate their knowledge needs, this opens the opportunity to investigate the various available technologies to engineering organizations and link them to exact knowledge needs. New technologies can also be developed to facilitate specific knowledge needs.
- Further research is required to fully test and validate the proposed methodology of implementation.

- Further research could be conducted in the area of KM performance measurement. There is a need for key performance indicators to aid in reviewing and measuring the status of the various KM facilitators.
- Further research could also be conducted to provide more detailed description of the various attributes. Also, continuous research to update the model's characteristics to facilitate organizations in general as well as environmental changes.

Appendix A

KM Questionnaire

Background Information

To help us classify your responses statistically, may we ask you a few questions about yourself and your organization.
(Please mark with x where appropriate)

About Yourself

a. Your Name (optional): ______________________________

b. Position in Organization: ______________________________

c. Contact email: ______________________________

About Your Organization

a. Name of Organization: ______________________________

b. Country of Location: ______________________________

c. Number of Employees:

☐ less than 100 ☐ 100-500 ☐ over 500

d. Primary Business:

☐ Public Utilities ☐ Manufacturing
☐ Oil industry ☐ Construction
☐ Consulting ☐ Other: ______________________

	Awareness and Commitment	Current status in your organization					How important is it to your organization				
A	**Understanding the concept of knowledge management (KM) and commitment of senior management to its use**	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
A1	If I use the term knowledge management anywhere in my company, most people will understand what it means for us and how it is applied to the business										
A2	Knowledge management is represented at the management level with a chief knowledge officer position or something similar										
A3	Senior management demonstrate the commitment to KM with resources, action, guidelines and activities										
A4	Senior managers support knowledge sharing, learning and other KM desired behaviours. This is often talked about in meetings										
A5	KM is seen as a vital element of business strategy and knowledge is widely recognized as the basis of our competitive position										

	Strategy	Current status in your organization					How important is it to your organization				
B	**Commitment to a program of KM improvement and managing it to ensure maximum business benefits**	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
B1	There is vision on how KM should be integrated into the business. It is clear how KM initiatives support the business plan										
B2	There is a shared understanding, based on a scenario plan, on what KM should be doing for us in two years time										
B3	There are defined responsibilities and a budget set for KM initiatives										
B4	Intellectual assets are inventoried or recognized and some measure of value is attached to each										
B5	Key performance indicators for KM are in place										
B6	KM principles are well established. There are definitions of key knowledge and guidelines for the creation and management of knowledge										
B7	There are initiatives within the business plan to improve KM										
B8	There is a senior level ongoing review of the effectiveness of KM in the whole company										
B9	There is a program of active participation in business conferences and other discussion forums to share ideas and experiences										
B10	We are committed to a Total Quality Management (TQM) program. Particularly, in the areas of continuous improvement and empowerment of employees										

C	Culture	Current status in your organization					How important is it to your organization				
	Behaviours in the company enable effective KM	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
C1	Failure is not punished; rather it is seen as an opportunity to learn										
C2	Recording and sharing of knowledge is routine and second nature. Next time I have a good idea, I know exactly how to share it										
C3	Individuals are visibly rewarded for team work and knowledge sharing										
C4	Holding of knowledge and being secretive about the best way to do something is actively discouraged										
C5	Asking for help from expert co-workers is monitored, encouraged and rewarded										
C6	Employees feel secure about there jobs. The organization makes it attractive to stay and long term employment is encouraged										
C7	We constantly seek best practice and try to reuse existing projects and knowledge whenever we can										
C8	Time is allowed for creative thinking. For example, staff are encouraged to reflect and thinking time is allowed for										
C9	Physical space supports knowledge transfer. For example, working in open space and providing meeting rooms										
C10	Love, care and trust are fostered among team members in the organization										

D	Structure	Current status in your organization					How important is it to your organization				
	The company is organized to make the most of its knowledge resources	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
D1	A flexible, well-structured, up-to-date knowledge map exists to point staff in the direction of the knowledge they seek										
D2	Formal networks and cross-functional teams exist to facilitate the dissemination of knowledge										
D3	Informal networks across the organization are encouraged, in fact management meetings often discuss our communities of practice										
D4	Staff are rotated to spread best practice ideas or natural staff turnover is positively used to assist with the dissemination of best practice										
D5	We are connected to external networks and knowledge sources which cause us constantly to re-examine what we are doing										

E	People	Current status in your organization					How important is it to your organization				
	Managers and employees in the company support KM	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
E1	Middle managers play a major role in transferring the organization's KM strategy into specific plans, actions, processes and defined KM roles										
E2	Managers scan the organization to identify knowledge needs										
E3	Knowledge sharing is seen as strength. Managers are responsible for motivating, mentoring and coaching their employees										
E4	We know who our leading experts are in all areas of activity. We take active steps to ensure that they share knowledge and do not leave without leaving their knowledge in the organization										
E5	Managers give considerable attention to creating the right mix of people when forming teams										
E6	Everyone is willing to give advice or help on request to anyone else in the company										
E7	Training and development programs in KM behaviour and procedures are encouraged from recruitment onwards										
E8	We have a number of people who are assigned the responsibility of ensuring that knowledge is transferred internally and externally										
E9	Specialized teams are assigned the responsibility of storing and maintaining knowledge										

F	Technology	Current status in your organization					How important is it to your organization				
	The right kind of technology is available and it is used effectively enough to support KM	Completely implemented	Partially implemented	Do not know	Plan to implement	Not implemented	Critical	Important	Do not know	Beneficial	Not important
F1	Technology is a key enabler in ensuring the right information is available to the right people at the right time										
F2	The information services team are constantly checking to ensure that our IT support our knowledge needs										
F3	Internet and a local intranet are available to support KM										
F4	Organization policies, standards and manuals are stored in databases and made available to employees										
F5	Procedures and lessons-learned from experience are documented and stored in databases										
F6	IT makes the search for information much easier. It is supported by search engines and document management systems										
F7	IT network is integrated with the specialized business software tools. For example, CAD/CAM and project management tools										
F8	Modelling systems, decision support systems and artificial intelligence are in use										
F9	IT allows effective communication across boundaries and even time zones aided by massaging systems and conference tools										
F10	Directories of staff indicating their field of expertise and their contacts are available for easy identification										
F11	Our hardware and software are updated routinely without significant debate										

Please Note: If you are interested in receiving a summary of our report, kindly advise us of your details so that it may be forwarded accordingly.

Kindly submit the completed questionnaire, at your earliest, to the following:

Ahmed Obaide
Email: A.Obaide@pgr.salford.ac.uk

Thank you for your kind cooperation in completing this questionnaire. If you have any additional comments, please let us know in the space provided below.

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