UNIVERSITY OF TECHNOLOGY, SYDNEY
SCHOOL OF BUSINESS

A Model for Assessing the Perceived Value of Knowledge Based Systems

Jeffrey Clark

A Dissertation submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

1999

Certificate

I certify that this thesis has not already been submitted for any degree and is not being submitted as part of candidature for any other degree.

I also certify that this thesis has been written by me and that any help that I have received in preparing this thesis, and all sources used, have been acknowledged in the thesis.

Signature of Candidate

Production Note:
Signature removed prior to publication.

Acknowledgments

I would like to thank my principal supervisor, Dr Fawzy Soliman. His extensive knowledge of the role of advanced technology in the management of organisations was of invaluable assistance and provided the seeds of inspiration for the thesis. Without his direction, encouragement, patience, and indomitable optimism the task would have been considerably more difficult if not impossible.

I am grateful for the guidance and support of my co-supervisor, Professor John Debenham. His initial guidance was instrumental in providing a coherent foundation and focus to my PhD studies. His continual support in the form of numerous industry contacts was instrumental in locating a suitable case study for analysis. I am also grateful for his feedback on the numerous papers and drafts associated with the thesis.

I would like to thank the management and staff at CSIRO Division of Information Technology, Sydney for their cooperation in providing me with access to their industrial clients which led to recruiting Organisation X as the case study upon which this thesis is based. I am also grateful for the cooperation and time of the key informant and the staff at Organisation X.

Thanks also to Associate Professor Jenny Edwards, head of the School of Computing Sciences, at UTS who provided a supportive and conducive work environment as did her predecessor Professor Igor Hawryszkiewycz. I am also grateful to Professor John Hughes for his valuable advice, support, and guidance throughout.

My family and friends have been patient and supportive throughout the years of study and to them I owe a great deal. I especially would like to thank my parents for instilling in me the will and determination needed for the task. Finally, thanks to my children Louise and Thomas who are two outstanding reasons for seeing this through.

Table of Contents

List of Tables

List of Figures

Abstract

Knowledge Based Systems (KBSs) have the potential to automate a significant number of the decision making processes across organisations of all types. This represents a unique capability, not available to conventional information systems. It gives KBSs the potential to increase internal efficiency, and to enhance an organisation's competitive position. Despite these potential improvements, the impact of this capability upon an organisation introduces a host of new and complex management issues.

Strategic planning for the use of KBSs in organisations is recognised as an important, but neglected area of KBS management research. In practice, KBS development methodologies are used to guide KBS strategic planning. Historically, KBS strategic planning efforts have been poor and are linked to the very high incidence of KBS failure in organisations. While KBS development methodologies may be able to identify potential KBS projects, they are unable to identify which projects have the highest organisational value. The core of the strategic planning problem is that KBS development methodologies adopt current valuation models which do not adequately assess whether investment in a KBS is worthwhile. These valuation models are designed for use in the domain of conventional information systems, but are problematic when applied to KBSs. The unique capability of KBSs to make decisions generates numerous tangible and intangible costs and benefits which cannot be captured by these current valuation models. In addition, these current valuation models fail in three key areas that are critical for adequately assessing KBSs value. First, they do not provide disaggregated information on costs and benefits, many of which are peculiar to KBSs. Second they do not classify these costs and benefits into categories that are meaningful to managers making KBS investment decisions. Third, despite the fact that current valuation models cannot measure intangible costs and benefits, they do not utilise the perceptions of KBS employees to measure them. Using employee perceptions to measure intangible costs and benefits is valid if a recognised psychological model is used to measure perceptions of value.

A valuation model specifically designed for KBSs, which addresses these key areas, is needed by managers planning for an organisation's KBS strategy to enable them to identify KBS investments with the highest organisational value. The aim of this thesis is to propose and verify such a model. To achieve this, the case study research methodology was used. The chosen case is a large sales and manufacturing organisation. At the time of study this

organisation was developing three KBSs and was interested in being able to measure the relative value of the systems.

The study found that the proposed KBS valuation model presented in this thesis overcame the inadequacies of current valuation techniques. First, the results indicate that value of a KBS to an organisation can be assessed by measuring KBS value perceptions of three key employee groups involved in the KBS lifecycle. These groups were found to be: KBS project managers; knowledge domain experts; and KBS users. Employee perceptions of KBS value were measured by adapting the Theory of Reasoned Action (TRA) which reliably produced valid measures of perceived KBS value. Second, the results indicate that the KBS value perceptions were able to be expressed as disaggregated tangible and intangible costs and benefits. Third, these disaggregated costs and benefits were able to be classified into three categories of value found to be common to all KBSs and meaningful to management. These categories are: time; finances; and quality. Finally, a new graphical technique, termed a "KBS value graph", designed to visually portray to managerial decision makers, the perceived value of a KBS was developed. It lucidly portrays perceived KBS value while supporting the three critical areas of KBS valuation.

Chapter 1

Introduction and Specification of the Research Problem

1.1 Introduction

Knowledge Based Systems (KBSs) also referred to as Expert Systems (ES) have been defined by Meyer and Curly (1991, p. 455) as follows:

> "Knowledge-based (*expert*) systems are generally understood to be software applications that incorporate substantial amounts of human reasoning for problem solving and decision making assistance."

According to Debenham (1989, p. 53) the terms ES and KBS refer to the same type of computer system. An expert system has been defined by Prerau (1990, p. 3) as:

> "....an advanced computer program that can, at a high level of competence, solve difficult problems requiring the use of expertise and experience; it accomplishes this by employing knowledge of techniques, information, heuristics (rules of thumb), and problem solving processes that human experts use to solve such problems."

Review of the literature reveals that management of KBSs in organisations has received inadequate attention. One explanation of this is the comparatively recent advent of KBS technology. KBS technology has matured enough to build a wide range of applications for organisations. With more applications being developed, there is a need to understand the management of KBS and in particular its introduction to organisations.

1.2 Organisational Impacts of Knowledge Based Systems

Duchessi *et al.* (1993) describe potential research areas for Artificial Intelligence (AI) technologies. AI technologies include: expert systems; speech recognition systems; neural networks; voice recognition systems; and speech synthesis systems among others (*ibid.*, p. 151). An important domain requiring research in AI is the interaction between AI technologies, management, and organisations (*ibid.*, p. 151). While significant research

has been conducted in these areas with regard to conventional information systems, comparatively fewer studies have been performed in the AI domain (*ibid.*, p. 151). There are two reasons for this (*ibid.*, p. 152). First, AI applications are a quite recent phenomenon which has restricted knowledge of their organisational affects. Second, technological issues regarding development of AI applications have naturally preceded study of their organisational impact.

These arguments are echoed by other prominent researchers such as Turban (1995, p. 800) who recognises that KBSs have unique characteristics and that little is known about the organisational implications of these characteristics since these technologies are so recent.

1.2.1 Unique Characteristics of KBSs

Mitev (1996, p. 243) states that the types of business problems solved by KBSs are different from conventional information systems. KBSs do not simply collect, manipulate and distribute information as do conventional information systems (Turban, p. 762). Instead KBSs make decisions based upon information generated by a conventional information system or some other source (Clark and Soliman 1999, p. 65).

Clark and Soliman (1999, p. 65) identify another difference between these two types of systems. They state that KBSs transfer decision making capability from experts to non-expert groups in the organisation. Conventional information systems unlike KBSs do not have this capability. Instead they can only provide information to organisational groups and these groups then apply the information to a manual decision making process to arrive at decisions.

Yet another difference involves the affect of KBSs upon employees. As in the case of conventional information systems, KBSs affect the job descriptions of user groups. However, unique to the case of KBSs, the experts are also affected (Clark and Soliman 1999, p. 65). These personnel must aid in development and maintenance of the knowledge in the KBS. In addition, their jobs may be further altered because the KBS may decrease their workload. This may enable them to spend time on other tasks, which they were not previously able to perform.

1.2.2 Organisational Impacts of KBS

KBSs may be able to impact organisations in a variety of ways. Clark and Soliman (1995, p. 249) propose that the organisational impacts of KBSs include changes in the: organisational structure; tasks performed in the organisation; and the personnel employed at

the organisation. However, due to the recent arrival of artificial intelligence in general, the presence and extent to which these impacts exist in KBSs remains largely unknown (Duchessi *et al.* 1993, pp. 151-152) (Turban 1995, p. 800).

Turban (1995, p. 802) states that KBS technology might affect the organisational structure by: increasing the span of control thereby reducing the need for supervision; and decreasing the number of experts. Capturing expert knowledge in a KBS may decrease the need for large numbers of experts. The decreased need for supervision may reduce the number of managerial levels resulting in a lower number of staff managers as well as line managers. Another structural impact concerns the possible reduction of overall employee numbers (*ibid.*, p. 803). This can result from the ability of lower level employees to perform higher level decision making tasks by using a KBS. The use of a KBS by lower level employees may also increase productivity when compared to levels prior to the KBS. This higher productivity may reduce the need for previous employee numbers.

Another possible change to structure concerns the addition of a previously absent artificial intelligence department in organisations with the responsibility for development of KBS and other artificial intelligence systems (Turban 1995, p. 805).

Personnel management may also be affected by KBS technology (Turban 1995, p. 808). Accordingly, a KBS may change the roles played by employees. For instance, the job content of lower skilled employees may change in that they could be given the responsibility for using a KBS in addition to, or instead of their current tasks. These changes may affect worker satisfaction. Jobs may become more interesting, while others become boring. In addition, some KBS users may perceive that these systems decrease their discretion in making a decision. Human experts who provide their knowledge for the development of a KBS may perceive that it will replace them or make their job less important. Alternatively, they may perceive that it frees them to pursue other important aspects of their job. Ultimately, these impacts upon personnel, may affect their motivation to perform KBS related tasks.

KBS technology could potentially give the organisation an advantage in competitiveness derived from: reductions in time to complete tasks; increased decision quality; cost reduction; and increased revenue (Turban 1995, p. 809).

Some of these organisational impacts are possibly common to both KBSs and conventional information systems. However, due to the unique characteristics that KBSs alone possess, managing the impact upon the organisation of a KBS is likely to be more complex than that

of conventional information systems (Turban, p. 762). Therefore, if a KBS is to be successful, management of these complex organisational impacts, is of paramount concern.

1.2.3 The Importance of Assessing KBS Value in the Management of KBSs

A large number of organisations are now utilising KBSs to solve business problems (Duchessi *et al.* 1993, p. 151). The development of KBSs represents a significant investment. Harmon *et al.* (1988, p. 184) has estimated (in US dollars) the cost for KBS development projects across three categories of KBS size. They estimate that "small" projects can cost between $25,000 - $50,000, "mid - size" projects $300,000, while "large" projects could cost between $2 million - $5 million to develop. Furthermore, there is evidence to suggest that KBS projects sustain an extremely high rate of failure (Turban 1995, p. 762).

According to Mitev (1996, p. 239), the high rates of KBS failures are associated with poor strategic planning for KBSs. The effect of this is that many KBSs usually do not meet business and organisational needs. The general objective of KBS development methodologies is to ensure that appropriate KBSs for a given organisation are identified and that they are successfully developed and implemented. KBS development methodologies have made significant strides and are now adequate for major development issues such as project control, project management, knowledge acquisition, logical design, system testing, and maintenance (*ibid.*, p. 238). However, many KBS methodologies do not have an effective strategic planning component and are thus unable to determine if KBS development projects will be feasible from an organisational perspective (*ibid.*, p. 240).

Mitev (1996, p. 241) suggests that such strategic planning for KBSs should be comprised of an analysis of an organisation from a business perspective to identify appropriate KBSs. Furthermore, the relative value of these systems should be assessed in order to choose which of these KBSs will contribute the highest value to the organisation. Strategic planning of this nature should begin by gaining an understanding of the organisation's business units, as well as an identification of their problems and opportunities. An analysis should be made of each business unit in terms of its: business processes; information flows; employee tasks and decisions which they make; planned changes to the organisation; and existing computing systems in use. Based upon this analysis, a portfolio of KBSs should then be proposed and these should be ranked in order of potential value to the organisation. The KBSs with the highest value should be chosen for development.

Clark and Debenham (1994) introduce the concept of a knowledge audit which goes some way towards solving the problem of strategic planning for KBS. The aim of a knowledge audit is to produce a report which identifies the sections of knowledge that exist in an organisation and describe the characteristics of the knowledge contained in them. The report can be used by management to identify sections of knowledge which are suitable for KBS development. However, knowledge auditing as described by Clark and Debenham (1994) does not attempt to match potential KBSs with an organisation's decision making needs.

Mitev (1996, p. 241) argues that such a process of strategic planning for the use of KBSs in organisations is paramount to the success of KBSs in organisations generally. Clearly, if business decision making needs are not properly analysed then KBS projects which do not directly meet these needs may be identified and chosen for development. As a result the subsequent developed systems are likely to fail. If an analysis of the business such as that described above is performed it will likely identify several potential KBS projects. Investing in these systems is likely to represent a substantial amount of funds, as well as expense in time, and effort. From a strategic perspective, due to their high development costs, it is vital that only KBS projects which have a high organisational value should be chosen for development. If KBSs are chosen for development without adequate assessment of their value, the opportunity cost to the organisation may be high.

Mitev (1996, p. 240) states that KBS development methodologies are weakest in assessing the feasibility of KBSs, when they provide little or no support for deciding whether it is worth developing a KBS. They do not provide an adequate means of identifying appropriate KBSs for the decision making needs of an organisation and they are inadequate for assessing the value of KBSs to an organisation, thus making it difficult to make prudent investment decisions. Therefore, deciding upon whether a KBS is a wise investment is difficult.

There appear to be two components of KBS strategic planning. The first involves analysis of business decision making needs and identification of KBSs which meet those needs. The second involves assessing the value of each KBS development project to the organisation and determining which of these contributes the most value to an organisation. These two areas of strategic planning have been inadequately addressed by existing KBS development methodologies.

Mitev (1996, p. 241) states that there is convergence between conventional information systems and KBSs in the first area of strategic planning. Accordingly, the processes used to identify conventional information systems are similar to those which would be suitable

for identifying KBSs. However, Mitev (1996, p. 241) claims there is divergence between the way the value contributed to an organisation by a potential KBS and a conventional information system are assessed. In other words, the models used to assess value in conventional information systems are not appropriate for KBSs. Like conventional information systems, assessing a KBSs value involves the valuation of the costs and benefits of a KBS to the organisation (Turban 1995, p. 651). However, when discussing performance of KBS feasibility studies, Mitev (1996, p. 243) states that the types of business problems solved by KBS are different from conventional information systems, and that the nature of their contribution to the business is also different. The unique characteristics of KBSs were stated in section 1.2.1 above. It is these unique characteristics which complicate assessing the value of a KBS. They render valuation models used in conventional information system development methodologies inadequate. The precise reasons for this are given in section 1.4 below. Without models to adequately estimate the development cost of a KBS and to assess the value of these impacts, it will be unknown if a KBS project is justified or unjustified. Coupled with this there is a considerable financial commitment needed to develop a KBS. In addition, Cronk and Fitzgerald (1997, p. 405) state that measuring the value of computing systems is one of the top ten concerns of chief executive officers in organisations.

In summary the need for a KBS valuation model is crucial given the significant amount of funds invested in a KBS and the unique organisational impacts KBSs present to organisations, and the lack of and need for appropriate models for assessing KBS value. If KBS development methodologies adopt existing models for identifying appropriate KBSs and if models are developed and used for assessing KBS value to choose prudent KBS investments, then it might be expected that the high rates of KBS project failure would decline.

1.3 A Focus Group Interview to Identify Managerial Issues in the Development of KBSs

The arguments presented in section 1.2.3 above strongly suggest that strategic planning for the use of KBSs in organisations is a major management issue which is inadequately incorporated into KBS development methodologies. There appear to be two components of strategic planning. The first involves analysis of business decision making needs and identification of KBSs which meet those needs. The second involves assessing the value of each KBS development project to the organisation and determining which of these contributes the most value to an organisation.

In order to verify the existence of these managerial issues, a focus group was held with KBS practitioners from industry. Morgan (1991, p. 43) recommends a range from six to eight participants for a focus group. Accordingly, seven participants were chosen. The participants of the focus group were all project managers of KBSs with several years of experience in KBS development. They all had extensive experience in development of conventional information systems. Project managers were chosen because it was felt that they would be best placed in the development team to have an understanding of the managerial issues concerning KBS development. The seven participants came from several different economic sectors including: insurance companies; manufacturers; banks; and telecommunications organisations and were previously known to the interviewer. The purpose of the focus group was to determine what managerial issues were faced by organisations in the development of KBSs. The participants were informed of the purpose of the focus group before it took place. The interview lasted for approximately 30 minutes and was held at the University of Technology Sydney which was within relatively close proximity to the work places of the participants.

After being introduced, the participants were asked to try to identify which managerial issues they were faced with in the development of KBSs. They were also asked to explain why the issues they identified existed in their organisations.

The results of the focus group will now be presented. The core managerial issue identified by the participants was that it was difficult to gain acceptance of KBSs in their organisations. Comments indicative of this include the following:

> "There is a lack of commitment from top management to KBS technology"

> "There is a lack of acceptance of KBS technology by management and users"

The participants indicated that there were two reasons for the lack of acceptance of KBS technology. Firstly, there is a lack of strategic planning for the identification of appropriate KBS projects given the organisation's needs. Secondly, it is very difficult to convince management that KBSs are worth the cost of development.

Consider the first reason for the lack of acceptance. It was generally perceived among the participants that a strategic planning for the use of KBSs was poor because there was no coordinated organisational wide effort aimed at identifying potential KBSs. Typical comments made by the participants indicative of this include:

"There is a lack of a strategic plan at the corporate level which is able to identify potential KBS applications for an organisation."

"There is a lack of a strategic plan which identifies KBS opportunities for an organisation."

Not only did the participants feel that there was no effort at the corporate level to identify potential KBSs, but they generally felt that there was no assessment of whether any given KBS project would help the organisation reach its objectives. Comments indicative of this include the following:

"There is a need to know if the problem to be solved by the potential KBS application actually supports the business function performed by the organisation."

"There is a need for a KBS strategic plan to be aligned with the objectives of a business's strategic plan."

Participants further indicated that strategic planning for KBSs suffered because there was no attempt to interface between KBS strategic planning and strategic planning for conventional information technology. In essence, KBS strategic planning should decide whether an organisational problem is better solved by a KBS or a conventional information system. Participant comments indicating this include:

"There is a need to know if a problem can be solved by traditional information systems technology or by KBS technology and which one is more appropriate."

"There is a need to know whether a problem should be solved by using KBS technology or traditional information systems technology."

Consider the second reason for the lack of acceptance of KBS technology: namely, the difficulty experienced in convincing management that KBSs are worth the cost of development. Comments indicative of this difficulty include the following:

"It is difficult to sell KBS technology to management and users."

"There is a problem in trying to communicate the benefits of KBSs over traditional information systems to top management."

"There is a high rate of failure of KBS projects."

"There is a high cost associated with KBS development."

The participants stated several reasons for the difficulty in convincing management of a KBS's value. First, reliable estimates of costs and benefits of KBS projects were unavailable. They indicated that is because KBS development costs cannot be reliably estimated in early lifecycle phases and KBS benefits cannot be estimated in dollar terms. As a result they were unable to perform adequate feasibility studies of KBS projects. Comments indicative of this included:

"There is a lack of reliable measures of the gains verses the costs of KBS projects."

"The ability of KBSs to make decisions is a benefit that is difficult to quantify."

"It is difficult to conduct a feasibility study to ensure that the KBS will be worth the investment, when cost and benefit estimations are unreliable."

"There is a need to be able to perform a feasibility study iteratively at each lifecycle phase because the costs and benefits evolve as the KBS is developed."

The focus group results are similar to the arguments expressed by Mitev (1996), Turban (1995), and Smith and Dagli (1992) discussed in section 1.2.3. Hence, the results of the focus group provide further justification that measuring KBS value is a management issue of importance.

1.4 Critical Overview of Traditional and Alternative Valuation Models When Applied to KBSs

The valuation models adopted by KBS methodologies include several types. These will now be critically reviewed in order to ascertain their inadequacies and to identify criteria required for developing a model suitable for assessing KBS value in organisations.

1.4.1 Traditional Models

The traditional models adopted by KBS development methodologies to assess KBS value include: Return on Investment; Internal Rate of Return; Cost-Benefit Analysis; and Net Present Value (Smith and Dagli 1992, pp. 61-64). These models focus upon assessing the financial value and are used widely in assessing value across all types of computing projects as well as numerous types of other organisational investment decisions. These

models are imperative for use in investment decisions, but are inadequate for fully assessing the value of a KBS project (1992, p. 64). As argued by Clark and Soliman (1997, p. 23) as well as Mitev (1996, p. 241) there is a need for valuation models specifically tailored for KBSs. There are several reasons for why this need exists.

Traditional models typically only consider tangible benefits and costs and are unable to measure the contribution to value from intangibles (Smith and Dagli 1992, p. 61). They are thus unable to assess the full value of a project as it evolves. This is especially important for KBS projects since they are typically characterised by more intangible costs and benefits than tangibles (O'Keefe 1989, p. 218). There is evidence that managers need information about intangibles when making organisational decisions in general (Taylor and Graham 1992, p. 52-53). Taylor and Graham (1992, pp. 52-54) demonstrate that information provided to managers does not include sufficient analysis of intangible factors and is biased towards financial information. In light of these findings it is proposed that it would be beneficial to provide managers with information on intangible factors with which to assess the value of investing in KBSs.

Another reason for the inadequacy of traditional valuation models is that KBS projects have an iterative nature which can make it difficult to predict both tangible and intangible contributions to value (Turban 1995, p. 652). It is unlikely that a prototype will have the full functional capability of an implemented KBS. Traditional valuation models cannot capture the eventual tangible value of a fully implemented KBS during these prototype phases (Smith and Dagli 1992, p. 64). Hence, cost benefit information generated by traditional models can arrive too late to be useful in deciding if investment in a prototype is justified or not, at least in the prototype phase.

Research has demonstrated that the preferences of managers in using information to make decisions including investment decisions is geared toward disaggregated information instead of aggregated information (Mintzberg 1994, pp. 261-263). The problem with using aggregated information in making a decision is that there is no explanation of how and why the aggregated information is the value that it is. In other words, there usually are no supporting interpretations explaining why the aggregated information is of a certain value. Despite this, many traditional valuation models used for information systems, attempt to measure value to the organisation through a single numerical figure or set of aggregated figures. It is therefore proposed that a valuation model should provide managers with disaggregated information about the value of a KBS.

A further problem with traditional models concerns the accuracy of the valuation produced. Mintzberg (1994, p. 264) argues that the quantified information used for decision making often is lacking in accuracy:

> "Anyone who has ever produced a quantitative measure.....[including] estimates of costs and benefits in a capital budgeting exercise-knows just how much distortion is possible, intentional as well as unintentional."

Research shows that when managers make decisions they try to understand the perceptions and opinions of affected employee groups towards the relevant decision options (Browne 1993, pp. 121-122). These perceptions and opinions are then used by the managers as input into their final decision. Furthermore, when making decisions, managers seek to gain information from employees of the organisation who are known to be knowledgable of the problem. They do this in order to ensure that the information used in making the decision is of a high quality (*ibid.*, p. 134). Mintzberg (1994, pp. 258-259) demonstrates that managers rely more upon soft information derived from discussions with employees, than they do hard quantified information when making decisions. Employee perceptions are used by managers for decision making in order to overcome the problems related to: measuring intangibles; aggregated information; the late arrival of quantified financial analysis; and the concern for the accuracy of cost benefit information (Mintzberg 1994, p. 259). As discussed above, these problems also exist in measuring the value of KBSs for making investment decisions. Therefore, measuring the perceptions of employees with respect to the value of KBSs may provide managers with the means to overcome the problems of traditional valuation models.

1.4.2 Alternative Valuation Models

Smith and Dagli (1992, p. 65) discuss the use of several alternative valuation models. These alternative models have been designed to overcome some of the problems associated with traditional models in the domain of conventional information systems. Examples of these alternative models include profile charts (Sullivan, 1986) and various linear additive models (Troxler and Blank, 1989) (Nelson, 1986) (Pienaar *et al.*, 1986).

Both profile charts and linear additive models disaggregate a measure of value into tangible and intangible costs and benefits. Linear additive models classify these costs and benefits into mutually exclusive value categories which are meaningful to managers. This is advantageous since it corresponds to the needs of managers for disaggregated information when making decisions. However, since these models are designed for conventional information systems, they do not include many of the intangible costs and benefits which

are relevant for measuring value in a KBS. There are two reasons why these intangibles are excluded from alternative models. First, as discussed in section 1.2.1, KBSs make decisions in the organisation, while conventional information systems do not. Many intangible benefits are potentially generated as a result of this decision making capability (Clark and Soliman 1999, p. 65). For example, a KBS can directly increase decision consistency, decision accuracy, and decision speed. None of these are directly improved by a conventional information system. Second, KBSs generate more tangible and intangible costs and benefits because any one KBS has an affect on more organisational functions than a conventional information system (*ibid.*, p. 65). Conventional information systems have an affect on the performance of the user groups who will use the system to perform some task. A KBS has this affect, but additionally, it affects the tasks performed by the human experts who previously made the decisions that the KBS now makes. Because the KBS affects the task performance of an additional group of employees, it generates extra tangible and intangible costs and benefits in the organisation over and above those generated by a conventional information system (*ibid.*, p. 65). Hence, general, alternative models do provide disaggregated information on tangibles and intangibles for conventional information systems. They are not appropriately formulated to provide this information on KBSs.

Neither linear additive models, nor profile charts attempt to measure the perceptions of organisational employees who interact with the system as input into the investment decision. However, managers require disaggregated information derived from perceptions of multiple employee groups as a major input to the decision making process. Both types of alternative models only appoint one human valuator to measure the value of an information system. The organisational perspective of this person is usually not specified. It is highly unlikely that this person could reliably measure the value of an information system from all the relevant perspectives. Independent valuators are likely to be less knowledgeable of the specific impacts of a KBS on a particular organisation when compared to employees with a broader and deeper understanding of the organisation. This is one reason why, when making decisions, managers ask employees for information regarding the various decision options. There are a number of employee groups that are relevant for the valuation of a KBS and will be introduced in Chapter 2. Since none of these alternative models include perspectives of the relevant groups, they cannot measure KBS value from the relevant perspectives.

Linear additive models in particular have a serious shortcoming with respect to the measurement of value based on the perceptions of multiple employee groups. Linear additive models are often criticised because human valuators have been found to inconsistently weight the contribution to value of a set of costs and benefits across

competing information system development projects. This results in conflicting valuations such as system A has more value than system B, and B has more value than system C, but C has more value than A. Thus rendering the results of the valuation unreliable (Smith and Dagli 1992, p. 69). In addition, when there are numerous team members all attempting to weight the costs and benefits of a system, it is likely that they will be unable to reach a consensus, or will likely reach a false consensus on the appropriate weighting's of the various costs and benefits. This weakness renders linear additive models inadequate in the valuation of KBSs because there are a number of employee groups involved in the valuation process. Profile charts do not suffer from this problem because they do not attempt to weight alternatives numerically.

All alternative models use a human valuator to measure the value of conventional information systems. However, none of them incorporate a well founded psychological model to guide the valuation process. Since human valuators are central to the successful application of these models, it is considered critical that a rigorous psychological model be used to ensure that a system's costs and benefits are identified and correctly measured. Without such a model the likelihood of obtaining reliable measures of value will be diminished.

Alternative models are inadequate for meeting the needs of managers in making KBS investment decisions because they do not: identify and measure the disaggregated tangibles and intangibles pertaining only to KBSs; measure the perceptions of employees knowledgable of the costs and benefits of a KBS to an organisation as input into the investment decision making process; and use an accepted psychological model for measuring perceptions of employees.

1.4.3 Other Criticisms of Traditional and Alternative Valuation Models

Cronk and Fitzgerald (1997) present a review of the value concept as it is used in information systems. There is an absence of definitions of value in the information systems literature and Cronk and Fitzgerald claim that this is a major omission in information systems research in this area (p. 409). Cronk and Fitzgerald (1997, p. 408) give two reasons for why defining value is important. First, so that the reader has the same understanding to that of the researcher regarding what value is. Second, to set guidelines for what is to be measured with regard to the value of an information system. Despite this, none of the traditional nor alternative models provide a definition of value.

1.5 Aims of the Thesis

Most of the problems inherent in both traditional and alternative valuation models when applied to KBS valuation centre around the absence of employee perceptions of KBS value. It is not denied that managers require an analysis of financial costs and benefits when making a KBS investment decision, and that this is usually best achieved through traditional models. However, it is clear that managers require an analysis of employee perceptions of value when making such decisions in order to overcome the problems discussed. Since there are no existing models which can adequately address the need for perceived measures of KBS value, the aim of this thesis is to present such a valuation model. Specifically the aims of this thesis are to:

- Propose a model designed to assess the value of KBSs as perceived by the key employees involved in its lifecycle; and

- Present the results of a case study used to analyse the model in an organisational setting.

1.6 Expected Contribution to Knowledge

As discussed in section 1.2.3, KBS development methodologies are inadequate at performing strategic planning for KBSs in organisations. Strategic planning includes identification of appropriate KBSs as well as their valuation for making investment decisions. The requirements of a model for the identification of appropriate KBSs converge with those models used in the domain of conventional information systems. However, as stated in section 1.2.3, the requirements of a model for assessing KBS value diverge from those used to assess value of conventional information systems. Given this, the main expected contribution to knowledge will be a model which is designed to assess the value of a KBS, and thereby overcome a major problem in the management of KBSs in organisations. An important expected practical outcome of this is, when by applying the model, practitioners will have more confidence that the strategic KBS investment decisions they make will be correct.

Chapter 2

Literature Review

2.1 Introduction

There are several desirable requirements of a model for the valuation of KBSs. Literature concerning these requirements will be reviewed in order to provide information for the derivation of a model specifically designed for KBS valuation. As discussed in Chapter 1, traditional valuation models are unable to fully assess the value of a KBS. To overcome this there are several valuation models which have been suggested for use in KBS development projects. These models were introduced in Chapter 1 and are reviewed in depth in this chapter to discover the degree to which they meet the requirements of KBS valuation.

It was proposed in Chapter 1, that a KBS valuation model should employ the use of a psychological model to measure perceptions of KBS value. The Theory of Reasoned Action (TRA) is the model adapted to measure perceptions of value for KBSs. The literature concerning the form of TRA and its strengths and weaknesses will be reviewed.

2.2 Requirements of a KBS Valuation Model

In Chapter 1 several desirable requirements for a model to value a KBS were outlined. These requirements can also be expressed as characteristics and are summarised below. It is desirable for a model to value a KBS to:

- define the concept of KBS value;
- provide managers with disaggregated information about the value of a KBS;
- use the perceptions of key employees regarding KBS value as input into KBS investment decisions;
- be capable of assessing KBS value in prototype phases when traditional valuation models cannot capture the eventual tangible value;

- provide managers with information on intangible costs and benefits with which to assess the value of investing in KBSs, in addition to tangible costs and benefits; and

- use a well founded psychological model with which to measure the perceptions.

Justifications for inclusion of these was provided in Chapter 1. However, a literature review is required for each characteristic. This is to enable adequate specification of their form in the model and to provide further necessary justification for their inclusion.

2.3 Definitions of the Concept of Value

Cronk and Fitzgerald (1997, p. 408) state that defining value is important. First, so that the reader has the same understanding to that of the researcher regarding what value is. Second, to set guidelines for what is to be measured with regard to the value of an information system.

A review of the literature on value reveals a paucity of definitions for the concept. Not only are there very few definitions of value in the information systems field as reported by Cronk and Fitzgerald (1997, p. 409), but there also appear to be few definitions of the concept in the management literature in general.

In the field of marketing, Reddy (1991, p. 15) defines perceived value as:

> "the value of the total offer or, in other words the maximum price the customer is willing to pay for the bundle of economic and non-economic attributes associated with the product."

Clearly Reddy views perceived value as a trade off between costs and benefits. This is evidenced by Reddy's indication that the customer may be "willing to pay" a "maximum price" to gain certain product "attributes".

Another definition from the field of marketing is proposed by Mazumdar (1993, p.28) who defines perceived value as:

> "...the degree to which a potential adopter perceives that the benefits of a new product exceed the sacrifices associated with its adoption and consumption."

Mazumdar contends that when assessing a product for possible purchase, a consumer will measure the benefits they receive in exchange for the monetary and non-monetary costs of acquisition and consumption. Therefore, the perceived sacrifices in Mazumdar's definition refer to monetary and non-monetary costs. The benefits include such factors as: superior product quality; convenience; and functional, psychological, as well as social benefits derived from the product. Benefits are both tangible and intangible. Therefore, Mazumdar differs from Reddy, in that he believes that perceived value is determined by, in part, costs which involve both the purchase price and other monetary and non-monetary costs. Despite this, it is clear that as does Reddy, Mazumdar views perceived value as a trade off between costs and benefits.

Again in the field of marketing Zeithaml (1988, p. 14) defines perceived value as:

> "...the customer's overall assessment of the utility of a product based on perceptions of what is received and what is given. Though what is received varies across consumers (i.e., some may want volume, others high quality, still others convenience) and what is given varies (i.e, some are concerned only with money expended, others with time and effort), value represents a tradeoff of the salient give and get components."

In Zeithaml's definition, the salient "give" and "get" components appear to closely parallel the concepts of costs and benefits as used by Mazumdar. It is therefore clear that as does Mazumdar, Zeithaml views value as a trade off between the costs and benefits as perceived by the consumer.

In the field of Information Systems Arkush and Stanton (1988, p.63) define information systems value to end user mathematically as:

> "Value = benefits - costs."

Arkush and Stanton consider benefits and costs to include both monetary and non-monetary factors. Their definition of value is mathematical because before any valuation is made they advocate transforming intangible benefits and costs into tangibles in the form of a dollar value. Despite this, it is clear that just as with the other definitions cited, Arkush and Stanton view information systems value to the end user as a trade off between benefits and costs.

An examination of these definitions collectively reveals that value is defined as a trade off between costs and benefits. The source for this interpretation of value probably has its

roots in the traditional models of valuation. These models commonly view value as a trade off between costs and benefits. Further examination of these definitions reveals that there is a similarity between definitions of both "perceived value" and "value". Both are defined as a trade off between costs and benefits.

2.4 Disaggregation of KBS Costs and Benefits

Mintzberg (1994) discusses the problem of aggregating information for making decisions in organisations. Mintzberg (1994, p.261) argues that much of the information provided to senior managers is too aggregated to be of use in making decisions. Such aggregated information is usually provided for the organisation as a whole and at the departmental or divisional levels. Accordingly, much of this information's detail is lost in the aggregation process. Aggregated information provides managers with information at the corporate and departmental levels, but does not provide them with much needed details regarding how and why the aggregated information is a certain value. Mintzberg (1994, pp. 261-262) argues that senior managers seek to disaggregate this information in order to gain detailed information with which to make decisions. They do this by obtaining the perceptions of employees who understand why the aggregated information is a certain value. It is this perception based disaggregated information that senior managers will use to make decisions.

For these reasons a measure of aggregated KBS value will only be partially useful to managers trying to decide on whether to invest in a KBS. A KBS is typified by both tangible and intangible costs and benefits (Lin 1991, p.101). Traditional valuation models aggregate the value of these costs and benefits into a single numerical figure or set of figures which forms the basis for a decision. Such aggregated measures of KBS value yield no detailed information to managers about why the KBS has a certain value. In other words, they do not decompose the value figure into component costs and benefits that are more meaningful to senior managers in making investment decisions. Because of this, traditional valuation models are inadequate for making investment decisions.

To decompose this information for decision making the following method could be applied. Assume that a hypothetical KBS exists in a financial organisation and is used for approving personal loan applications. Assume that the costs of the KBS include among other costs: funds spent on development; and a large amount of time spent by employees during development. Assume further that the benefits of the system among other benefits include: less time spent on assessing loan applications; a decrease in the cost of employees resulting from a decrease in the number of staff involved with the approval process. These

hypothetical costs and benefits are decomposed in the sense that they are not represented by a single numerical figure. When measurements for these costs and benefits have been taken they can then be assigned to meaningful and mutually exclusive value categories. Each value category would contain a group of costs and benefits which have a common characteristic pertaining to that category. In this example, there is one benefit and one cost which clearly pertain to time and could be assigned to a time category. Similarly, there is one benefit and one cost which are of a financial nature and could be assigned to a financial category. Once assigned to their categories the relative contribution to value of these costs and benefits could be compared by managers.

This method of decomposition would be advantageous to managers for two reasons. First, by identifying the individual costs and benefits of a KBS, it would provide managers with more detailed information with which to make an investment decision. Second, by specifying categories with which to classify the costs and benefits, it would make this information more meaningful to managers. This method of decomposition is supported by Troxler and Blank (1989, p. 177) who use this approach to assess value of information systems used in manufacturing.

2.4.1 Literature Review of the Costs and Benefits of KBSs

The method of decomposition described above requires the specification of categories in which to classify the costs and benefits pertaining to KBS value. However, before such specification of categories can begin these costs and benefits need to be identified. To achieve this a review of KBS literature concerning concepts closely paralleling the concept of value was performed. This included studies focusing on: KBS success; the affect of KBSs on organisational performance; and KBS effectiveness.

Hayes-Roth and Jacobstein (1994, p.31) attempt to identify several potential disaggregated benefits of KBSs in industrial and commercial applications. These include:

- increased speed of complex task accomplishment;
- increased quality;
- reduced errors;
- reduced cost;
- decreased employees required;
- reduced training time;
- improved decisions;
- retention of volatile and portable knowledge; and
- improved customer service.

According to Hayes-Roth and Jacobstein (1994, p.31) these disaggregated benefits represent a wide range of those known to have been delivered by KBSs across a large number of industrial and commercial applications. This list is useful since it goes beyond benefits associated with development of a KBS project to identify disaggregated benefits of an implemented KBS to a commercial organisation. Despite this, the authors do not offer a similar list of the costs associated with an implemented KBS to a commercial organisation.

Turban (1995, p. 484-486) discusses the following potential disaggregated benefits of KBSs to users in organisations:

- cost reduction;
- increased output;
- increased decision quality;
- reduced down time;
- capturing scarce expertise;
- flexibility of decisions made;
- easier equipment operation;
- use of less expensive equipment;
- operation in hazardous environments;
- reliability of decisions made;
- increased integration of other computerised systems;
- integration of several experts' opinions;
- ability to work with incomplete or uncertain information;
- provision of training;
- enhances problem solving;
- solve complex problems in a narrow domain; and
- knowledge transfer to remote locations.

This list of potential disaggregated benefits expands upon the list provided by Hayes-Roth and Jacobstein (1994, p.31). It focuses specifically upon the user, but all of these benefits are those which accrue to the organisation as a whole. Turban (1994) does not provide a similar list of potential costs of KBSs in organisations.

O'Leary and Turban (1987, p. 13) examine the potential organisational impact of expert systems and identify the following benefits:

- improved decisions by non-experts;
- more consistent decisions;

- reduced response time;
- improved training; and
- cost reduction.

These benefits are reflected by the later publications by Turban (1995) and Hayes-Roth and Jacobstein (1994). Again, the costs of successful or failed KBSs to organisations are not mentioned. The types of costs encountered during development are also not mentioned.

Hauser and Herbert (1992, pp. 10-11) identify the following benefits of KBS technology which add to those listed above:

- timeliness of decision making;
- productive use of inexperienced employees;
- productive use of expert employees;
- accuracy and reliability of decision making;
- documented organisational knowledge;
- improved accessibility to expert knowledge; and
- documentation of decisions made.

Once again, while identifying disaggregated benefits, disaggregated costs of a KBS project are not discussed in this study and the focus is upon benefits that accrue after implementation.

Stockdale and Wood (1992, p. 48) identify the following benefits of a KBS designed to evaluate tenders for the supply of new freight containers:

- time saved in task performance;
- labour savings; and
- improved ability to analyse problems.

Again the study does not assess the disaggregated costs of KBSs to organisations and focuses upon organisational benefits after implementation.

In a case study Sviokia (1990) identified the benefits of the XCON KBS for computer systems configuration as:

- reduced order cycle time;
- salary savings through the use of lower skilled employees;
- greater accuracy of decisions;

- greater decision completeness;
- increased output;
- broader solution scope; and
- reduced number of follow up telephone calls.

These benefits are similar to those reported by the other authors and also tend to ignore KBS costs to the organisation after implementation as well as those encountered during development.

Turban (1988 p. 72) addresses the issue of identifying costs associated with KBSs by describing several costs incurred during the development phases and after implementation. These include:

- a long development time frame
- a lengthy time needed to extract knowledge from experts;
- a high cost of development;
- large salaries paid to scarce knowledge engineers;
- difficulty in extracting accurate and complete knowledge from experts;
- difficulty in selling KBSs to management; and
- most KBSs only work well in a very narrow domain.

The issue of identifying costs associated with KBS development has been further addressed by Weitz and De Meyer (1990) who describe several costs associated with the development of KBSs. These include the cost of:

- employees, such as knowledge engineers, users, experts, and management;
- software and hardware for development;
- training users;
- operations including implementation; and
- updating the knowledge in the KBS.

Weitz and De Meyer (1990) also identify benefits such as:

- speedier solutions;
- more consistent problem solving;
- preservation and dissemination of scarce expertise;
- relieving experts of tedious tasks; and
- allowing experts to concentrate on more difficult/interesting problems.

As a whole the literature on KBS costs and benefits does identify a comprehensive range of disaggregated costs and benefits pertaining to KBSs. The range of costs and benefits includes typical costs incurred during systems development as well as many encountered after systems implementation. There is a high degree of convergence across the literature, especially concerning the benefits of KBSs to organisations which suggests that the majority of the benefits of KBSs are known. Despite this there has been no direct attempt to classify these costs and benefits into meaningful categories of value.

2.4.2 Categories for Classifying KBS Costs and Benefits

The above literature review represents a broad range of studies which identify the costs and benefits of KBSs in an organisation. In order to ascertain which categories are relevant for classifying these, a literature review was conducted across the management and information systems disciplines. The review revealed a significant number of research studies proposing the factors of time, cost, and quality as fundamental categories for analysis of concepts such as organisational or system performance, effectiveness, and success.

For instance, Sharman (1995) outlines a framework for measuring the performance of organisational processes and includes the criteria time, cost, and quality, for the measurement of performance Pengelly *et al.* (1993, p. 375) in a study of the software modelling process state that the aim of an organisational process is to produce products that are on time, to cost, and of a high quality. Corsten and Will (1995, p. 69) in a study of integrated production state that the success determinants in a production system are: cost; quality; and time. In the Retail and Purchasing literature Monczka and Trent (1991, p. 4) advocate that competitive success depends upon the following factors: achieving a position near low-cost producer status; the ability to maintain world class quality levels; and the ability to move from product concept to market in reduced time. Maximov and Gottschlich (1993, p. 3) state that the three critical dimensions that determine the attainment of a competitive advantage in retailing are: time (savings at each stage of the value added chain); cost (savings at each stage of the value added chain); and quality (savings at each stage of the value added chain).

This review reveals that these three categories are used to measure such concepts as performance, success, and effectiveness in a wide cross section of organisational activities. Therefore, it is proposed that they are likely to be meaningful to managers.

Table 2.1 represents an attempt to classify the costs and benefits of KBSs into these categories. All of these costs and benefits were able to be classified into one of three categories, namely: time; cost; and quality. Looking at the table the three categories appear

to be mutually exclusive in that each KBS value attribute can be classified in one and only one category.

Table 2.1 KBS Value Categories

Author/Date	Time	Cost	Quality
Turban (1995) KBS Benefits	Reduced down time	Cost reduction	Improved decision quality
			Increased output
	Response time	Use of less expensive equipment	Capturing scarce expertise
			Flexibility of decisions made
			Knowledge transfer to remote locations
			Easier Equipment operation
			Operation in a hazardous environment
			Reliability of decisions made
			Ability to work with incomplete and uncertain information
			Provision of training
			Increased integration with other computerised systems
			Enhances problem solving
			Integration of several experts' opinions
			Solve complex problems in a narrow domain
Author/Date	**Time**	**Cost**	**Quality**
Hayes-Roth and Jacobstein (1994) KBS Benefits	Increased speed of task accomplishment	Reduced cost	Increased quality
	Reduced training time	Decreased employees required	Improved decisions
			Retention of volatile and portable knowledge
			Reduced errors
			Improved customer service
Author/Date	**Time**	**Cost**	**Quality**
Stockdale and Wood (1992) KBS Benefits	Time saved in task performance	Labour savings	Improved ability to analyse problems

Table 2.1 KBS Value Categories (Continued)

Author/Date	Time	Cost	Quality
Hauser and Herbert (1992) KBS Benefits	Timeliness of decision making		Accuracy and reliability of decision making
	Productive use of inexperienced employees		Documented organisational knowledge
	Productive use of expert employees		Improved accessibility to expert knowledge
			Documentation of decisions made
Author/Date	**Time**	**Cost**	**Quality**
Weitz and DeMeyer (1990) KBS Costs and Benefits	Allowing experts more time to concentrate on more difficult/interesting problems	Project development costs including: cost of employees, software and hardware, training, operations, and updating	Preservation and dissemination of scarce expertise
	Speedier solutions		More consistent problem solving
			relieving experts of tedious tasks
Author/Date	**Time**	**Cost**	**Quality**
Sviokia (1990) KBS Benefits	Reduced order cycle time	Salary savings through the use of lower skilled employees	Greater accuracy of decisions
			Broader solution scope
			Greater decision completeness
			Increased output
			Reduced number of follow-up telephone calls
Author/Date	**Time**	**Cost**	**Quality**
Turban (1988)KBS Costs	A long development time frame	A high cost of development	Difficulty in extracting accurate and complete knowledge from experts
	A lengthy time needed to extract knowledge from experts	Large salaries paid to scarce knowledge engineers	Difficulty in selling KBSs to management
			Most KBSs only work well in a very narrow domain
Author/Date	**Time**	**Cost**	**Quality**
O'Leary and Turban (1987) KBS Benefits	Reduced response time	Cost reduction	Improved decisions by non experts
			More consistent decisions
			Improved training

2.5 Using Employee Perceptions of Value as Input into KBS Investment Decisions

Research by Browne (1993, pp. 121-122) shows that when managers make decisions they try to understand the perceptions and opinions of affected employee groups towards the relevant decision options. These perceptions and opinions are then used by the managers as input into their final decision. Furthermore, when making decisions, managers seek to gain information from employees of the organisation who are known to be knowledgable of the problem. They do this in order to ensure that the information used in making the decision is of a high quality (*ibid.*, p. 134).

Mintzberg (1994, p. 258) cites research which demonstrates that managers rely more upon "soft" information derived from perceptions of people, than they do on "hard" quantified information when making decisions. Mintzberg (1994, p. 258) states that around 80 percent of the time, a manager will use such perception based information to make decisions. Managers prefer this "soft" perception based information over "hard" quantified information because "hard" information: is often erroneous and needs to be checked for accuracy against the perceptions of employees; is usually too aggregated to be useful in decision making; does not include non economic and non quantitative factors; and usually arrives too late to be of use in decision making (*ibid.*, 1994).

Research from the information systems field reinforces these findings. In particular Hamilton and Chervany (1981a, p. 67) state that when evaluating a management information system's (MIS's) effectiveness, the view points of the major employee groups affected by the MIS should be measured. This is because these employee groups represent the organisational functions affected by the MIS. Measuring their perceptions of the MIS's affect on these organisational functions will provide a gauge of the MIS's effectiveness. This research indicates that perceptions of employees provide vital input for general decisions made by managers. It further indicates that these perceptions are important for evaluation of information systems.

The KBS value model proposed in this thesis is used to make decisions about whether or not to invest in a KBS. Therefore, the research by Mintzberg (1994) and Browne (1993) is particularly important because it justifies that the use of employee perceptions forms part of the basis for making these decisions. Furthermore, it indicates that managers require perception based information on both tangible and intangible factors.

Since using the perceptions of employees as the basis for making KBS investment decisions is justified, a decision must be made as to which employees to use. The employee

groups which Hamilton and Chervany (1981b, pp. 79-80) cite include: management; users groups; information system developers; and employees from the organisation's internal audit function.

For the same reasons as a MIS, the effect of a KBS will likely be different for each organisational function. Therefore, the relevant employee groups to use would include those coinciding with the organisational functions affected by the KBS. The employees affected by the KBS are discussed in (Turban, 1995). These include: senior managers; project managers; KBS users; experts; knowledge engineers; and programming employees. Senior managers perform the role of project champion. Project managers manage the project on a day to day basis. KBS users use the KBS to perform a decision making process. Experts provide knowledge for KBS development. Knowledge engineers acquire the knowledge from experts and represent it formally. Programmers use these formal representations to create the KBS program.

2.6 Assessing KBS Value During Prototype Phases

In addition to the preferences of managers for perception based information there are other reasons for using perceptions as the basis of this KBS valuation model. First, Smith and Dagli (1992, p. 64) state that in early phases of a KBS project's lifecycle, cost estimates generated using traditional models are unreliable, but become less so as the project develops. Furthermore, Turban (1995, p. 652) states that both costs and benefits of a KBS project are difficult to predict because the capabilities of a KBS are changed constantly as it is developed. These constant changes are due to the iterative development nature inherent in a KBS project. The development of a KBS is iterative in the sense that a series of prototype systems are developed each with a successively larger number of rules which make a successively larger number of decisions. During these development iterations it is difficult to measure the likely tangible benefits and costs by using the traditional models. This is because these traditional models base their predictions of tangible financial benefits and costs upon an estimation of how much the KBS will earn and how much it will cost to develop and maintain once it is fully operational. However, since the KBS is a prototype, the figures used to make these estimations are very unreliable. Thus when a KBS prototype is being developed estimates using these traditional indicators are very unreliable (Smith and Dagli 1992, p. 64).

As a result of these considerations, the concept of using perceptions of employees could beneficially be applied to measuring KBS value, during these prototype phases. In short

they could be used to estimate the perceived contribution of tangibles to value, in addition to intangibles.

2.7 Measurement of Intangible Costs and Benefits

Taylor and Graham (1992, p. 52) state that the information needs of organisational executives for decision making are not being met and that the information provided to these executives is biased towards financial indicators. Furthermore, the information given to them lacks details on non-financial factors otherwise known as intangible costs and benefits (*ibid.*, p. 52). In order to make effective decisions, information on non-financial factors is needed in addition to financial factors.

KBSs are characterised by tangible benefits and costs as well as intangible benefits. Lin (1991, p.101) states that intangible costs also exit in KBSs. As argued by Smith and Dagli (1992), in order to make a decision of whether or not investment in a KBS is justified an assessment of both tangibles and intangibles should be performed.

It is evident that executives need information on intangibles in addition to tangibles. Furthermore, KBSs are typified by both tangible and intangible costs and benefits. Therefore, a KBS valuation model which assesses both tangibles and intangibles should be held in high regard by managers.

2.8 Use of a Psychological Model to Elicit Perceptions of KBS Value

The valuation model presented in this thesis uses perceptions to assess the value of a KBS. A valid and reliable psychological model which elicits and scores these perceptions is therefore required (Clark and Soliman 1996, p. 145). Without such a model to guide elicitation, and assessment of KBS value attributes, there is no way of validating the results obtained and no way of ensuring that the valuation model presented here is reliable. In section 2.11 below such a model with these capabilities is reviewed.

2.9 Valuation in Each KBS Lifecycle Phase

Valuation of the KBS in each life cycle phase of the KBS represents another relevant requirement for the KBS valuation model in addition to those already specified. It is likely useful for a manager to know what phase in the KBS lifecycle the system was when the

value measurements were taken. Consider the following hypothetical scenario. Two KBSs, system A and system B, are currently under development. Because of funding cuts, one system is to be shelved and the other is to receive continued funding. All things equal, the system with the highest value should be chosen for continued development.

Assume now that system A is near completion but has a lower value than system B which itself is in an early development phase. Possibly, system B with the highest value should be chosen. If significant funds had already been spent on system A, the manager may want to choose it instead. It is not an aim of this thesis to solve decision scenarios such as this one. Instead the aim as stated in Chapter 1 is to assess the value of a KBS as perceived by key employees involved in its lifecycle. However, this scenario does demonstrate that it may be desirable to identify the lifecycle phase each system is in when it is valued as additional input into making these decisions.

In addition to this, it is likely that KBS value will evolve across the phases of a system's lifecycle. This is likely to occur because with each new KBS prototype, new functionality will be added. Hence, it would be useful for a manager to know which phase the KBS project was traversing when it was valued in order to track whether the value of the KBS is rising or falling. In this case the value model should be capable of measuring value in each phase. It must therefore, be capable of identifying which phase the KBS project is traversing when valued.

In view of the advantages of measuring KBS value at each lifecycle phase, as described above, it is proposed that the KBS valuation model presented in this thesis be designed with this capability. To achieve this, a review of the literature was made to identify the phases of a KBS lifecycle.

Harmon *et al.* (1988, p. 168) identify the following KBS development phases:

Phase 1: Front End Analysis

- Identify appropriate problem
- Determine Cost/effectiveness
- Arrange management support

Phase 2: Task Analysis

- Identify appropriate task
- Identify behavioural sequence

- Identify knowledge required

Phase 3: Prototype Development

- Identify case studies (criteria)
- Develop a small system to provide proof of concept and practice

Phase 4: System Development

- Rearrange overall structure as necessary
- Add knowledge

Phase 5: Field Testing

- Test system with actual users
- Revise as necessary

Phase 6: Implementation

- Port system to hardware to be used in the field
- Train users to use the system

Phase 7: Maintenance

- Establish means to update the system
- Update the system as needed

Turban (1995, p. 633) specifies these phases of the KBS development lifecycle:

Phase I: Problem Initialisation

- Problem definition
- Needs assessment
- Evaluation of alternative solutions
- Verification of an expert systems approach
- Consideration of managerial issues

Phase II: System Analysis and Design

- Conceptual design and plan
- Development strategy
- Sources of knowledge
- Computing resources
- Feasibility study
- Cost-Benefit Analysis

Phase III: Rapid Prototyping

- Building a small prototype
- Testing, improving, expanding
- Demonstrating and analysing feasibility
- Completing design

Phase IV: System Development

- Building knowledge base
- Testing, evaluating, and improving the knowledge base
- Planning for integration

Phase V: Implementation

- Acceptance by users
- Installation, demonstration, deployment
- Orientation, training
- Security
- Documentation
- Integration, field testing

Phase VI: Post implementation

- Operation
- Maintenance and upgrades
- Periodic evaluation

Mumford (1987, p.140) identifies the following stages of a KBS development lifecycle:

1. The identification of a suitable business problem;
2. The initial prototyping of a solution to check its validity;
3. The creation of a project team. This should consist of a mix of experts, knowledge engineers - who act as the link between the human expert and the system - and future users;
4. The creation of a steering committee;
5. The development of a project plan;
6. The training of project team members in the technology, problem area and methods of systems design;
7. The creation of an initial design;
8. The development of a basic shell;
9. The testing of this in the user environment;
10. Installing the system in the user environment and training the users;
11. Enhancing the system; and
12. Adapting it to changing business needs.

Prerau (1990, p. 30) states that a plan for development of a KBS project includes the following phases:

Initial phases

- Project start-up
- Selection of the domain
- Selection of the development environment

Core Development Phases

- Development of a feasibility prototype system
- Development of a full prototype system

Final Development and Deployment Phases

- Development of a production system
- System deployment
- System operation and maintenance

Kahn (1992, p. 133) offers the following phases in a Knowledge Based Systems Development lifecycle:

1. Initiation Phase

- Definition of problem
- Determination of KBS technology feasibility
- Identification of the users
- Identification of appropriate domain expertise

2. Concept Phase

- small prototypes built to test whether KBS technology is appropriate

3. Definition/Design Phase

- Stand alone prototype to demonstrate user interface and problem solution capabilities
- Prototype implemented in a representative target environment and subjected to a set of comprehensive test cases

4. Development Phase

- Fully integrated operational prototype implemented in an environment equivalent to the target operational environment

5. Deployment Phase

- Installation and testing of operational prototype at each user site

6. Post-deployment Phase

- Maintenance of system
- Post-implementation evaluation of use
- Planned enhancements of the system

Clark (1992, p. 311) proposes that the following key phases of a methodology for KBS design should include the following:

- a strategy for KBS development;
- selection of an application domain;
- selection of domain expert(s);
- estimation of costs and benefits of development;
- elicitation of acquired knowledge;
- representation of acquired knowledge;
- derivation and representation of a logical model;
- derivation and representation of a physical model;
- implementing and testing of a KBS; and
- maintenance of a KBS.

As can be seen from this review, while there are differences across the proposed models in terms of the number of phases present, and the phases in which the activities are performed, there appears to be general agreement on the types of activities performed over the lifecycle. Since there exists a wide variety of lifecycle models in the literature, it is assumed that there is likely a wide variety of such models used in practice. Therefore, the valuation model proposed in this thesis does not advocate any one lifecycle model. Instead, it firstly identifies the lifecycle model used in practice at an organisation. Secondly, it identifies the phases in that lifecycle. Thirdly, it assesses the value in each phase as the KBS traverses the said lifecycle. This allows the manager to track the value of a KBS as it evolves and to provide him/her with more information regarding the comparative value of two or more KBSs under development.

2.10 Review of Valuation Models Relevant to KBSs

2.10.1 Scoring Models of Project Valuation

Smith and Dagli (1992) outline several models which are relevant to valuation of KBSs. According to Smith and Dagli (1992, p. 64) these models are known as "nonclassical" models for appraising development and implementation of factory automation information systems and are relevant to the KBS valuation domain. In this thesis they are known as alternative models. These models include profile charts, symbolic scorecards, and linear additive models. These models are relevant because the development and implementation of KBS and factory automation information systems share a common characteristic. Both are typified by numerous intangible attributes which contribute significantly to system value.

Smith and Dagli (1992, p. 64) suggest that traditional valuation models are unable to completely measure the worth of KBSs for the justification of KBS projects because they are unable to measure the contribution to value from intangibles.

In addition to this, Smith and Dagli (1992, p. 69) argue that in the early phases of a KBS project's lifecycle, cost estimates generated using traditional models are unreliable, but become less so as the project develops. Also as previously mentioned, Turban (1995, p. 652) states that both costs and benefits are difficult to predict during the lifecycle phases of KBS projects due to their iterative development and implementation nature. In order to estimate the value of a KBS project in its early phases and to measure the contribution of intangibles to value at all phases of a KBSs lifecycle, Smith and Dagli (1992, p. 64) advocate that the alternative models of valuation can be coupled with traditional models to overcome these obstacles. The alternative models will now be critically reviewed in terms of their capability to fulfil the requirements of a KBS valuation model as previously specified.

2.10.1.i Troxler and Blank's Scoring Model for Manufacturing Information Systems

Troxler and Blank (1989) present a scoring model which is designed to measure and compare the value of multiple manufacturing information systems. It uses a valuator to score two or more systems across three categories of value. It then compares these results to determine which system to invest in. It decomposes the costs and benefits of a manufacturing information system project. It then classifies them into the categories of: suitability; capability; performance; and productivity. These categories form the basis for comparison of value between systems. The categories have the ability to encompass both tangible and intangible costs and benefits. However, they are not relevant categories for use in KBS valuation. The costs and benefits relevant to KBSs as identified in the previous literature review are more easily placed in categories of time, cost, and quality than they are into these categories. Furthermore, it is proposed that the categories of time, cost, and quality are more meaningful to management than those proposed by Troxler and Blank (1989).

The model is designed to measure value to the system user. Despite this it does not measure perceptions of value from the users themselves. Instead it uses the perceptions that a manager has regarding the value of the system to user groups. Therefore, it does not measure the perceptions of users for input into decision making. Even if the model did use actual user perceptions it would still be inadequate for assessing value in KBSs. This is because KBSs include other employee groups besides users.

The model attempts to elicit perceptions that a manager has regarding the costs and benefits of users. However, since it does not use a well founded psychological model to elicit perceptions of value, it is not assured of eliciting relevant and accurate perceptions.

The measures of costs and benefits used by Troxler and Blank (1989) rely on traditional valuation approaches in addition to the perceptions of a valuator. This is an impediment to being able to measure value in a KBS during early lifecycle phases. Recall that traditional valuation approaches cannot be used due to their inaccuracy during these phases.

The Troxler and Blank (1989) model does provide information to managers regarding the intangible costs and benefits in addition to tangibles. It achieves this by having the valuator rate intangible costs and benefits based upon his/her perceptions of the value of these intangibles to the users.

Troxler and Blank (1989, p. 180) envisage the use of the model to measure value in the planning and post implementation phases of a manufacturing system's lifecycle. Exactly what constitutes these phases is not specified. Despite this it probably would be able to measure value in each phase of a system's lifecycle. All that this would require is execution of the model at each lifecycle phase.

In order to test its capabilities, Troxler and Blank applied the model to an organisation intending to employ manufacturing technology (1989, p. 180). It was used to evaluate three competing manufacturing system possibilities within this organisation. However, due to the weaknesses identified regarding the requirements of a KBS valuation model, it is an inadequate model for assessing the value of a KBS.

2.10.1.ii Pienaar's Scoring Model

Pienaar *et al.* (1986) present a scoring model which is designed to measure and compare the value of multiple manufacturing systems. It uses user groups to score two or more systems across three categories of value. It then compares these results to determine which system to invest in. It decomposes costs and benefits and classifies them into the following categories: system utility; system availability; and system cost/benefit. These categories include measures for both tangible and intangible costs and benefits. However, they are unsuitable for use in assessing KBS value. Firstly, it is proposed that they are not as meaningful to management as time, cost, and quality. In particular the category of system cost/benefit is too general. Secondly, the costs and benefits of KBSs derived from the literature review fit more appropriately into the time, cost and quality categories.

The model measures value to users, based upon the perceptions of the user groups. However, it does not assess value to other employee groups relevant to the manufacturing systems domain. This is inadequate for assessing value in KBSs since KBSs include other relevant employee groups in addition to the user.

The measures of costs and benefits used in the model include a mix of traditional valuation approaches and alternative techniques. This is an impediment to being able to measure value in a KBSs early lifecycle phases. As discussed earlier, traditional valuation approaches cannot be used due to their inaccuracy during these prototype phases.

The model does provide information to managers regarding the intangible costs and benefits in addition to tangibles. It achieves this by having the users rate intangible costs and benefits based upon their perceptions.

The model uses the perceptions of user groups to assess the value of a system. However, it does not utilise a well founded psychological model with which to elicit these perceptions. Without such a model to guide the elicitation of perceptions there is no guarantee that the perceptions will be complete or accurate.

Pienaar *et al.* (1986) do not indicate whether their model is suited to measuring value in each of the various phases of a manufacturing system's lifecycle. However, this could be achieved since all that this would require is execution of the model at each lifecycle phase.

This model has been successfully applied to a situation where a large development corporation was building a dam for two neighbouring countries (Pienaar *et al.* 1986, p. 12). The two countries represented two user types with different needs. However, due to its inadequacies it represents and insufficient model for valuing a KBS.

2.10.1.iii Nelson's Linear Additive Scoring Model

Nelson (1986) presents a linear additive scoring model for valuation of multiple manufacturing information system projects. It uses an appointed valuator to numerically score each project cost and benefit in terms of its importance. It then weights each attribute according to some predetermined guidelines. Weights and importance scores for each project attribute are multiplied. The products are summed resulting in a final value score.

Nelson's (1986) model decomposes a measure of value into individual costs and benefits. It then categorises these costs and benefits into the classes of: technology assessment;

equipment evaluation; capacity elasticity; and cost/budget data. These categories have little in common with the costs and benefits of KBSs as identified in the literature review above. In addition, it is proposed that they are far less meaningful to managers faced with making an investment decision, than the categories of time, cost, and quality.

The model does not specify who should perform the valuation, nor how many valuators there should be. It is thus evident that the model is not designed to measure value using perceptions of employee groups. Therefore it cannot provide the information in the form of perceptions of employees which is needed by managers to make a KBS investment decision.

The measures of costs and benefits used by the model include a mix of traditional valuation approaches and alternative techniques. This is an impediment to being able to measure value in a KBSs early lifecycle phases since traditional valuation approaches cannot be used due to their inaccuracy during these early phases.

The model does provide information to managers regarding the intangible costs and benefits in addition to tangibles. It achieves this by having an unspecified valuator rate intangible costs and benefits based upon his/her perceptions.

The model must use the perceptions of a human valuator to score the costs and benefits of a system. Despite this, it does not utilise a well founded psychological model with which to elicit these perceptions. Without such a model to guide the elicitation of perceptions there is no guarantee that the perceptions will be meaningful or accurate.

Nelson (1986) does not indicate whether the model is suited to measuring value in each of the various phases of a manufacturing system's lifecycle. However, this could be achieved since all that this would require is execution of the model at each lifecycle phase.

This model has been successfully applied to an organisation assessing the development of three alternative manufacturing systems (Nelson 1986, p. 354). However, because of the inadequacies identified, it is not possible to apply it to KBS valuation.

2.10.1.iv Sullivan's Profile Chart and Symbolic Scorecard

Sullivan (1986) presents two models for assessing the costs and benefits of a manufacturing information system project. The first is a visual model for evaluating a project's costs and benefits known as a profile chart (*ibid.*, p. 44). It is thus non numeric, utilising instead a shading technique to visualise the degree to which each project attribute is

a cost or benefit. Profile charts do not attempt to rank alternative development projects. Instead they provide information on costs and benefits of each project independent of other projects. The manager uses his own judgement to select alternatives for investment, given the profile charts of the individual projects.

The second model is also a visual model known as a symbolic scorecard (Sullivan, p. 44). This is a project valuation model similar to profile charts, but words are used instead of shading and a system of colours is used to rate alternative projects. The results provide a ranking of alternative projects from which the manager chooses.

Both models do not calculate a total value for a system since both are non numeric. Both models list all costs and benefits in a tabular format. Therefore, they provide a decomposed assessment of a system's costs and benefits. However, the data is displayed as a list with no classification into categories for costs and benefits of a common type. Classification of this nature is viewed as desirable by Troxler and Blank (1989, p. 177) because it is more meaningful to managers.

Sullivan (1986) does not specify who should perform the valuation, nor how many valuators there should be. In addition, both profile charts and symbolic scorecards are not designed to measure value to employee groups. Therefore, they cannot provide the information in the form of perceptions of employees which is needed by managers to make a decision.

The measures of costs and benefits used by Sullivan (1986) in both models are based purely upon the perceptions of the valuator. This is an advantage in measuring value in a KBSs early lifecycle phases since traditional valuation approaches cannot be used due to their inaccuracy during these early phases.

Both profile charts and symbolic scorecards do provide information to managers regarding the intangible costs and benefits in addition to tangibles. This is achieved by having an unspecified valuator rate intangible costs and benefits based upon his/her perceptions.

Sullivan (1986) does not indicate whether profile charts or symbolic scorecards are suited to measuring value in each of the various phases of a manufacturing system's lifecycle. However, this could be achieved since all that this would require is use of either model at each lifecycle phase.

For both models a valuator must rate the costs and benefits of a system. However, a well founded psychological model is not used to elicit the valuator's perceptions. Without such a

model to guide the elicitation of perceptions there is no guarantee that the perceptions will be meaningful or accurate.

Both profile charts and scorecards have been applied by the University of Tennessee's Centre for Computer Integrated Engineering and Manufacturing (CIEM) to measure the value of manufacturing information systems for client organisations (Sullivan 1986, p. 45).

2.10.2 Value Analysis of Decision Support Systems

Keen (1981) presented a model designed specifically to measure Decision Support System (DSS) value. Keen demonstrates that DSS projects are typified by numerous intangibles and as a result traditional approaches to valuation are unable to value DSSs. In addition, Keen (1981, p. 1) states that in a DSS project the monetary value of benefits and costs are not easy to identify because with each new system version, new requirements and capabilities are added. This makes value estimation using traditional models impossible or at least very inaccurate. DSSs and KBSs share these same two characteristics. According to Keen (1981, p. 1) it is these two characteristics that render traditional valuation models inadequate for the valuation of DSSs.

The value analysis model proposed by Keen (1981) is an attempt to overcome these problems in the domain of decision aiding systems. O'Keefe (1989, p. 217) states that decision aiding systems comprise those systems that are used to aid the process of making a decision in an organisation. O'Keefe (1989, p. 217) includes both DSS and KBS as decision aiding systems.

Based upon an exhaustive literature review the model by Keen (1981) represents the only model found in the literature which is designed to overcome the difficulties in measuring value in the domain of decision aiding systems as defined by O'Keefe (1989, p. 217). Since KBSs also fall into this domain, Keen's model was reviewed in order to judge its relevance to the measurement of KBS value.

Keen's model measures DSS value to the DSS user at various stages of the development lifecycle. These development stages include: planning; prototype development; assessing the prototype; costing of version one; and development of each subsequent version.

The model is founded on Keen's idea of value analysis. Central to the concept of value analysis, is an emphasis on benefits first and cost second. Value analysis identifies the benefits and compares them to the cost or price that those employees who use the system are willing to pay for the DSS. Hence, at each stage of development the benefits of the DSS

are compared to the cost of development and the amount the evaluator is willing to pay for the system. Based on this comparison a decision is made to perform further development, delay development, or scrap the project.

Keen's model appears to overcome the problem of valuing intangibles. However it has several shortcomings when applied to KBSs. While it identifies intangible benefits, it has no mechanism for identifying and measuring intangible costs. Lin (1991, p. 101) recognises that intangible costs also exist in KBS projects in addition to intangible benefits. Since Keen's focus is on DSS benefits, the only cost included is the financial cost of development. Potential intangible costs are not measured. Intangible costs may occur at various phases in the KBS lifecycle. They may include, for example: increased amount of time to provide a KBS generated decision; large amount of time taken for the expert to provide knowledge for development and update; decreased time for other job functions on the part of those staff involved in the KBS project.

Keen does not measure the perceptions of all relevant employee types when assessing the value of a DSS. Keen only includes the DSS user as a valuator. A DSS may have value to other organisational employees, such as, the system developers, system users, and management to name three. However, the intangible benefits accruing to developers and other managerial staff other than the DSS user are not measured. In the case of KBSs, expert employees, users who are not managers, and managers, to name three, will also derive value from the system. Keen's model only provides information on the perceptions of one relevant employee type.

In Keen's model the user is the valuator and is required to estimate in dollars the maximum amount he/she is willing to pay to receive the benefits from the DSS. He/she is also a manager and is, therefore, in a position within the organisation to estimate the maximum amount he/she is willing to pay. In a KBS there are several employees who stand to gain or lose from the KBS, such as experts, users, and management staff. It is questionable whether the expert and user employees would be able to meaningfully estimate how much money they would be willing to spend to receive their intangible benefits. Their dollar estimates may not be meaningful, realistic, or acceptable to management.

Keen's model does provide disaggregated information on intangible benefits, but only provides an aggregated figure for tangible cost. Furthermore, his model does not attempt to classify these disaggregated benefits into categories which will be meaningful to management.

Keen does propose to measure perceptions of DSS users, but his model does not use a well founded psychological model with which to elicit these perceptions. Hence, there is no guarantee that his model will measure perceptions of value with the required precision.

At each stage of a DSS project Keen's model measures and compares the benefits with the maximum dollar cost that a user/manager would be willing to pay to obtain the benefits. Hence, his model does not rely upon traditional valuation models which are unable to calculate value in these prototype phases. However, Keen's model does not measure the contribution to value of intangible costs. Therefore, it is incapable of measuring the full value of a DSS in these prototype phases.

Ford (1994, p. 26) proposes that Keen's (1981) idea of value analysis is relevant and can be applied to traditional information systems valuations. However, value analysis as proposed by Ford (1994) does not overcome any of the problems of Keen's (1981) original model. Indeed Ford (1994 p. 26) cites the length of time taken to perform value analysis as a disadvantage of the model.

2.10.3 Criticisms of Scoring Models

Nelson (1986), Pienaar *et al.* (1986), and Troxler and Blank (1989) all propose scoring models which attempt to weight the relative importance of both tangible and intangible costs and benefits of a system. Consider the rationale for weighting attributes in these models. It is to measure the relative importance of each attribute so that the relative contribution of each to total value can be determined. All of these scoring models reviewed except Nelson (1986) elicit from a valuator scores of relative importance for each attribute. Nelson (1986, p. 347) assumes that the weights for each attribute will be equal. The models then use a numerical method to calculate the normalised weight for each attribute, where the term normalised means the sum of the weights is 100 points. The weights are then used to determine the relative importance of each attribute to total value. However, Smith and Dagli (1992, p. 67) state that caution should be applied when individuals assign weights as inconsistency and subjectivity can be introduced into the process. Inconsistency occurs because individuals can provide conflicting ratings of attribute importance. For instance attribute A has more value than attribute B, and attribute B is better than C, but C is better than A (Smith and Dagli 1992, p. 69).

Sullivan (1986 p. 46) indicates that since profile charts do not assign weights to attributes, they are not afflicted by these problems. Profile charts instead provide the manager with a visual presentation of a system's value with no rank of the relative importance of the various costs and benefits. The manager examines the costs and benefits which are

represented pictorially for one or more projects. He/she then uses his/her own judgement to choose between systems regarding the relative importance of the costs and benefits.

2.10.4 Other Alternative Approaches to Measuring Intangibles

2.10.4i Real-Options Analysis

Recently attempts have been made to measure intangibles by measuring them in financial terms. One notable attempt was made by Kemerer (1998) who proposes that "real-options analysis" can be used to measure intangibles in conventional information technology projects. Real-options analysis treats investments in information technology as if they were investments in financial options which can be bought or sold for a price in the future (Kemerer 1998, p. 170). Hence, an investment in an information system has a benefit upon completion and a benefit in future as the system evolves to have more capabilities. This is a particularly useful concept to KBSs, because their value typically changes as they traverse the KBS development lifecycle as described in Chapter 2 section 2.9. Despite this advantage, real-options analysis as proposed by Kemerer (1998) has some critical inadequacies when applied to KBS valuation. First, it appears to provide an aggregated measure of intangibles, which is expressed in financial terms. Second, it does not specify which employee groups can buy and sell options. Furthermore, it is doubtful that a user or expert in a KBS could place a meaningful dollar value upon a KBS. They do not have enough knowledge of the worth of the system in dollar terms to the organisation.

2.10.4.ii Simulation and Role Playing

Ford (1994, p. 27) proposes the use of simulation and role playing in which employees use a computer program to simulate performance of a task. The simulated computer program is designed to simulate performance of a task which previously was performed manually and in future could be performed through the use of an information system. It is intended that the employees use the simulation program in a role playing scenario and then rate their satisfaction of using the system if it were to be truly implemented. There are a number of problems with this idea when applied to KBS valuation. First, it would be very difficult and costly to develop a simulation program of a KBS which would adequately simulate an environment representative of the jobs of experts, users, and managers involved in valuing a KBS. The simulated program for the user would indeed be the KBS. A separate program would be required to simulate the new job of the expert. Second, it is possible to foresee how some of the aspects of the jobs employees involved in the KBSs development may change, and to design a role playing scenario which defines each employee's new task responsibilities and sequences in task performance. However, it is proposed that it is

unlikely that a role playing scenario could foresee all relevant changes to the tasks of KBS experts, managers, and users. Such a role playing scenario is at best a fuzzy reflection the real life task performance scenario in which the user, expert, and manager are likely to find themselves. Therefore, the accuracy with which employee groups could be expected to measure the costs and benefits of the KBS is questionable using simulation and role playing.

2.11 A Model Specifically Designed for the Valuation of a KBS

With the exception of the DSS value analysis model by Keen (1981), Smith and Dagli (1992) advocate the use of all the project valuation models reviewed above for the measurement of KBS value. However, these models have been designed for the conventional information systems domain. Smith and Dagli (1992) overlook the fact that the models have not been designed for use in measurement of KBS value. Likewise, Keen's (1981) value analysis model has been designed for DSS valuation and is not appropriate for KBS valuation. As discussed above all of these models are not effective tools for valuation of projects in the KBS domain. This is because they do not effectively deal with the requirements of a KBS valuation model as discussed in this chapter.

To overcome the problems of these existing models, this thesis presents a new model which is specifically designed for KBS valuation. This new model will incorporate the requirements identified in this chapter. Therefore, it will bridge the gaps discovered in the models reviewed. Accordingly, this model represents an original contribution to the field of KBS management.

The KBS valuation model presented in this thesis aims to achieve this by first providing disaggregated information to managers for making KBS investment decisions. Second, this disaggregated information will be placed into the categories of time, cost, and quality. Third, the model will measure the perceptions of key employees involved in the KBS in order to assess the value of a KBS. Fourth, the model will adapt a psychological model in order to accurately elicit the perceptions of KBS value. Fifth, the model will measure intangibles and tangibles from the perspectives of the key employees. Sixth, the model will be capable of measuring value during the prototype phases where traditional models are incapable of measuring value.

2.11.1 Overview of the Theory of Reasoned Action

The psychological model used to measure the perceptions of key employees involved in KBS is the Theory of Reasoned Action (TRA), (Ajzen and Fishbein 1980), (Fishbein and Ajzen 1975). The reasons for choosing TRA will be given in Chapter 3. TRA will now be reviewed to give the reader an understanding of its workings and to establish its credibility as an effective psychological model for the measurement of human perceptions in general and perceptions of KBS employees regarding KBS value in particular.

TRA is a psychological model designed to predict performance of certain behaviours by individuals and to provide an understanding for why they are performed. TRA is a psychological model designed to explain why a person performs a certain behaviour and/or to predict that behaviour. It is a well formulated generic model and thus has subsequently been applied to a wide range of behavioural domains including information systems. Its application to literally hundreds of studies and a number of quality critiques provide the foundation for a good review of its capabilities.

The theory utilises the constructs of belief, belief evaluation, attitude, normative belief, motivation to comply, subjective norm, intention, and behaviour. *Behaviour* is referred to as observable acts performed by a subject (Fishbein and Ajzen 1975, p. 13) An individual can perform a behaviour, in terms of time, context, and target (Ajzen and Fishbein 1980, p. 34). A target refers to an event, a physical entity, or an institution to which a behaviour is directed (*ibid.*, p. 34). Context refers to the situation in which the behaviour takes place (*ibid.*, p.34). Time refers to the time in which the behaviour takes place (*ibid.*, p.34). *Intention* is defined as the likelihood that an individual will perform a certain behaviour (*ibid.*, p. 42). *Attitude* is defined as the evaluation made by the individual of whether performing a behaviour is favourable or unfavourable (*ibid.*, p. 6). A *subjective norm* is referred to as a person's perception of the social pressures placed upon him/her to perform or not perform a behaviour (*ibid.*, p. 6).

A *Belief* is defined as an individual's perception that performing the target behaviour will result in a certain consequence (Fishbein and Ajzen 1975, p. 29). Consequences of performing a behaviour are perceived by an individual to be either positive or negative. A *Belief evaluation* is defined as the likelihood to which a belief will occur or has occurred (Ajzen and Fishbein 1980, p. 66). *Normative beliefs* are referred to as the person's beliefs that specific individuals or groups think he/she should or should not perform the behaviour (*ibid.*, p 73). For each normative belief there is a motivation to comply. A *motivation to comply* refers to a person's desire to comply with a normative belief (*ibid.*, p. 75).

Figure 2.1 shows the model of beliefs, belief evaluations, normative beliefs, attitude, subjective norm, intention and their effect upon performance of a behaviour. An individual formulates positive and negative beliefs concerning the performance of the behaviour. Attitude toward performing the behaviour is a function of beliefs held and their associated belief evaluations. The overall value of these beliefs and evaluations directly affects the value of the individual's attitude. The more positive the beliefs and evaluations are the more positive will be the attitude component.

The individual also formulates positive and negative normative beliefs regarding performance of the behaviour. The subjective norm is a function of the normative beliefs and their associated motivations to comply. The overall value of these normative beliefs and motivations to comply directly affects the value of the individual's subjective norm.

Intention toward performing the behaviour is a function of attitude and the subjective norm. The more positive the attitude and subjective norm, the more positive the intention to perform the behaviour. Finally, behaviour is a function of intention. The more positive the value of intention, the more the individual is likely to perform the behaviour.

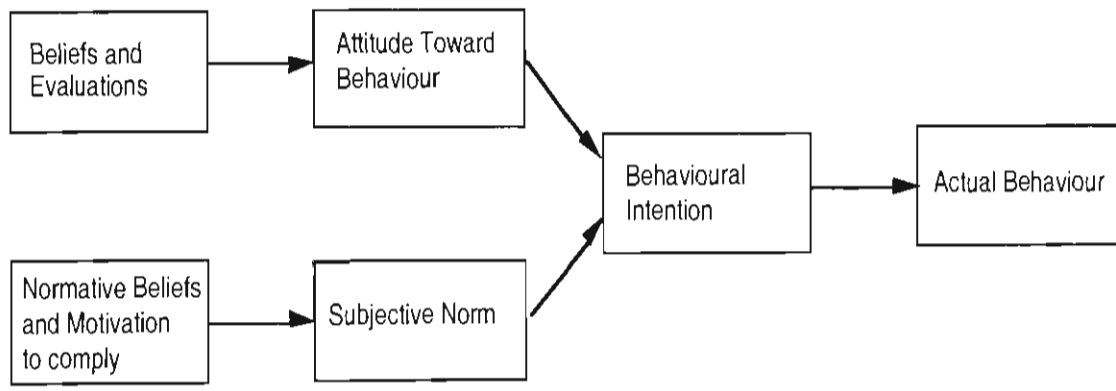

Figure 2.1: Causal Factors in the Determination of an Individual's Behaviour

Adapted from Ajzen and Fishbein (1980) p. 8.

TRA states that any behaviour can be described as consisting of four elements: action; time; context; and target Ajzen and Fishbein (1980 p. 34). Any particular action is carried out in regard to a particular target, in a certain situational context, and at a certain time (Fishbein and Ajzen 1975 p. 889). If the behaviour of interest was not defined with respect to these criteria, then it would be unclear if indeed this behaviour was actually being measured. TRA is designed to explain and/or predict behaviour, based upon its constructs. The constructs of TRA represent the reasons why a certain predefined behaviour is performed. In order for these constructs to correctly explain and predict a behaviour they must be

defined in terms of action, time, context, and target just as is done for behaviour. If these constructs were not defined with respect to these criteria, then they would not correspond to the behaviour of interest, and would be unable to predict or explain why the behaviour was performed.

TRA treats attitudes toward targets, personality traits, and demographic characteristics as external variables (Ajzen and Fishbein 1980 p. 9). TRA recognises that they may be related to behaviour, but states that any such relation is an indirect one which is mediated completely by the constructs of the model Ajzen and Fishbein (1980, pp. 82-86).

2.12 Critical Analysis of TRA

2.12.1 The Assumption of Volitional Control

TRA is designed to explain and predict behaviour that is under the volitionary control of an individual (Ajzen and Fishbein 1980, p. 5). It is best suited to situations where an individual's performance or non-performance of a behaviour is entirely under his/her volitional control, but may not be as well suited to situations which do not meet this criterion (Sheppard *et al.* 1988, p. 326). TRA assumes that most relevant behaviour is under an individual's volitional control (Ajzen and Fishbein 1980, p. 5). As a result, TRA assumes that intention is the immediate determinate of behaviour and no other factors influence the performance of the behaviour (*ibid.*, p. 5). However, there are situations where this assumption does not hold. For example, once a car is bought, the owner must buy petrol. If there is only one petrol station in town, the owner has no choice in buying or not buying petrol at that station. In this case a person's buying of petrol at that station is determined by other factors besides intention to, or not to, buy petrol at that station. The purchase of petrol in this instance is not under the individual's volitional control. His/her behavioural beliefs, attitude, normative beliefs, subjective norm, and intention, are not the only predictors of the behaviour. In this case these variables may not fully predict nor accurately explain why he/she bought petrol at this station. He/she may do it simply because he/she had no other choice.

In any circumstances where an individual's performance of a behaviour is wholly or partially influenced by factors outside his/her volitional control the assumption of volitionary control is violated Sheppard *et al.* (1988, p. 326). These factors have been categorised as follows: information, skills, and abilities; emotions and compulsions; opportunity; and dependence on other people Ajzen (1988, pp. 128 - 131). Each of these factors will now be discussed.

If a person lacks the information, skills, and/or ability required to perform a behaviour, then it follows that he/she will be unable to perform the behaviour. In instances such as these, performance of the behaviour will not be under the person's volitional control. Even if the person has a positive intention to perform the behaviour, he/she will be unable to do so. In this instance, TRA will be unable to explain or predict performance of a behaviour.

Some behaviours are based upon compulsions. A compulsive behaviour can be described as one which is out of the volitional control of the individual. Even if a person has a negative intention, he/she will more than likely engage in the compulsive behaviour. Other behaviours are based upon emotion. In these situations strong emotion may lead a person to perform a behaviour even, if he/she did not intend performing the behaviour. In situations, characterised by either emotion or compulsion, performance of the behaviour is not under the volitional control of the individual and TRA cannot be used to explain or predict behavioural performance.

In other situations, the individual may intend to perform a behaviour, but there may not be an opportunity to do so. Unanticipated events may occur which prevent the person from performing the behaviour. Absence of opportunity is only a problem for events that occur once and once only. Relatively speaking, in situations where there are many opportunities to perform the behaviour, performance will likely occur on some occasions at least.

In other cases, performance of behaviour may be reliant upon the involvement of other people. An individual may intend to perform a certain behaviour, but be unable to do so because performing it requires the behavioural cooperation of another person, who is unavailable. Again the performance of the behaviour is not under the volitional control of the individual.

The implications of this volitionary control assumption extend to situations where TRA is used to explain or predict performance of behaviour to attain a goal. Attaining a goal results from performance of a behaviour. Sheppard *et al.* (1988) reviews studies that have been performed which aim to measure goals through the use of TRA. TRA may not be well suited to predict or explain attainment of goals that result from performance of a behaviour, unless attaining those goals are under volitional control of the individual Sheppard *et al.* (1988, p. 326). Examples of goals are: a person losing weight; a student passing an exam; or a person owning a car. In these examples, TRA could be used to predict: a person losing weight by measuring the persons performance of dieting behaviour; a student passing an exam by measuring his/her proper exam preparation; or a person owning a car, by measuring his/her act of purchasing it. Explanation and prediction of such goals may not be

accurate using TRA if they depend upon factors outside a persons volitional control. This may be the case in the examples just listed. Loss of weight may be influenced by a person's metabolic rate. Passing an exam may be determined by a clerical error in processing a student's result. Owning a car may be determined by the car salesperson accepting the buyer's terms of settlement.

Sheppard *et al.* (1988) provides a critical review of the application of TRA in the literature. They found that TRA had been applied by researchers to study situations where the assumption of volitional control has held and where it has not. Their results indicate that TRA explains and predicts performance of behaviour very well in situations where the assumption of volitional control holds. They also found that in studies where the assumption of volitional control was violated, TRA was still able to explain and predict behaviour although slightly less well than in situations where the assumption held.

2.12.2 Crossover Effects Between Attitude and the Subjective Norm

There is evidence indicating that the attitude and subjective norm constructs of TRA are not independent of each other as is implied by Figure 2.1 above. Several studies have found interdependence between these constructs. The literature refers to this interdependence as the 'crossover effect', which is presented in Figure 2.2 below. There are two types of crossover effects that have been found to occur. One is when the normative beliefs/motivation to comply (the normative belief structure) influences attitude. The other is when the belief/belief evaluation construct (behavioural belief structure) influences the subjective norm component. Fishbein and Ajzen (1975 p. 304) acknowledge the possibility of these cross over effects. The existence of these effects has led some critics to question the construct validity of the behavioural belief structure and the normative belief structure (Miniard and Cohen 1979) (Miniard and Cohen 1981) (Warshaw 1980). Despite the interdependence of the variables, it has been shown that construct validity is achieved, (Gur-Arie *et al.* 1979), (Ryan 1982). These studies found that while highly interdependent, the two variables were separate constructs.

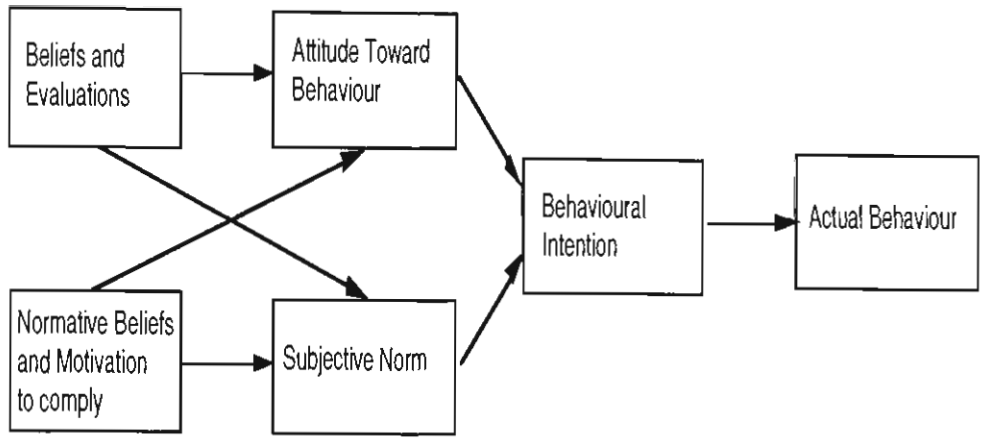

Figure 2.2: Crossover Effects in TRA

Several studies have found evidence of a cross over effect from normative belief structure influencing attitude. Ryan (1982) discovered this effect in a study concerning the determinates of church attendance. Oliver and Bearden (1985) found evidence of it in a study of determinates of taking an appetite suppression pill. Taylor and Todd (1995a) also discovered the crossover in a study of consumer adoption decisions of an automatic programmer for household video recorder/players.

This particular crossover effect is hypothesised to be due to the influence of a person's perceptions of social influences upon his/her attitude. In other words a person's attitude can be reinforced if he/she thinks that relevant others believe his/her attitude is favourable. For example, a person may have positive behavioural beliefs about attending a university and subsequently his/her attitude is also positive. If the person believes his/her parents support attending university, then his/her attitude towards attending will be positively influenced.

Shimp and Kavas (1984) provide evidence of influences from behavioural belief structure to subjective norm in a study of the determinates of supermarket coupon usage. Oliver and Bearden (1985) also found evidence of this crossover effect in their study of determinates of taking an appetite suppression pill.

This crossover effect is attributed to the concept of false consensus Ross (1977, p. 188), which suggests that because an individual holds certain behavioural beliefs, other people will also hold them. For example, a man may perceive that his smoking of cigars is stylish. Because he holds this belief, he assumes that other people will also hold it. Hence the effect upon subjective norm.

The presence of these crossover effects in relation to any computer related behaviour is unknown because there are yet to be any studies examining this phenomenon in the information systems domain.

2.12.3 Past Behaviour and its Effect Upon Future Intention

TRA does not assess the role of past behaviour as an influence on the intention to perform future behaviour. Past behaviour is not included as an independent variable because the model assumes that most behaviour of social relevance is under the control of the individual - the assumption of volitional control. Past behaviour might only affect future intention to perform behaviour for behaviours which occurred due to habit (Eagly and Chaiken 1993, p. 180).

Research has been conducted attempting to ascertain if past behaviour can influence attitude, subjective norm, intention and behaviour. Bentler and Speckart (1979) used structural equation models to examine the effect of past behaviour to predict future behaviour. Specifically, they tested the original TRA and a modified version of TRA which included past behaviour as an independent variable that was hypothesised to affect intention, and behaviour. The behaviours studied included student self reported use of alcohol, marijuana, and hard drugs. They recorded estimates of past behaviour, attitude, subjective norm, and intention at one point in time and then recorded self reported behaviour two weeks later. The results indicated that the model containing past behaviour as a predictor of future behaviour provided the best fit to the data over and above TRA. Furthermore, they suggested that past behaviour directly influenced intention and behaviour.

This finding is in opposition to the ascertain by Ajzen and Fishbein (1980, p. 5) that intention is the only direct predictor of behaviour. However, TRA is restricted to prediction and explanation of behaviours that are under volitional control of individuals. Because drug consumption is addictive, it is doubtful that it is entirely under the volitional control of an individual (Eagly and Chaiken 1993, p. 181). Hence, Bentler and Speckart's (1979) finding does not appear to undermine TRA . Moreover, the fact that intentions to perform the drug taking behaviour were measured two weeks prior to performance may have attenuated the intention behaviour relationship. That is, intention to perform the behaviour may have changed between when the intention data were collected and when the behaviour was performed, thus underestimating the effect of intention upon behaviour (Eagly and Chaiken 1993, p. 180). Despite this, Bentler and Speckart's (1979) findings do show that for behaviours based upon habit, inclusion of past behaviour may enhance prediction of

future behaviour. Additionally, their results reinforce the use of TRA in predicting and explaining behaviour that is truly under volitional control.

Despite these findings Taylor and Todd (1995b) have found evidence to suggest that past experience with the use of an information system may increase the influence of intention on behaviour. They contend, that knowledge of past behaviour can influence intention to perform the behaviour (*ibid.*, p. 562). Their results indicate that for experienced users, the addition of a variable capturing the influence of past experience upon intention will improve the prediction of behaviour.

2.12.4 Validity and Reliability of TRA

TRA has been successfully applied in numerous research and practical situations as reviewed by Eagly and Chaiken (1993). For example, strategic choice in prisoner dilemma games, donation of blood, voting in political elections, attending church services, family planning, eating at fast food restaurants, smoking marijuana, mothers' infant feeding practices, dental hygiene behaviours, having an abortion, consumer purchasing behaviour, and attendance at employee training sessions . In addition, as it has been successfully applied to explain and predict use of computer systems (Davis *et al.* 1989) (Hartwick and Barki 1994).

Eagly and Chaiken (1993, p. 176) review a significant meta analysis of TRA which is designed to assess the predictive ability of TRA. The meta analysis was performed by Sheppard *et al.* (1988) and consisted of 87 TRA applications.

According to Eagly and Chaiken (1993, p. 176) the Sheppard *et al.* (1988) study found an R of 0.66 for prediction of intention from attitude and subjective norm. R denotes a multiple correlation coefficient. It is an index measuring the degree to which intention can be predicted from the simultaneous consideration of attitude and subjective norm (Ajzen and Fishbein 1980, p. 99). For the relation between intention and behaviour Sheppard *et al.* (1988) found an average r of 0.53. r denotes the correlation coefficient. It is the index which measures the degree to which there is a relationship between two variables within TRA, such as between intention and behaviour (Ajzen and Fishbein 1980, p. 98). (Sheppard *et al.* 1988) found a high degree of variability across studies reviewed for the relation between intention and behaviour. Fishbein and Ajzen (1980, p. 47) state that correlation between these two variables may not always be high. This might result because of a time delay between measurement of intention and measurement of behaviour. During this time delay intentions to perform the behaviour may change. However, if the time delay was reduced, higher intention behaviour relations would be observed.

Sheppard *et al.* (1988, p. 336) indicate that the intention behaviour relation measure was weaker in studies where the volitional control assumption was violated. These studies had an average *r* of 0.45. In addition, studies which used a "yes/no" intention measure had an average *r* of 0.49, while those which used an estimation measure of intention had an average *r* of 0.57. An estimation measure is superior because apparently people weigh up a variety of factors which are likely to influence their ability to perform or not perform the behaviour. Hence, a measure of estimation will more accurately predict the overall likelihood of an individual's performance of a behaviour, than a simple "yes/no" measure of intention. The results of Sheppard *et al.* (1988, p. 336) indicate that these reasons may account for the variance in the intention behaviour relation.

2.12.5 The Issue of the Normative Component

Ajzen and Fishbein (1975, p. 304) express uncertainty over the way the subjective norm and the motivation to comply are operationalised. Warshaw (1980) critically assesses these concepts in relation to how they are operationalised in TRA. Subjective norm measures the individual's perception of the degree to which relevant others think he/she should or should not perform a behaviour. Relevant others are measured as a whole. However, relevant others might include an individual's parents, spouse, employer, children, and coworkers, to name five. The perceived views of these groups may conflict. For example, what a person perceives as his parents wishes toward his/her performance of the behaviour may be in opposition to that of his/her spouse. Warshaw (1980, p. 158) argues that in this situation people may have a neutral perception of what relevant others think he/she should do. Alternatively, when scoring his/her subjective norm, the person might consider only a particular relevant other whom approves of the behaviour in one time period and hence have a highly positive subjective norm. While in a subsequent time period, the same person may consider a different relevant other whom disapproves of the behaviour, thus yielding a highly negative subjective norm. In addition, the influence of each relevant other will likely be non-homogenous. Here, particular relevant others will hold more influence over the performance of the behaviour than the remaining relevant others. Therefore, despite the perceived majority opinion of the relevant others as a whole, the respondent will likely be influenced in the direction of the particular relevant other that holds more influence. For example, a wife wants her husband to sell their home and buy another home in a different suburb. However, the husband's mother, child, and employer all want him to not sell the home. Suppose that the relative influence of each relevant other is non-homogenous, and that the wife holds more influence over the husband than the others. In this case the husband may only include the influence of the wife in his measurement of his subjective norm. The subjective norm does not capture these considerations because it is a general

measure of perceptions of what the relevant others as a whole think the person should or should not do (*ibid.*, p.158).

Instead these considerations are captured in the motivation to comply which measures the degree to which a person wants to do or does not want to do what a particular relevant other thinks he/she should do.

Warshaw (1980, p. 158) argues that the problems of this measure of motivation to comply, specifically, its wording does not reflect the true level of influence on intent. In essence the person may want to perform the behaviour not because of the influence of a relevant other, but because of the person's own favourable behavioural beliefs. Furthermore, socially desirable answers may be given for relevant others with high levels of influence over the person. Warshaw (1980, p. 159) argues that motivation to comply is not independent of behaviour as is presented in TRA. Furthermore, it is not independent of the strength of the opinions of the relevant others concerning performance of that behaviour also as is presented by TRA. Fishbein and Ajzen (1975, p. 304) share these concerns and state that future research is needed to develop better measures of the normative components.

2.12.6 Review of the Use of TRA in Information Systems Research

Davis *et al.* (1989) represents the first use of TRA to predict and explain use of information systems. Davis *et al.* (1989) employed an adapted version of TRA named the Technology Acceptance model (TAM) to explain and predict use of a word processing package by university students. Davis *et al.* (1989) made an adaptation to TRA which resulted in excluding the normative component. The normative component was omitted because it failed to explain any of the variance on intention to use the word processing package. One reason given by Davis *et al.* (1989, p. 986) for the failure of the subjective norm to predict intention was that crossover effects might be present from the normative belief structure to attitude. A second reason was that use of the word processing package was voluntary which meant that the influence of the normative component was likely to be insignificant (Davis *et al.* 1989, p. 989). Thirdly, due to the uncertain theoretical status of the subjective norm and motivation to comply as described in section 2.12.5 dealing with the criticisms of the normative component, the subjective norm was dropped from the model (Davis *et al.* 1989, p. 989).

The results of the study found that student beliefs regarding use significantly predicted and explained attitude toward use (Davis *et al.* 1989 p. 993). Furthermore, attitude toward use explained and predicted intention to use and intention to use predicted degree of use (Davis *et al.* 1989, p. 993).

The results of Davis *et al.* (1989) concur with those found by Mathieson (1991) in a study of student users of spreadsheet software at a university. According to Mathieson (1991, p.180) the use of the software was voluntary. Mathieson (1991, p. 185) found that the subjective norm did not provide any significant prediction of intention.

TRA was also used by Hartwick and Barki (1994) to explain and predict use of information systems in actual organisational settings. The study surveyed 130 companies implementing information systems. The study measured the relation between attitude, subjective norm, and intention as well as the relation between intention and behaviour for users of these information systems. These constructs were measured in a pre development and post-development environment. Hartwick and Barki (1994, p. 445) specifically measured whether use of the systems were mandatory or voluntary by asking the respondents. Sixty-two of the users felt use was mandatory, while 58 indicated that use was voluntary. The results indicated that for systems which were used on a voluntary basis, attitude provided the sole prediction of intention, while subjective norm provided no prediction of intention (Hartwick and Barki 1994, p. 458). In the situations where use was mandatory, the subjective norm predicted intention, while attitude did not account for any of the variance of intention (Hartwick and Barki 1994, p.458).

Both the results of Hartwick and Barki (1994), Mathieson (1991), and Davis *et al.* (1989) indicate that when predicting and explaining the degree of use of an information system, the normative component seems only to be significant in situations where use is mandatory. In situations where use is voluntary, the attitude component provides the most significant prediction and explanation of behaviour. These results are not to be unexpected. Ajzen and Fishbein (1980, p. 58) indicate that the relative influence upon intention from the attitude component and the normative component will vary for reasons such as this. Therefore, in situations where the behaviour is voluntary it is expected that the attitude component will be the most significant in predicting and explaining behaviour. In situations where the behaviour is mandatory, the normative component will be most significant. Hartwick and Barki (1994, p. 458) indicate that this is generally supported by past research.

2.13 Conclusion

A review of the literature has given an interpretation to the meaning of the concept of value in general, and information systems value in particular. There is ample support in the literature which justifies inclusion of several desirable requirements for a model designed to value KBSs. Current valuation models suggested for use in valuation of KBS projects do

not adequately incorporate these desirable requirements It is, therefore, evident that a new model for KBS valuation is required which overcomes the weaknesses of current information systems valuation models.

TRA represents a good model to predict and explain a wide range of behaviours. Its components have been shown to provide an explanation why many behaviours under volitional control occur. It also enables adequate prediction of such behaviours. There have been suggestions to expand the model's components to increase explanation and prediction of volitional behaviour. There has also been criticism of the formulation of some of TRA's components, specifically the normative component. Furthermore, it has been shown that due to crossover effects, the model is more complex than thought earlier. Despite this, it is clear that TRA as it was originally formulated, is able to provide sufficient prediction and understanding of volitional behaviour. The theory has been successfully applied to predict and understand information systems use both in organisations and university campuses, which suggests that it may be useful in other computing related behaviours, where the assumption of volitional control is upheld. This is of particular importance since it provides support for the use of TRA in the measurement of employee perceptions of KBS value. This is presented in Chapter 3.

Chapter 3

A Proposed Model for Assessing the Value of KBSs

3.1 Introduction

In order to meet the needs of managers deciding on whether to make new investments or to continue existing investments in KBS projects there are several desirable characteristics of a KBS valuation model. The literature review in Chapter 2 identified these desirable characteristics. This chapter will describe the role and format of each characteristic making necessary definitions and assumptions where appropriate. Finally, how the model functions in practice will be described in principle.

These desirable characteristics which were derived in Chapter 2 are now listed as:

- Characteristic 1: use of a psychological model to measure the employee perceptions of KBS value;
- Characteristic 2: using employee perceptions of KBS value as input into investment decisions;
- Characteristic 3: definition of perceived KBS value;
- Characteristic 4: disaggregation of costs and benefits pertaining to the value of a KBS;
- Characteristic 5: valuation in prototype phases;
- Characteristic 6: valuation in each KBS lifecycle phase; and
- Characteristic 7: provision of information on tangible and intangible perceived costs and benefits to managers.

3.2 Characteristic 1: Measuring Employee Perceptions of KBS Value

TRA provides the required basis for measuring perceptions of KBS value. However, it is inadequate by itself to perform this task. Therefore, the value model presented here has adapted TRA. The issues regarding TRA and its application as discussed in Chapter 2 will now be discussed in the context of the KBS value model. Some of these issues relate very closely to the other characteristics and will be discussed in the appropriate sections below. In particular: the issue of past behaviour and its effect upon future behaviour will be addressed in relation to Characteristic 3: definition of perceived KBS value; and the question of volitional control will be discussed in relation to Characteristic 2: using employee perceptions of KBS value as input into investment decisions.

Two issues relating to TRA have no direct bearing upon any particular characteristic, but are relevant to the measurement of perceived KBS value in general. These include the issue of the normative component and crossover effects in TRA. In addition, the role of TRA in measuring perceptions of KBS value will be described.

3.2.1 Reasons for Omitting the Normative Component

The normative component in TRA is omitted from this KBS value model. The aim of this thesis indicates that perceptions of key employees involved in the KBS lifecycle will be used to assess KBS value. In order to achieve this the perceived costs and benefits of the KBS must be identified and measured. While the normative component may help predict and explain why behaviour is performed, it does so only in terms of social factors and not in terms of costs and benefits. The normative beliefs provide the cognitive social reasons for performance of the behaviour based upon a person's perceptions of what relevant others think should be done. The subjective norm provides a measure of this general perceived social pressure to perform the behaviour, which then influences intention to perform it. While the normative component may be important in explaining and predicting the behaviour of employees involved in the lifecycle of a KBS, it cannot identify and measure the perceived costs and benefits of a KBS which pertain to value. It does not identify the perceived costs and benefits of the KBS which give it value. It only measures a person's perceptions of what behaviour relevant others think the person should perform.

The attitudinal component predicts and explains why behaviour is performed, but it does so in terms of personal factors. The behavioural beliefs provide the cognitive perceptions of the positive and negative consequences of performing the behaviour. The attitude provides a measure of whether performing the behaviour is positive or negative, which then influences intention to perform the behaviour.

Because the behavioural beliefs identify and measure the perceived negative and positive consequences of performing the KBS related behaviour for each key employee, they in effect measure the perceived costs and benefits related to the value of the KBS relevant for that employee. Since the aim of the thesis is to measure perceived KBS value and the behavioural belief component enables measurement of that value, only the attitudinal component of the model will be used.

As discussed in Chapter 2 section 2.12.6, studies in the use of information systems have found that in situations where use is voluntary, the attitude component provides all or almost all of the explanation of why a person in an organisational environment uses a system. While in situations where use is mandatory the normative component provides all or almost all of the explanation (Hartwick and Barki 1994) (Davis *et al.* 1989) (Mathieson 1991). In these studies it was found that in voluntary situations, the influence of the relevant others such as peers and superiors is low because there is no requirement to perform the behaviour which was use of the information system. Instead, employees and students in these studies used a particular information system because they perceived favourable consequences of use. Based upon these findings, in voluntary situations the attitude component which contains the personal reasons for performance of the behaviour provides the best prediction and explanation for the subsequent behaviour performance. In situations of mandatory use the influence of relevant others is likely to be high because superiors require the use of the system. In these situations the main determinate of use is what the user perceives as the superior's wishes toward his/her use. Hence in mandatory situations the normative component provides most of the prediction and explanation of system use. These results are supported by Ajzen and Fishbein (1980, p. 80).

It is expected that for most KBSs, behaviour related to the system would be voluntary. Many KBSs are experimental and their organisational effects are unknown because when compared to information systems, they are a recent phenomenon (Duchessi *et al.* 1993, p. 152). In this situation, bids for funds to introduce a KBS probably would be contingent upon demonstrating the system's value. Since the value of KBSs is probably uncertain, it is likely that the providers of funds would not mandate involvement in system introduction. To do so would take valuable manpower away from key organisational activities which have a high and known value and spend them on the unproven activity of KBS development. Therefore, involvement in a KBS would probably be more a matter of free choice on the part of the employees involved in its lifecycle. As will be presented in Chapter 6, section 6.2.2, all of the respondents in the study upon which this thesis is based indicated that their involvement in the introduction was voluntary.

Because KBS related behaviour is likely to be voluntary it is expected that the results of Hartwick and Barki (1994) Davis *et al.* (1989) and Mathieson (1991) reviewed in Chapter 2, section 2.12.6 will hold in the KBS domain. That is, the attitudinal component will provide the most significant explanation and prediction of subsequent KBS related behaviour.

Another important reason for omission of the normative component is criticism in the literature which shows that problems exist in how the motivation to comply and the subjective norms are operationalised. As was indicated in Chapter 2 section 2.12.5, the consensus among researchers is that future research is required to develop better measures of the normative components.

3.2.2 Crossover Effects

Several studies have discovered the existence of two types of crossover effects from the normative belief structure to attitude and from behavioural belief structure to subjective norm. These effects have been documented in several studies of a variety of social behaviours as discussed in Chapter 2, section 2.12.2. None of the studies in Chapter 2, section 2.12.6, which applied TRA to use of information systems have tested for crossover effects. There are no known studies which attempt to test for these effects in KBSs. However, as is discussed above, it is highly likely that involvement of employees in KBS development will be voluntary in organisations. Hence, the crossover effect from the normative belief structure to attitude is likely to be minimal. This crossover effect would likely only be significant in mandatory behaviour situations where the normative component would also likely be significant. For these reasons the influence of this crossover effect is likely to be minimal in situations where behaviour performance was voluntary such as KBS development.

3.2.3 Variables Used in Measuring Perceived KBS Value

Ajzen and Fishbein (1980 p. 5) state that intention is the immediate determinant or predictor of behaviour in an individual. Furthermore, they state that a person's attitude and subjective norm are the immediate determinants of his/her intention to perform the behaviour (*ibid.*, p. 6). Finally, they indicate that a person's behavioural beliefs are the determinants of his/her attitude (*ibid.*, p. 65) and that his/her normative beliefs are the determinants of his/her subjective norm (*ibid.*, p. 6). These statements indicate that TRA can be applied to an individual and not just a sample of a population of individuals. Indeed Ajzen and Fishbein (1980) illustrate the application of TRA to individuals through examples. In particular, they provide a comprehensive example which demonstrates prediction of attitude from a

person's behavioural beliefs (*ibid.*, p. 66). In this example, they state that since the person's beliefs are slightly positive, the person's attitude is predicted to also be slightly positive. Further, they state in the prediction of a person's intention from attitude, the more favourable his/her attitude the more the person will intend to perform the related behaviour (*ibid.*, p. 56). Alternatively, the more unfavourable a person's attitude the more he/she will intend not to perform the behaviour.

These statements by Ajzen and Fishbein (1980) advocate the application of TRA for prediction and explanation of behaviour in individuals. In sum, Ajzen and Fishbein (1980) are positing that when TRA is applied to an individual, if his/her behavioural beliefs are positive, his/her attitude will also be positive. Additionally, if his/her normative beliefs are positive his/her subjective norm will also be positive. In turn, if his/her attitude and subjective norm are both positive they will predict his/her intention which should also be positive. Finally, if the individual's intention is positive, then he/she should perform the behaviour. If TRA is successfully applied to an individual then such positive results or inverse negative results would occur. In other words if this pattern of results or its inverse occurs, in the case of an individual, then TRA has been successfully applied to an individual. It can, therefore, be applied to predict and explain performance or non-performance of behaviour in an individual.

Based upon the discussion in section 3.2.1 above, it is expected that in the case of KBSs the normative component will likely have little or no affect on intention. Instead the influence upon intention will likely originate from the attitude component. In these situations, the statements made by Ajzen and Fishbein (1980) are still valid. That is for an individual the beliefs and their evaluations should predict attitude, which should predict intention, which in turn should predict behaviour.

As with TRA, the perceived KBS valuation model presented here is successfully applied to an employee when there is a positive or negative pattern among the variables. Firstly when, his/her behavioural beliefs toward performing a KBS behaviour are positive or negative, and they predict the attitude which is also positive or negative. Secondly when the employee's attitude predicts intention. Thirdly, when intention predicts the performance of the KBS behaviour.

If the behavioural beliefs towards performing a KBS behaviour are positive, and they predict the attitude which is equally positive, and it predicts intention, and intention predicts the performance of the KBS behaviour, then there is a positive relationship between these variables. Moreover, if a key employee does perform the KBS behaviour then there must be a perceived value to that employee derived from performance of the behaviour. A

rational person would not perform a behaviour in a situation where he/she had free choice unless the behaviour had a positive value. However, the performance of the behaviour itself does not provide a meaningful measure of value. It does indicate that a KBS has value to an employee, but does not identify the positive and negative consequences of performing the behaviour which contribute to value. Nor does it measure the relative contribution to value from each of these consequences. Only the behavioural belief component of the model can identify the positive and negative consequences of performing a KBS behaviour which pertain to value and assess their relative contribution to value. Behavioural beliefs do this by identifying the positive and negative consequences of performing the KBS behaviour and assessing the extent to which they contribute to value.

Therefore, if there is a positive relationship between the variables of behavioural belief, attitude, intention, and behaviour, then performance of the KBS behaviour indicates that the KBS has a value. However, the reasons why the value exists and their relative contribution to value will only be known by identifying and measuring the positive and negative consequences of performing the behaviour. These are of course represented by the behavioural beliefs and their associated evaluations.

These variables have been expressed as formulae by Fishbein and Ajzen (1975). They are summarised in Table 3.1 below.

Table 3.1 Variables Used to Measure Perceived KBS Value

Variable	Expression	Explanation
Performance of a Behaviour	$BH_e = \Sigma BH_i$ where i =1, 2, ..., n	BH_e = the value for the performance of the KBS behaviour by employee e ΣBH_i = the sum of the behavioural performance indicators.
Intention toward performing a behaviour	$I_e = \Sigma I_i$ where i =1, 2, ..., n	I_e = the predicted value for intention of employee e toward performing his/her KBS behaviour ΣI_i = the sum of the intention indicators
Attitude toward performing a behaviour	$A_e = \Sigma A_i$ where i =I, 2, ..., n	A_e = the predicted value for intention of employee e toward performing his/her KBS behaviour ΣA_i = the sum of the attitude indicators
Belief toward performing a behaviour	$B_e = \Sigma B_i E_i$ where i =1, 2, ..., n	B_e = the predicted value for attitude of employee e toward performing his/her KBS behaviour $\Sigma B_i E_i$ = the sum of the positive and negative beliefs multiplied by the belief evaluations

3.3 Characteristic 2: Using Employee Perceptions of KBS Value as Input into Investment Decisions

As previously justified in Chapter 2, section 2.5 it is valid to use key employees for measuring perceived KBS value. The specific types of key employees used will now be identified and their inclusion justified. Since perceived KBS value is defined in terms of the behavioural roles performed by key employees, the roles for each employee type will be identified.

3.3.1 Key Employees and Their Behavioural Roles

The three key employee types included in the model are: knowledge domain experts; KBS project managers; and KBS users. These employees are involved in a KBS in a variety of phases comprising a KBSs lifecycle. Justification for the inclusion of each type as well as the omission of other employees is made below. The roles of each employee type will now be stated.

Provision and testing of domain knowledge is considered to be the major role of a knowledge domain expert during the KBS lifecycle (Turban 1995, p. 476). *Knowledge domain experts* are defined as those employees whose behavioural role is to provide and test their domain knowledge at various phases over the lifecycle of the KBS. Benefits are accrued and costs are incurred in the context of their job in the organisation as a result of performing this role (Clark and Soliman 1998, p. 430). This type of employee will be referred to as an 'expert'.

Using the KBS is considered to be the major role of a user during the KBS lifecycle (Prerau 1990, p. 73). *KBS Users* are defined as those employees whose behavioural role is to use the KBS at various phases across its lifecycle. Benefits are accrued and costs are incurred in the context of their job in the organisation as a result of performing this role (Clark and Soliman 1998, p. 430). A KBS user will be referred to as a 'user'.

Managing the KBS project is considered to be the major role of a project manager during the KBS lifecycle (Prerau 1990, p. 58). *KBS Project Managers* are defined as those employees whose behavioural role is to provide managerial support to the KBS project across of its lifecycle. Benefits are accrued and costs are incurred in the context of their job in the organisation as a result of performing this role. *Managerial support* is defined as those actions required to ensure that the KBS is managed successfully (Clark and Soliman 1998, p. 430). A KBS project manager will be referred to as a 'manager' or a 'KBS manager'.

3.3.2 Adherence to the Elements of Target, Behaviour, Time, and Context

As was discussed in Chapter 2, section 2.11 it is necessary to adhere to the elements of target, behaviour, time, and context when eliciting beliefs. Outcome beliefs can change depending on: the time in which they are elicited; the context in which the behaviour occurs; the target of the behaviour; and the nature of the behaviour being studied. Defining the key employee behaviour's correctly in these terms, as was done in the previous section, ensures that only relevant beliefs are elicited.

3.3.3 The Assumption of Volitional Control

Chapter 2, section 2.12.1 reviewed the conditions under which the assumption of volitional control holds. Briefly the assumption holds if: a person must have the required skills, and/or ability to perform a behaviour; the behaviour cannot be classified as compulsive or based upon strong emotions; there must be an opportunity to perform the behaviour; and if cooperation of other people is necessary it must be assured.

As discussed in section 3.2.1, KBS behaviour is likely to be voluntary. However, both mandatory and voluntary behaviour may still be under a person's volitional control Hartwick and Barki (1994, p. 454). This is true if the conditions of volitional control are met.

Consider the case of a KBS manager. To perform behaviour related to being a KBS manager a person must have the required skills and ability to provide managerial support as defined above. If a person chooses to be a KBS manager, it is reasonable to assume that he/she would have the necessary skills and ability to perform in that position. Management of a KBS project is a rational behaviour and usually not one based upon strong emotion. Further, it cannot be classified as compulsive behaviour. While there may be some unanticipated events which decrease the opportunity to perform behaviour related to managerial support, it is expected that if an organisation decides to invest in at least a prototype of a KBS there will likely be ample opportunity for the manager to perform the behaviour. Cooperation of other employees is required in order to provide managerial support. While cooperation cannot be guaranteed, a high level of it is probable in situations where involvement by other employees is voluntary, and if these employees have decided to be involved in the KBS project. In sum, a KBS project manager is likely to have volitional control over provision of managerial support.

The expert provides knowledge for the development and update of a KBS. The exercise of knowledge provision by the expert is guided by a knowledge engineer. The expert must provide his/her knowledge given questions from the knowledge engineer. Given this, in order for an expert to provide knowledge, there are no special skills or abilities needed beyond an understanding of the knowledge required to be an expert. Provision of knowledge by an expert is rational and not a compulsive behaviour and not one based upon strong emotions. While there may be some unanticipated events which decrease the opportunity to provide knowledge, it is expected that if an organisation decides to invest in at least a prototype of a KBS there will likely be ample opportunity for the expert to perform the behaviour. Cooperation of other employees is required for an expert to provide knowledge. While cooperation cannot be guaranteed, a high level of it is probable in situations where involvement by other employees is voluntary, and if these employees have decided to be involved in the KBS. In sum, an expert is likely to have volitional control over provision of knowledge.

To use a KBS the user must have general computing skills and abilities as well as enough background knowledge to understand the decisions made by the KBS. Therefore, some training may be needed in the use of the KBS. Provided the organisation supplies these requirements, the user should be able to use the system. Given the ubiquitous nature of information systems user training programs in organisations it is expected that KBS users would also be adequately trained. Use of a KBS is rational and not a compulsive behaviour and not usually one based upon strong emotions. While there may be some unanticipated events which decrease the opportunity to use the system, it is expected that if an organisation decides to invest in at least a prototype of a KBS there will likely be ample opportunity for the user to perform the behaviour. Cooperation of other employees may be required for a user to use the KBS. While cooperation cannot be guaranteed, a high level of it is probable in situations where involvement by other employees is voluntary, and if these employees have decided to be involved in the KBS. In sum, a user is likely to have volitional control over his/her use of the KBS.

3.3.4 Other Key Employees

As was presented in Chapter 2, section 2.5, Turban (1995) identifies the following employee types as being involved with the KBS project lifecycle: senior managers, project managers, users, experts, knowledge engineers, and programmers.

Senior managers are not included in the model. It is assumed that in most cases, these individuals will be responsible for deciding whether or not investment in a KBS is justified. Therefore, they will use the valuations of the other employee types as input into

this decision. Furthermore, any such valuation role is already catered for in the model through the KBS manager.

Knowledge engineers and programmers are also not included. Increasingly, organisations are hiring knowledge engineers and programmers on a contractual basis due to the lack of in-house skills in these roles and as a result of down sizing. Asking them to measure their perceptions of KBS value would not be applicable since their perceptions would not be in the context of any long term job in the organisation.

3.4 Characteristic 3: Definition of Perceived KBS Value

3.4.1 Perceived KBS Value Defined as a Trade off Between Costs and Benefits

All the definitions of value reviewed in Chapter 2, section 2.3, interpreted the concept of value to be a trade off of costs and benefits of the entity being valued. It was also noted that traditional valuation approaches such as: net present value; internal rate of return; return on investment; and cost benefit analysis all calculate value as the difference between costs and benefits. This review also recognised that definitions of "perceived value" and "value" were given in terms of a trade off between costs and benefits. Based upon this literature it is proposed that perceived KBS value can be defined as a trade off between the costs and benefits of a KBS.

3.4.2 Perceived KBS Value Assessed Via Costs and Benefits of Performing a Behaviour by Key Employees

In section 3.4.1 above it was proposed that KBS value can be expressed as a trade off between costs and benefits. As is presented in section 3.3.1, there are key employees involved in the lifecycle of a KBS. Each key employee has a behaviour to perform in the lifecycle. It is proposed that there are costs and benefits which accrue to an employee's job in an organisation which result from performing this KBS behaviour. The construct of belief in TRA supports this proposal. This is because belief as defined in Chapter 2, section 2.11 represents the positive and negative consequences of performing a behaviour with respect to a target, in a certain time period, and in the context of a situation. When assessing perceived KBS value, the costs and benefits are represented by the positive and negative consequences. The performance of KBS behaviour is the behaviour. The KBS is the target. The KBS lifecycle is the time period in which the behaviour occurs. The employee's job in the organisation is the context of the situation.

3.4.3 Definition of Perceived KBS Value

It is clear that the belief construct supports the propositions made about assessing perceived KBS value. It is therefore, valid to use it to guide the definition of perceived KBS value.

Cronk and Fitzgerald (1997, p. 408) state that defining value is important. First, so that the reader has the same understanding to that of the researcher regarding what value is. Second, to set guidelines for what is to be measured with regard to the value of an information system. It is proposed that these same reasons apply to why perceived KBS value should be defined.

The belief construct, and the other variables in TRA, must be defined via the elements of behaviour, target, context, and time (Ajzen and Fishbein 1980, p. 80). So doing ensures that the beliefs elicited are those regarding performance of a pre-specified behaviour, with respect to a specified target, context, and time. If this is not done the beliefs may not be related to the behaviour under consideration. These elements were highlighted in justifying the applicability of the belief construct to assessing perceived KBS value. They will now be applied in defining perceived KBS value.

Perceived KBS value to a key employee is defined as the trade off between the perceived benefits and the perceived costs to his/her job in the organisation which result from performing his/her role during the KBSs lifecycle phases (Clark and Soliman 1999, p.66).

As can be seen the elements of time, target, context, and behaviour were applied in the definition. The KBS represents the target of the behaviour. The behaviour is represented by the employee's role in the KBS lifecycle. Context is represented by the employee's job in the organisation. Time is represented by the phases of the KBS lifecycle in which the behavioural role occurs. This will provide the basis upon which the data on perceived value will be collected. The presence of these elements in the definition mean that the only beliefs elicited will be those related to the value of the KBS within the organisation.

The following definitions are required to clarify some of the terms used to define perceived KBS value.

A *key employee* is defined as an employee who performs a role necessary in one or more phase(es) of the KBSs lifecycle (Clark and Soliman 1997, p. 25).

A key employee's *role* in the KBS lifecycle is defined as the actions or set of actions constituting a behaviour performed by that employee with respect to the KBS (Clark and Soliman 1997, p. 25).

3.5 Characteristic 4: Disaggregated Costs and Benefits Pertaining to the Value of a KBS

3.5.1 Categories for Classifying Perceived Costs and Benefits of KBS Value

The literature review of Chapter 2, section 2.4.1 was concerned with a broad range of studies assessing the affects of KBSs on organisations. Most of these affects were able to be classified into one of three categories, namely: time; cost; and quality. The results of this review were summarised in Chapter 2, Table 2.1. Table 3.2 below also presents this data which is the same as Table 2.1, except for one major amendment. The column labelled "cost" has been changed to "finances" in Table 3.2. Most of the financial costs and benefits derived from the literature review refer to benefits in the form of reductions in financial cost. All omit the possibility of financial gains which might result not due to decreasing costs, but to increased financial revenue. It is proposed that financial gain is a possible benefit which may result from the use of a KBS in an organisation. It is considered inaccurate to label the category referring to financial costs and benefits as "cost". It is proposed that the category of "finances" is more appropriate and therefore should be used as the label for this category.

Table 3.2: KBS Value Categories

Author/Date	Time	Finances	Quality
O'Leary and Turban (1987) KBS Benefits	Reduced response time	Cost reduction	Improved decisions by non experts
			More consistent decisions
			Improved training
Author/Date	**Time**	**Finances**	**Quality**
Turban (1988)KBS Costs	A long development time frame	A high cost of development	Difficulty in extracting accurate and complete knowledge from experts
	A lengthy time needed to extract knowledge from experts	Large salaries paid to scarce knowledge engineers	Difficulty in selling KBSs to management
			Most KBSs only work well in a very narrow domain

Table 3.2: KBS Value Categories (Continued)

Author/Date	Time	Finances	Quality
Weitz and DeMeyer (1990) KBS Costs and Benefits	Allowing experts more time to concentrate on more difficult/interesting problems	project development costs including: cost of employees, software and hardware, training, operations, and updating	preservation and dissemination of scarce expertise
	Speedier solutions		More consistent problem solving
			Relieving experts of tedious tasks
Author/Date	**Time**	**Finances**	**Quality**
Sviokia (1990) KBS Benefits	Reduced order cycle time	Salary savings through the use of lower skilled employees	Greater accuracy of decisions
			Broader solution scope
			Greater decision completeness
			Increased output
			Reduced number of follow-up telephone calls
Author/Date	**Time**	**Finances**	**Quality**
Stockdale and Wood (1992) KBS Benefits	Time saved in task performance	Labour savings	Improved ability to analyse problems
Author/Date	**Time**	**Finances**	**Quality**
Hauser and Herbert (1992) KBS Benefits	Timeliness of decision making		Accuracy and reliability of decision making
	Productive use of inexperienced employees		Documented organisational knowledge
	Productive use of expert employees		Improved accessibility to expert knowledge
			Documentation of decisions made
Author/Date	**Time**	**Finances**	**Quality**
Hayes-Roth and Jacobstein (1994) KBS Benefits	Increased speed of task accomplishment	Reduced cost	Increased quality
	Reduced training time	Decreased number of employees required	Improved decisions
			Retention of volatile and portable knowledge
			Reduced errors
			Improved customer service

Table 3.2: KBS Value Categories

(Continued)

Author/Date	Time	Finances	Quality
Turban (1995) KBS Benefits	Reduced down time	Cost reduction	Improved decision quality
			Increased output
	Response time	Use of less expensive equipment	Capturing scarce expertise
			Flexibility of decisions made
			Knowledge transfer to remote locations
			Easier equipment operation
			Operation in a hazardous environment
			Reliability of decisions made
			Ability to work with incomplete and uncertain information
			Provision of training
			Increased integration with other computerised systems
			Enhances problem solving
			Integration of several experts' opinions
			Solve complex problems in a narrow domain

Canada and Sullivan (1990, p. 248) states that a tangible cost or benefit can be classified as a tangible when it can be measured directly in financial terms. Accordingly, any cost or benefit which cannot be measured directly in financial terms is an intangible. With this in mind, the three value categories pertaining to a KBS as identified above will now be defined.

The *financial category* is defined as that value category in which financial costs and benefits are classified. A *financial cost or benefit* pertaining to a KBS is defined as a tangible because it can be directly measured in units of financial currency (Clark and Soliman 1999, p. 68).

The *time category* is defined as that value category in which intangible costs and benefits relating to time are classified. A *time cost or benefit* pertaining to a KBS is defined as an intangible. While these time benefits and costs can be directly measured in units of time, they cannot be directly measured in monetary units and are therefore intangible in nature (Clark and Soliman 1999, p. 68).

The *quality category* is defined as that value category in which intangible costs and benefits of a qualitative nature are classified. A *qualitative cost or benefit* pertaining to a KBS is defined as an intangible because it cannot be directly measured by units of financial currency (Clark and Soliman 1999, p. 68).

3.5.2 Definitions for the Perceived KBS Value Categories

3.5.2.i Perceived Time Category

The *perceived time category* is defined as that value category in which perceived costs and benefits with respect to time are classified.

Perceived Time benefit is defined as any perceived earnings of time to an individual in his/her job in the organisation, resulting from performing his/her role in the KBS lifecycle (Clark and Soliman 1997, p. 26). An example may be an expert's perception that provision of knowledge for development of the KBS will decrease the amount of time spent on making decisions when the system is eventually used.

Perceived Time cost is defined as any perceived expenditures of time or loss of time incurred on the part of an individual in his/her job in the organisation, resulting from performing his/her role in the KBS lifecycle (Clark and Soliman 1997, p. 26). An example may be a user's perception that the length of time involved in using the system is too long.

3.5.2.ii Definitions for the Perceived Financial Category

The *perceived financial category* is defined as that value category in which perceived costs and benefits with respect to money are classified.

Perceived Financial Benefit is defined as any perceived earnings in monetary terms to an individual in his/her job in the organisation, resulting from performing his/her role in the KBS lifecycle (Clark and Soliman 1997, p. 26) This may be manifest as manager's perception that use of the KBS in his/her department will lead to an increase in sales revenue made. This example is tangible because increased sales revenue can be expressed as a dollar value.

Perceived Financial Cost is defined as any perceived expenditures in monetary terms incurred on the part of an individual in his/her job in the organisation, resulting from performing his/her role in the KBS lifecycle (Clark and Soliman 1997, p. 26). This may be manifest as a manager's perception that using the KBS will lead to a decrease in sales made

by his/her department. This example is tangible because decreased sales revenue can be expressed as a dollar value.

3.5.2.iii Definitions for the Perceived Quality Category

The *perceived quality category* is defined as that value category in which perceived costs and benefits of a qualitative nature are classified.

Perceived Quality Benefit is defined as the perceived positive qualitative earnings to an individual in his/her job in the organisation, resulting from performing his/her role in the KBS lifecycle (Clark and Soliman 1997, p. 27). An example is an expert's perception that the act of providing knowledge for the development of the KBS reinforces his/her understanding of the knowledge in the problem domain. Another example is the perception that the number of decision errors may be reduced when the system is used. These examples are intangible because they cannot be directly expressed as a dollar value.

Perceived Quality Cost is defined as the perceived negative qualitative expenditures incurred on the part of an individual in his/her job in the organisation, resulting from performing his/her role in the KBS lifecycle (Clark and Soliman 1997, p. 27). An example is an expert's perception that the task of providing knowledge is very onerous. Another example is a manager's perception that the number of decision errors will increase. Again these are intangible because they cannot be directly expressed as a dollar value.

3.6 Characteristic 5: Valuation in Prototype Phases

As was discussed in Chapter 2, section 2.6, it is known that traditional valuation models cannot measure tangibles nor intangibles during early lifecycle phases (Smith and Dagli 1992, p. 64). The KBS value model presented in this thesis is able to measure value during the early lifecycle phases because it measures perceptions of costs and benefits in the form of an employee's beliefs and their associated evaluations. Once the user, expert, and manager employees have been identified, measurement of value during any phase including early phases is possible using this model.

3.7 Characteristic 6: Valuation in Each Lifecycle Phase

3.7.1 Valuation With Differing Lifecycle Models

The literature review in Chapter 2, section 2.9, identified a variety of representations of the KBS lifecycle model. While there are differences across these representations in terms of the number of phases present, and the phases in which the activities are performed, there appears to be general agreement on the types of activities performed over the lifecycle. Since there exists a wide variety of lifecycle models in the literature, it is assumed that there is likely a wide variety of such models used in practice.

The KBS value model presented here does not advocate one lifecycle model over another. While the phases in which key employee behaviours are performed may vary depending upon which lifecycle model is used, the general behaviour performed by each key employee is constant across lifecycle models. Since the behaviours of the managers, experts, and users are constant these employees can be used to measure KBS value no matter which lifecycle phase their behaviours occur. In light of this, to manage the process of KBS valuation using the value model presented here, first the lifecycle model used at the organisation is identified in terms of its phases. Secondly, the phases in which the employee roles are performed are identified. Valuation of the KBS is performed by measuring the perceptions of the costs and benefits to the key employees according to which phases they perform their behaviours.

3.7.2 Timing of the Value Measurements

The KBS value model presented in this thesis is designed to assess perceived value to the jobs in organisations of the users, experts, and managers over the lifecycle of a KBS. Turban (1995, p. 653) states that justification of a KBS project should be performed whenever a justification decision is required and that such decisions will usually occur at the end of each phase in the KBS lifecycle. The timing of value measurements will depend upon which KBS lifecycle model is used. It is a requirement of the value model presented here that the lifecycle phases used for a KBS project be specified before it is valued. This is to ensure that comparisons can be made across systems and the value of a system can be tracked from one phase to another.

3.8 Characteristic 7: Provision of Information on Tangible and Intangible Perceived Costs and Benefits to Managers

Nelson (1986), Pienaar *et al.* (1986), and Troxler and Blank (1989) all propose scoring models which attempt to weight the relative importance of both tangible and intangible costs and benefits of a system. Consider the rationale for weighting attributes in these models. It is to measure the relative importance of each attribute so that the relative contribution of each to total value can be determined. All of the scoring models reviewed except Nelson (1986) elicit from a valuator scores of relative importance for each attribute. Nelson (1980, p. 348) assumes that the weights for each attribute will be equal. All of these models, then, use a numerical method to calculate the normalised weight for each attribute. Where the term normalised means the sum of the weights is 100 points. The weights are then used to determine the relative importance of each attribute to total value.

Despite the use of this weighting technique, Smith and Dagli (1992, p. 67) state that caution should be applied when individuals assign weights as inconsistency and subjectivity can be introduced into the process. Inconsistency occurs because individuals can provide conflicting ratings of attribute importance. For instance attribute A has more value than attribute B, and attribute B more than C, but C has more than A (Smith and Dagli 1992, p. 69). Subjectivity is unavoidable since human valuators are used in these models.

As was described above in section 3.3, a desirable characteristic of a KBS valuation model is assessment of perceived value from the perspectives of experts, managers, and users. One of the scoring approaches reviewed in Chapter 2, section 2.10.1 could be used to make a valuation. However, since there is likely to be multiple valuators for a KBS, each valuator will likely weight each cost and benefit differently. Hence there will be inconsistency in the weights assigned and it may be difficult to reach a consensus (Smith and Dagli 1992, p. 69). In addition to this, it is likely that there will be different costs and benefits depending upon the employee type performing the valuation. For instance a user will likely value a KBS with a different set of costs and benefits than an expert. These issues make the numerical scores generated by applying a scoring model to multiple employee types undesirable.

Furthermore, there may be multiple KBSs that require valuation. Each of these KBSs will likely have different employees assigned to them. The costs and benefits of each KBS will likely differ compared to other KBSs. In addition, the weights assigned to each cost and

benefit will differ across the individuals. Therefore, any numerical scores generated by the application of a scoring model will not be comparable.

Sullivan (1986, p. 47) states that since profile charts do not assign weights to attributes, they are not afflicted by these problems. Profile charts instead provide the manager with a visual presentation of a system's value with no rank of the relative importance of the various costs and benefits. The manager examines the costs and benefits which are represented pictorially for one or more projects. He/she then uses his/her own judgement regarding the relative importance of the costs and benefits to choose between projects.

It is a fact that humans process the majority of information presented to them through visual means (Walczak and McNally 1998, p. 496). The presentation of information in visual form conveys more meaning to a person and more quickly than other means such as those based upon a passage of text or a set of numbers. A visual presentation of KBS value would therefore, be advantageous to managers if it could support the requirements of a KBS valuation model.

The general concept of profile charts could, therefore, be used to assess the value of KBSs. However, as they are currently formulated, profile charts are inadequate for KBS valuation. Recall from section 2.10.1 in Chapter 2 that they do not classify costs and benefits into categories that are meaningful to managers. They do not use a well founded psychological model to elicit value perceptions. They do not attempt to assess KBS value from multiple organisational perspectives. They do not specify who the valuator should be, nor how and if profile charts could be used in a situation of multiple valuators.

A new technique for the representation of KBS value is needed which adapts the idea of a profile chart (Clark and Soliman 1999, p. 70). This new technique should be designed to overcome these deficiencies and support the characteristics of a KBS valuation model. An instance of this technique is termed a KBS value graph (Clark and Soliman 1999, p. 70). This term is used since it precisely states that the value of a KBS will be presented in graphical form. Table 3.3 is a hypothetical example of the graph. Clark and Soliman (1999, p. 70) propose that a KBS value graph has several unique features which differentiate it from the idea of profile charts as presented by Sullivan (1986). First, it classifies the results of an employee's KBS valuation in the value categories of time, finances, and quality (Clark and Soliman 1999, p. 74). As previously discussed, the profile charts advocated by Sullivan (1986) make no attempt to separate the costs and benefits into categories which are meaningful to managers. Second, a KBS value graph is presented for each user, manager, and expert of a particular KBS (Clark and Soliman 1999, p. 74). Therefore KBS value graphs provide information from the three organisational perspectives relevant to a KBS. In

the profile charts put forth by Sullivan (1986), only one organisational perspective is offered. Third, the rating scale used in KBS value graphs has three evaluation points on each side of the cost benefit scale, while that proposed by Sullivan (1986) has only two on each side. The additional points are proposed to be an improvement over profile charts since they enable the expression of a greater range of variability of the costs and benefits (Clark and Soliman 1999, p. 70). In addition, the evaluation points use words instead of numbers. It has been proposed by Clark and Soliman (1999, p. 71) that words are more meaningful to managers than a non-descriptive number. Finally, the degree of likelihood that each cost and benefit will eventuate is presented by a system of shading as shown in Table 3.3. This is an important adaptation with respect to Sullivan's (1986) profile charts which do not attempt to indicate the degree of certainty attached to each cost and benefit. The KBS value model measures perceptions of value. It is therefore, critical that the degree of confidence a person has regarding the likelihood that a cost or benefit will occur should be measured (Clark and Soliman 1999, p. 71). This information will provide managers with extremely useful additional information on the value of a KBS.

The primary input into a KBS value graph is the results of the belief component from the adapted TRA. Accordingly, the result for each belief is the product of belief and belief evaluation as described by equation 1 in section 3.2.3. TRA specifies that the possible values for a positive belief and its associated belief evaluation are 1, 2, and 3. Conversely, the possible values for a negative belief and its associated belief evaluation are -1, -2, and -3. When equation one is invoked, this yields the following possible range of results for the product of belief and belief evaluation: 9, 6, 4, 3, 2, 1, -1, -2, -3, -4, -6, and -9. This range excludes the values of 8, 7, 5, -5, -7, and -8. These values are excluded because they are not possible products of a belief and its associated belief evaluation. It is proposed that the construction of a KBS value graph based upon this range of values could possibly be misleading to a manager. For instance, the degree to which a benefit with a rating of 9 exceeded a benefit of 4 would not be clearly represented on the graph using this scale. In order to overcome this obstacle Clark and Soliman (1999, p. 70) have developed the system of shading described above and demonstrated in Table 3.3.

Table 3.3 Hypothetical KBS Value Graph for a Manager

KBS Manager	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
B1 The KBS gives a quick response to the customer's need						
B2 There is a time delay in responding to a customer						
Finance						
B3 The KBS will increase sales of the product						
B4 There is a high cost of obtaining hardware and software for running the KBS						
Quality						
B5 The KBS will provide documented advice						
B6 The KBS improves the service to the customer						
B7 The KBS provides new business leads by identifying new potential customers						
B8 The KBS can be used as a sales tool to entice customers to buy						
B9 The KBS provides increased control over end users						
B10 The KBS enables better utilisation of the Technical Department						

Cost/Benefit is extremely likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is slightly likely to occur

Clark and Soliman (1999) argue that KBS value graphs support the desirable characteristics of a KBS valuation model. They support Characteristic 1 since they have the ability to represent the constructs of belief and belief evaluations. Characteristic 2 is supported because once measured, employee perceptions of KBS value in the form of beliefs and belief evaluations can be presented to the manager in graphical form as input into a KBS investment decision. Characteristic 3 states that KBS value is defined as the trade off between the benefits and costs of a KBS to an employee. This is supported in KBS value

graphs since the trade off between costs and benefits are presented in graphical form. Characteristic 4 states that disaggregated information on KBS value should be presented to managers. Since each belief is listed and categorised into the value classes of time, finances and quality on the KBS value graph, this characteristic is supported. Characteristic 5 refers to valuation of tangibles and intangibles in the early lifecycle phases and Characteristic 6 refers to the ability of a KBS valuation model to measure value in each KBS lifecycle phase. As a presentation technique, the KBS value graph should support both characteristics since the lifecycle phase a KBS is traversing does not directly affect any of the components of the graph. Characteristic 7 is supported since the KBS value graph provides information on perceptions of both tangible and intangible costs and benefits.

3.9 Conclusion

This chapter presented the characteristics of a model for assessing perceived value of a KBS at an organisation. The form of these characteristics in the KBS value model was explained and justified. The idea of a KBS value graph was described and justified as a new technique for presenting perceived KBS valuations to management. Its aim is to pictorially represent the perceived value of a KBS whilst incorporating the desirable characteristics of a model to assess KBS value. Several propositions are implicit in each of the characteristics presented in the chapter. These will be explicitly stated in Chapter 4.

Chapter 4

Research Methodology

4.1 Introduction

The desirable characteristics of a model to assess KBS value were described and discussed in Chapter 3. The degree to which they are effectively incorporated into the model needs to be tested. Yin (1994, p. 21) advocates stating a theory's propositions which describe the theory in terms of what it aims to achieve. A theory's propositions form the first step in testing its ability to achieve its aims. Once the propositions are stated a research methodology can be formulated to act as a vehicle for testing whether or not these propositions hold. The perceived KBS valuation model proposed in Chapter 3 represents a theory which aims to assess the value of KBSs. Embedded into the desirable characteristics described in Chapter 3 are the core propositions of the model. The first purpose of this chapter is to explicitly state these propositions so that the model can be tested using the chosen research methodology.

The second purpose of this chapter is specify a research methodology for testing these propositions. A case study approach was chosen as the research methodology. There are several reasons for why this approach was chosen. These will be explained and justified. A company called Organisation X formed the basis of the case study. The reasons for using Organisation X as a test case will be explained. Part of describing the research methodology involves detailing the procedures used to collect data for testing whether the propositions of the model hold. Description of these are quite detailed and make for lengthy reading. Therefore, they are placed in Appendix A, where the reader can refer to them when required. The third and final purpose of this chapter is to explain the techniques used to achieve validity and reliability in the Organisation X case study.

4.2 Propositions of the KBS Perceived Value Model

4.2.1 Proposition 1

Proposition 1 incorporates the first two characteristics of the model. These are Characteristic 1: use of a psychological model to measure the employee perceptions of KBS value, and Characteristic 2: using employee perceptions of KBS value as input into

investment decisions. As argued in Chapter 3, section 3.3, a KBSs perceived value can be assessed by measuring the beliefs of the expert, manager, and user employees involved in a KBS project. Given this, Proposition 1 is expressed as follows. Employee beliefs represent a measure of perceived KBS value when there is a pattern of prediction from these beliefs, to attitude, to intention, and to behaviour. The aim of this proposition is to test whether or not this pattern exists for managers, experts, and users involved in a KBS project. If it does exist, then beliefs represent a measure of perceived KBS value.

From the discussion in Chapter 3, section 3.2 and 3.3, there are some preconditions which must be established for testing this proposition. First, whether or not employee behaviour concerning KBS involvement is voluntary needs to be determined. As explained in Chapter 3, section 3.2.1, if involvement is voluntary, then the normative component would not be expected to contribute to intention to perform a given KBS behaviour. Second, this proposition is expected to hold in situations where KBS behaviour is volitional. This means that each employee is able to perform their relative KBS behaviour without any external factors preventing them from performing it. Third, for comprehensive measurement of value, there must exist an expert, manager, and user all of whom have been involved in a KBSs development from its beginning. Fourth, in order to ensure that only relevant beliefs are elicited from respondents, adherence to the elements of target, behaviour, time, and context must be clearly established.

4.2.2 Proposition 2

Proposition 2 concerns Characteristic 4: disaggregation of cost and benefits pertaining to KBS Value. As discussed in Chapter 2 Section 2.4, a disaggregated measure of costs and benefits refers to the situation where an aggregated measure of KBS value is broken down into measures of the individual costs and benefits which together contribute to the overall value of the KBS. Proposition 2 states that employee beliefs provide a disaggregated measure of perceived costs and benefits of a KBS.

4.2.3 Proposition 3

Proposition 3, is dependent upon Proposition 2. As discussed in Chapter 3, section 3.6.1, several costs and benefits are associated with KBSs. These costs and benefits can be identified as either being tangible or intangible. Proposition 3 states that the employee beliefs are a disaggregated representation of both perceived intangible and tangible costs and benefits rather than an aggregated representation.

4.2.4 Proposition 4

Proposition 4 is also dependent upon Proposition 2. In Chapter 2, section 2.4.2, it was discovered that the disaggregated intangible and tangible costs and benefits associated with a KBS could be classified into the value categories of time, cost, and quality. In Chapter 3, section 3.5.1 the possibility of financial gain from a KBS was proposed. In light of this possibility the "cost" category was relabelled "finances". Proposition 4 is threefold. First, it states that a finances category is more advantageous than a cost category because there may be financial benefits as well as costs associated with a KBS. Second, it states that expert, user, and manager beliefs will fit into the value categories of time, finances, and quality. Third, it states these categories are mutually exclusive with respect to belief classification with the effect that the chances of dual classification of any belief is unlikely.

4.2.5 Proposition 5

Proposition 5 concerns Characteristic 5: valuation in the prototype phases. As discussed in Chapter 2 section 2.6, traditional valuation models cannot measure either tangibles or intangibles during early KBS lifecycle phases. Proposition 5 states that the KBS value model can measure perceived intangible and tangible value during early lifecycle phases by measuring expert, user, and manager beliefs during these phases.

4.2.6 Proposition 6

Proposition 6 refers to Characteristic 2: using employee perceptions of KBS value as input into investment decisions. In Chapter 3, section 3.3.1 it is stated that employee beliefs measure the perceived costs and benefits to the employee's job in the organisation. Proposition 6 states that together the beliefs of the user, expert, and manager of a KBS will measure the perceived value of a KBS to the organisation as well as the individual jobs of each employee.

4.2.7 Proposition 7

Proposition 7 refers to Characteristic 7: provision of information on tangible and intangible perceived costs and benefits to managers. As stated in Chapter 3, section 3.8, situations may arise where multiple KBS projects require valuation. Proposition 7 states that managers can determine the comparative perceived value across multiple KBSs by examining the employee beliefs which are presented in the value graphs.

4.3 Description and Justification for a Single Embedded Case Study Design

Yin (1994, p. 6) proposes that the case study methodology can be used as an explanatory technique when the aim of the investigation is to determine why or how something occurs. The KBS value model is essentially explanatory. It proposes a theory to explain how, why and to what degree managers, experts, and users place a value upon KBSs in organisations.

According to Yin (1994, p. 38), there are two possible broad case study designs: a single case; and multiple cases. A single case study involves investigation of one entity such as one organisation. A design related to a single case is the single embedded case, where two or more information systems, for example, are being implemented in an organisation. The information systems constitute cases embedded into the overall case study. Yin (1994, pp. 38-44) identifies three reasons for using a single case study. It is justified when the single case represents the critical case in applying a well formulated theory. In this instance, the theory has specified the propositions and the circumstances in which these propositions are perceived to hold. There may exist a single case which meets all the requirements for confirming, challenging, or extending the theory. In essence, this single case can be used to test whether the theory is correct or whether a different theory provides a better explanation. Such a single case can, therefore, contribute by extending existing knowledge and theories in the field of investigation. Using a single case is analogous to the single scientific experiment, where a well formulated theory is applied to a single experiment to test the theory's propositions. An experiment is designed to show that in a particular setting and under well specified circumstances a theory's propositions hold true. The goal in this situation is to generalise to theoretical propositions and not to populations or universes. As stated by Yin (1989, p. 21):

> ".....the case study, like the experiment, does not represent a "sample," and the invesigator's goal is to expand and generalize theories (analytic generalisation) and not to enumerate frequencies (statistical generalization).

Yin (1994, pp. 36) further clarifies the issue:

> "Critics typically state that single cases offer a poor basis for generalizing. However, such critics are implicitly contrasting the situation to survey research, in which a "sample" (if selected correctly) readily generalizes to a larger universe. *This analogy to samples and universes is incorrect when dealing with case studies*. This is because survey research relies on *statistical* generalization, whereas case studies (as with experiments) rely on *analytical*

> generalization. In analytical generalization, the investigator is striving to generalize a particular set of results to some broader theory."

Yin (1994, p. 36) argues that if the theory is supported by the evidence provided in the single case, then the theory will be able to identify other cases to which the results can be generalised. Herein lies the contribution of performing a single critical case. It can be used to demonstrate the relevance of a new theory in explaining something which was previously unexplained or unknown and can be used as the basis to identify other cases where the theory can be used. Later the results can be replicated in subsequent cases. Yin (1994, p. 36) illustrates this with the following example on neighbourhood change:

> "For example, the theory of neighborhood change which led to a [single] case study in the first place is the same theory that will help identify the other cases to which the results are generalizable. If the study focused on "gentrification",....., the procedure for selecting a neighborhood for study also will have identified those types of neighborhoods within which gentrification was occurring. In principle, theories about changes in all these neighborhoods would be the target to which the results could later be generalized."

In sum, while generalisation is not automatic, a critical single case is still a valid research design when it can be used to test the propositions of a well formulated theory and identify other cases where the theory's propositions should be valid.

Single case approaches are also justified when the case represents an extreme or unique situation. A single case of this type is one which rarely occurs. It may be an opportunity to gain insight into rare phenomena.

A third rationale for single case studies is where the case represents a revelatory situation. In this instance an opportunity presents itself to make observations, where they previously did not exist. This is distinguished from the unique or rare case, because the phenomena under study are widespread, but study of them was previously impossible.

Yin (1994, pp. 44-51) identifies the reasons for using a multiple case study design. Multiple case studies involve investigation of two or more entities. Comparisons are made across cases. Multiple embedded case studies involve study of embedded entities within each of the cases. For example, an investigator may be interested in studying the implementation of two information systems in two organisations. In each organisation there are two information systems being implemented. The information systems in each organisation constitute the embedded entities within the multiple case study.

Multiple case and single case designs have relative advantages and disadvantages. Multiple cases provide evidence across two or more cases. The evidence is compared and if similar findings are made across the cases, then generalisation of a theory is possible. Usually the rationale for single case designs cannot be satisfied by using multiple case design. By definition, single case designs are relevant for situations where only one case exists. For example, it would be unlikely, to find two unique cases, or revelatory cases. This also applies to the critical case scenario because it would be unlikely to find two cases which met the pre-conditions for testing the theory's propositions. In addition, Yin (1994, p. 45) states that investigation using a multiple case design can require resources and time beyond the capability of the single researcher. Accordingly, Yin (1994, p.45) states that the decision to use a multiple case design should be considered thoroughly before the single researcher commits to it.

4.3.1 The Organisation X Case Study

Organisation X is a large multinational which manufactures and sells a variety of products ranging from chemicals, household cleaning products, office supplies, data storage devices, to medicines. At the time of study, Organisation X possessed three KBSs in various stages of development. One system, a customer service system which will be referred to as KBS A, was built for a division in Organisation X. Another customer service system named KBS B, was built for a second division. A training system for customer support representatives named KBS C, was built for a third division.

Organisation X and the three KBSs represent a single embedded critical case design for testing the KBS value model. The model itself meets a major justification for using a critical case. It represents a well formulated theory which has specified the propositions and the circumstances in which these propositions are believed to hold. These propositions were listed in section 4.2 above.

Organisation X meets several circumstances or pre-conditions for testing the model's propositions. One pre-condition needed to test the model is an organisation which is developing two or more KBSs. Proposition 7 stated that managers can assess the comparative value of two or more KBSs by comparing KBS value graphs from two or more KBSs. Organisation X met this pre-condition because it was developing three separate KBSs, thus enabling testing of the model's capability to compare valuations.

A second pre-condition, related to the first, is an organisation characterised by a centralised decision making body which is responsible for making the decision to invest in one or more KBSs. This pre-condition is necessary for the testing of Proposition 7. An

organisation characterised by decentralised decision making and funding allocation whereby only one KBS was being developed per decentralised entity would not be comparing multiple KBSs in order to choose the KBS with the most value. Organisation X was characterised by centralised decision making and funding allocation whereby there were multiple KBSs being developed in different divisions of the organisation, but scrutinised by the central decision making body. Hence, Organisation X meets this second pre-condition for testing Proposition 7.

A third pre-condition required to test all propositions is the use of manager, user, and expert employees from the organisation with no outsourcing of these employees. Some organisations may outsource the development and use of the system. In this case, the manager, user, and/or the expert employees may be acting as consultants to the organisation. In such a scenario, these employees would not be able to place a value upon the KBS in the context of their jobs, within the organisation. They would not have enough knowledge of the costs and benefits of the KBS to the manager's, user's, nor the expert's job within the organisation. All three systems at Organisation X used internal expert, manager, and user employees, therefore, meeting this pre-condition.

A fourth pre-condition for testing the propositions is an organisation with stable KBS valuators. This excludes organisations where previous experts, managers, and users have been replaced as a result of attrition, by new employees or current employees who are unfamiliar with the KBS. Using such employees may jeopardise the valuation of any KBS because they would be unable to give an informed valuation due to their unfamiliarity with the system. Organisation X was able to provide three systems with stable, informed valuators.

A fifth pre-condition related to Proposition 1, is that the experts, managers, and users studied have free choice in performing their respective KBS behaviour's. As explained in Chapter 3, section 3.2.1, if performing the behaviour is voluntary, then the normative component would not be expected to contribute to intention to perform a given KBS behaviour. Intention to perform behaviour would be dependent upon attitude, which would be solely determined by the beliefs and their associated evaluations. In the case of the employees at Organisation X, performance of their behaviours was voluntary. A fact which will be demonstrated in Chapter 6, section 6.2.2.

A sixth pre-condition which relates to Proposition 1 is that performance of the KBS behaviour is volitional. This means that each employee is able to perform their relative KBS behaviour without any external factors preventing them from performing it. In the case of the Organisation X employees, there were no factors which interfered with the

performance of their KBS behaviours. A fact which will be demonstrated in Chapter 6, section 6.2.2.

In addition to a critical case, Organisation X represented a revelatory case as described by Yin (1994, p. 40). As was discussed in Chapter 1, section 1.2.1, KBS technology has certain unique characteristics. These include among other possibilities: decentralised decision capability; more accurate decisions; and faster decisions. These attributes enable KBSs to be used as competitive weapons against rival firms. As a result, many KBSs are introduced to organisations in secret. This makes it very hard to recruit organisations for an indepth study of the value of KBSs which they have in operation or are planning for development. Organisation X was an exception to the norm and was quite receptive to the KBS value study. Other organisations were approached, but were unwilling to cooperate with the study.

The above arguments give credence to the use of a single case design in this KBS valuation study. Moreover, Organisation X meets the pre-conditions for testing the model and is therefore an ideal candidate for study. In addition, as stated above Yin (1994, p. 45) indicates that investigation using a multiple case design can require resources and time beyond the capability of the single researcher. Accordingly, the decision to use a multiple case design is not to be taken lightly. Hence, even if another case could be found, which proved difficult, the resources required to conduct the case would likely be beyond those available to a single researcher.

4.4 Overview of the Data Collection Method

As was explained in section 4.1 the procedures for data collection are described in Appendix A: Case Study Protocol. However, a brief overview of the data collection method will be presented now to give the reader a better understanding of the context in which the case study was conducted. The data collection method consisted of a series of procedures in the form of structured and unstructured interviews and structured questionnaires which were administered to employees of Organisation X, by the data collector and thesis author. The employees included the study's key informant, and managers, experts, and users from the three KBSs.

4.4.1 Procedure 1: A Structured Interview with the Key Informant

A structured interview was held with the key informant of Organisation X in order to determine the following:

- whether KBSs were being developed at Organisation X;
- identify the experts, users, managers involved with each KBS;
- what KBS lifecycle model was being used at Organisation X;
- based upon the lifecycle model used, determine which of these lifecycle phases managers, users, and experts perform their KBS behaviour;
- what the major KBS management issues were at Organisation X; and
- whether the pre-conditions for use of Organisation X as a case study were met.

4.4.2 Procedure 2: An Unstructured Interview / Demonstration with the Key Informant

An unstructured interview was held with the key informant in which the KBSs were demonstrated. The aim of this interview was to:

- identify the KBSs at Organisation X with a demonstration of each system;
- ascertain the authenticity of the KBSs studied;
- locate which lifecycle phase that each KBS was currently traversing;
- determine what organisational task(s) each KBS is/are designed to support;
- determine how each organisational task is/was performed before implementation of the KBS; and
- determine how each organisational task was/will be performed after implementation of the KBS.

4.4.3 Procedure 3: A Structured Interview for Managers, Experts, and Users

Following this a structured interview was administered to each employee. Its purpose was to elicit from each expert, manager, and user his/her:

- age;
- sex;
- position in Organisation X;
- role in the KBS lifecycle;

- beliefs regarding the positive and negative consequences of performing the KBS behaviour ; and
- actions indicative of performing the relevant KBS behaviour.

4.4.4 Procedure 4: An unstructured Informal interview with Managers, Users, and Experts

An unstructured informal interview with each respondent was held directly after the structured interview to:

- determine if performing KBS behaviour was perceived to be voluntary or mandatory by the respondent; and
- ensure that the interviewer understood the beliefs and behaviours elicited by each employee.

4.4.5 Procedure 5: Structured Questionnaires for Each Respondent

A questionnaire was given to each user, expert, and manager of the three KBSs to rate:

- beliefs and their associated evaluations; and
- attitude, intention, and performance of behaviour.

4.4.6 Procedure 6: Unstructured Interview with Key Informant

An unstructured interview was held with the key informant to:

- judge whether the actions of the respondents were indicative of those required to perform their respective KBS behaviours;
- judge whether the beliefs were relevant; and
- determine usefulness of study results.

4.5 Validity and Reliability of the Data Collection Methodology

According to Robson (1995 pp. 68-72) and Yin (1994, p. 33), there are three types of validity with respect to research designs that are relevant to both qualitative case studies and quantitative studies alike. These are: construct validity, internal validity, and external validity. Yin (1994, p. 33) defines these concepts. Construct validity refers to use of the

correct operational measures for the concepts being studied. Internal validity refers to correctly establishing a causal relationship across variables in a study. External validity refers to correctly establishing the domain to which the findings can be generalised.

4.5.1 Construct Validity

To demonstrate the achievement of construct validity in this study requires evidence that the instruments used to measure belief, attitude, intention, and behaviour have likely measured these variables. Structured interviews and questionnaires were used as the main source of data collection in the study. They were designed to measure employee beliefs, attitude, intention, and behaviour. From the definitions above, in this study, construct validity then refers to the degree to which the variables being studied have been appropriately defined. The variables of belief, belief evaluation, attitude, intention and behaviour were all defined using the guidelines from TRA as specified by Ajzen and Fishbein (1980). The literature review on TRA in Chapter 2, section 2.12.2 indicates that construct validity has been extensively proven for these variables across a wide variety of applications. The same guidelines were followed in this study as in those reviewed in Chapter 2, section 2.11. This provides support for the achievement of construct validity in this study.

Specifically, the TRA guidelines state that the variables of belief, attitude, intention, and behaviour should be measured in terms of four criteria: time, context, target, and behaviour. These criteria have been included in the wording of the questions and the verbal instructions given to respondents hence increasing construct validity.

In addition to the guidelines presented in TRA, Yin (1994) proposes three techniques for achieving construct validity in case studies. One technique involves using multiple sources of evidence which converge on one conclusion (*ibid.*, p. 34). If two or more sources converge on the same conclusion, then it is likely that construct validity is being achieved. Yin (1994, p. 79) proposes six sources: documentation; archival records; direct observations; participant observation; interviews; and physical artefacts. Many of these techniques are unsuitable for the purpose of the study or impractical in the Organisation X environment.

Documentation such as letters, proposals, progress reports, and memoranda did not exist since Organisation X uses a minimum of paper work, as pointed out by the key informant. Archives such as sales records, budgets, and personal diaries were unattainable due to their proprietary and sensitive nature. In addition, there was no documentation available at Organisation X which measures an employee's beliefs, attitude, and intention.

Direct observations were not used, since many of the behaviours such as observations of managerial support were difficult to observe. Some of these behaviours had been performed recently in the past, or over a long period of time, therefore making it difficult to observe. Most importantly, it is impossible to directly observe an employee's beliefs, attitude, and intention.

Participant observation was impossible and inappropriate since it requires the researcher to become an active participant in the study. For example, the researcher would have to adopt the role of an expert, manager, and a user. In any of these roles, the measures of beliefs, attitude, intention, and behaviour made by a researcher are likely to be inaccurate. He/she is not a real employee in Organisation X and thus has no previous experience as an employee performing a specific job at Organisation X. Additionally, he/she will have no future experience in any such job. Thus, it is unlikely that such a researcher could accurately elicit the beliefs, attitude, intention, and behaviour in the context of a permanent employee at Organisation X.

A study of physical artefacts cannot be used to measure the beliefs, attitude, intention, and behaviour since these variables are abstract concepts only and with the exception of behaviour they have no physical manifestation.

Structured interviews and questionnaires were used as the main source of data collection. As is discussed above, their design has followed exactly the TRA data collection guidelines. Since these guidelines were followed, there is significant support that construct validity is achieved.

The second technique proposed by Yin (1994, p. 34) is to maintain a chain of evidence of the case study results. If a chain of evidence is presented in the form of a case study data base (explained in section 4.5.4 below) then an external judge is in a better position to review the findings of the study. This can help to achieve construct validity since the logic of the findings and the steps taken to arrive at them are now identifiable and assessable. Such a data base for this study is presented in Chapter 5 where the results of applying the procedures of data collection are presented including those for belief, intention, attitude, and behaviour.

The third technique proposed by Yin (1994, p. 35) advocates performing a review of the case study by the key informant as well as other participants. Review by the key informant essentially involves producing a summarised version of the case study to him/her. He/she then checks the facts of the document, thus reducing the likelihood of false reporting and

increasing construct validity. Informant and participant review was conducted in this case study at several levels.

Participant review was done in Procedure 4 by having the results for the beliefs checked by the employees directly after they were elicited, to ensure that they were correct, and that they were accurately interpreted by the interviewer. The key informant also reviewed the actions and beliefs elicited by the employees in Procedure 6.

Second, the participant employees were each asked whether there was anything else besides the advantages and disadvantages elicited that he/she associated with performing the KBS behaviour. If no further beliefs regarding the consequences of performing the behaviour was elicited, then the chances are increased that the instrument used to collect beliefs achieves construct validity.

The degree to which the instrument for measuring beliefs achieves construct validity is also checked by participants when their individual beliefs are rated. The scale used to measure the degree to which a belief is held is presented in Figures A.1 and A.2, of Appendix A. These scales provide an opportunity for the respondent to disagree with beliefs which he earlier elicited. Hence, this represents a chance to test construct validity of beliefs since it checks to see if the beliefs a person previously elicited represent his/her beliefs at the time of rating. Construct validity of attitude is tested by using several items that are indicative of attitude. Construct validity of behaviour is also tested by using many actions indicative of the general KBS behaviour of users, managers, and experts. The reader may wish to refer to Appendix A to view the scales used to measure these variables.

Informant review was conducted in two interviews described above. The results for beliefs, attitude, intention, and behaviour were presented to the key informant in Procedure 6, to check whether, in his opinion, the results reflected reality. This technique presented an opportunity to assess construct validity. The key informant had been working closely with all employees. In informal discussions they had expressed their beliefs, attitude, and intention. In addition, the key informant knew what types of behaviours the employees should have been performing. Hence, he was in a position to check the construct validity of the results for the variables studied.

4.5.2 Internal Validity

There are several threats to internal validity which have previously been reviewed (Robson 1995, pp. 70-71). These include:

- history;
- maturation;
- testing;
- instrumentation;
- regression;
- mortality;
- selection;
- selection by maturation interaction;
- ambiguity about causal direction;
- diffusion of treatments;
- compensatory equalisation; and
- compensatory rivalry.

These will now be explained and discussed in the context of the data collection procedures detailed in Appendix A. According to Judd *et al.* (1991, p. 75) the main technique for reducing the likelihood that these threats will occur is to choose subjects randomly. However, due to the nature of this case study choosing subjects randomly is not feasible. The managers, users, and experts comprising each KBS were already formed before the study began.

History refers to events that have changed in the study's environment which are not part of the study, but which may affect the dependent variables. TRA states that any environmental factor which influences behaviour will do so only indirectly. These environmental factors will only directly affect beliefs. Then beliefs will affect attitude, which affects intention and finally intention affects behaviour (Ajzen and Fishbein, 1980, p. 82). Therefore the environmental factors will only affect the other variables indirectly through their affect on beliefs. The scales used to rate beliefs can be used to see if there were any changes from the time of the initial interview to the time of the administered questionnaire. These scales gave the employee the opportunity to change his/her mind about each belief. Each belief could be rated as good or bad, or neutral, regardless of whether it was originally elicited as an advantage or disadvantage. This procedure identifies environmental changes reflected by changes to previous beliefs, but does not identify changes which add additional beliefs to this already known set of beliefs. However, the incidence of this threat is likely to be fairly

low since the time between initial elicitation of beliefs and rating of beliefs in the administered questionnaire was only two or three days for each participant.

Maturation refers to changes in the participants of the study and may affect the performance of these participants. Again, the scales used to rate beliefs in the administered questionnaire can be used to see if there were any changes in the beliefs of the participants as elicited in the initial interview. This should indicate changes in the participants since any change in a participant should be first reflected in his/her beliefs, to cause a change in subsequent variables. This is supported by TRA which states that in order to affect behaviour any change should first affect a persons beliefs before affecting attitude, intention, and behavioural performance (Ajzen and Fishbein, 1980, p. 82). Again, this procedure identifies changes in participants reflected by changes to previous beliefs, but does not identify changes which add additional beliefs to this already known set of beliefs. As was the case for history, the incidence of maturation is fairly low since the time between initial elicitation of beliefs and rating of beliefs in the administered questionnaire was only two or three days for each participant.

Testing refers to changes that may occur in scores given by participants because of experience gained from involvement in pretests before the treatment of the experiment occurs. While there was no treatment and therefore no pretest, it may be conceivable that the beliefs elicited in the initial interview may have changed due to maturation and are no longer relevant. For example, an employee would have had time to think about the beliefs he/she elicited and subsequently revised this original belief set. Again the scales used to rate beliefs provide some test of whether this has occurred, but will not identify changes which add additional beliefs. Once again, the incidence of testing is fairly low since the time between initial elicitation of beliefs and rating of beliefs in the administered questionnaire was only two or three days for each participant.

Instrumentation refers to lack of consistency in measuring instruments. There was consistency in the instruments used across respondents. All instruments followed the guidelines of TRA which were equally applied to all respondents.

Regression occurs when selection of participants for a study is done on the basis that they are unusual. It refers to the situation in which participants who score highest on a pre-test, score lower on a post-test. This tends to yield results which gravitate toward the mean expected score. There was no treatment in this study. It simply measured the beliefs, attitude, intention, and behaviour of users, experts, and managers at one point in time. There was no pre treatment scores and no post treatment scores. Hence, regression is not an issue.

Mortality refers to participants dropping out of the study. This threat is of no significance in the study because no participants dropped out in the course of data collection. That is, there were no experts, managers, nor users whose beliefs were elicited during the initial interview, but later were unable to rate the degree to which they held the beliefs in the second administered questionnaire.

Selection refers to the fact that the groups selected for the study may be different before the study begins. These initial differences may explain the differences between pre-test and post-test results between two groups in a study. In this case study there was no treatment administered to the groups, so there was no pre-test nor post-test results. However, the users, experts, and managers in the Organisation X case study were already formed before the study began. There may be pre-existing differences between these employees. These differences may lead to the elicitation of different beliefs from experts, managers, and users, when it would rationally be expected that the same beliefs would be elicited.

For example, imagine that an organisation has a KBS which provides advice on product choice to customers. It might be expected that a user and a manager of the KBS would hold some of the same beliefs. For instance, it might be expected that both of them think the KBS provides consistent advice to customers on the most appropriate products, given the customers need. However, it might occur that the user holds this belief, but the manager does not. If this occurs then it is likely that there is some pre-existing difference between the employees causing the variation in beliefs held between the manager and user. External variables such as demographics, attitudes towards people, attitudes towards Organisation X or the division in which an employee worked, and personality traits could conceivably influence beliefs held by the different respondents. These differences are captured by the beliefs, which influence attitude, and attitude in turn influences intention, and finally actual performance of behaviour. If these differences were significant, they might explain in part the differences in the value employees attach to KBSs. To control for these external variables is a formidable task. There is likely a very large number of external variables which might be reasonably expected to influence the beliefs held by an employee. Performing an experiment to test the existence of each variable, its relative level of influence, and the situations where it is expected to be present would require resources beyond those available for this study. In addition, such a study of the external variables is beyond the scope of this study. The aim of this study is to propose a model for assessing the value of KBSs as perceived by the key employees involved in its lifecycle. The reasons for using employee perceptions for measuring KBS value were put forth in Chapter 2, section 2.5. As argued in Chapter 2 and further argued in Chapter 6, section 6.4, despite the fact that there may be differences in perceptions, managers still rely upon them when

making decisions including investment decisions. Given the merits of using perceptions and the fact that there is little or no choice in the experts, users, and managers performing the valuation the selection threat to internal validity is not a major issue. Despite this, measurements of age, sex, and position in the organisation were taken in order to at least record whether or not these differences in these variables coincided with differences in beliefs for managers, experts, and users.

Selection-maturation interaction refers to the situation where groups chosen for a study grow apart or together. Maturation, and even changes due to history, or mortality, may give one group an advantage or disadvantage over another which affects the results. In this study a change due to any of these factors may cause beliefs to change. Data collection occurred over a relatively short period of time, from November 1994 to January 1995 of the following year. This is a relatively inactive period of the year and it is unlikely that any changes due to the above factors could have occurred.

Ambiguity about causal direction refers to the situation where an independent variable may cause variation in a dependent variable, but reciprocal causation cannot be ruled out. As was reported in Chapter 2, section 2.12.3 performance of past behaviour may be more significant in predicting intention and behaviour, especially in habit forming behaviours, than either attitudes or beliefs. Evidence was found by Taylor and Todd (1995b, p. 566) that prediction of information systems use by an experienced user may be improved when a measure of past behaviour is taken into account. For inexperienced users, a measure of past behaviour probably will not improve prediction. The KBS value model measures value via a measure of positive and negative beliefs and their associated evaluations. The positive and negative beliefs represent the costs and benefits of a KBS to an employee. A measure of past behaviour will not improve this measure of value because it does not capture any additional costs and benefits. In addition, as was reviewed in Chapter 2, section 2.12.6 there is ample evidence to support the validity and reliability of TRA in explaining and predicting use of information systems in the absence of measuring past behaviour. For these reasons past behaviour was not measured.

Diffusion of treatments refers to the situation where one group learns about aspects of an experiment which was only intended for another group. This threat is of no concern since, there was no differential treatment of employees across the KBSs studied. The interviews and questionaries applied to each user, expert, or manager were identical.

Compensatory equalisation of treatments occurs if one group receives differential treatment and other groups exert pressure to receive the same treatment. Again, since there was no

differences in how the employees pertaining to each KBS were treated, this threat is of no concern.

Compensatory rivalry refers to the situation where one group (for example, a group working in an organisation which is expected to perform at a certain standard or better) perceives that it is under threat from change and improves performance. This may affect beliefs, attitude, intention, and behaviour because they may feel they are being evaluated. In this case, there was only one manager, user, and expert per KBS. It was futile to attempt to keep employee identities secret. The key informant was the superior of the employees and knew the identity of each person. In fact employee identification was critical so that the key informant could verify the results to help establish construct validity as discussed in section 4.5.1 above. As is detailed in Procedure 3 of Appendix A, to reduce the threat of compensatory rivalry, the aim of the study was revealed to each respondent and he/she was informed that the results of the study were not going to be used to evaluate his/her performance. Respondents were also instructed to provide answers which were truthful and honest. All this was intended to overcome any feelings on the part of the respondent of being treated special and therefore giving untruthful results. In addition, the location and time of interview was scheduled at a time and place where the respondent felt most comfortable.

Yin (1994, p. 35) states that there are two modes of analysis which can be used to test whether there is internal validity in a case study or not. These are pattern matching and explanation building. These two modes test internal validity during data analysis. Hence, they will be explained and applied in Chapter 5: Presentation of Results and Chapter 6: Analysis and Interpretation of Results. These modes of analysis represent additional techniques for demonstrating the existence or absence of the internal validity threats discussed above. They are particularly useful techniques in case studies where random choice of respondents is difficult to achieve.

4.5.3 External Validity

According to Yin (1994, p. 35) external validity refers to correctly establishing the domain to which the findings can be generalised. Two strategies found in the literature for establishing external validity are replication and expert review. Replication was discussed in section 4.3 and will not be discussed here.

Expert review as a solution to the problem of external validity lies in the concept of extrapolation. Sykes (1990, p. 7) suggests that the domain in which the findings can be usefully applied might be established by using an expert who reviews the findings of the

report and forms an expert opinion about the generalisability of the findings to other research settings. In other words the expert provides an extrapolation.

An expert could be used to assess the external validity of the KBS value model by extrapolating the applicability of its findings to other hypothetical cases which are similar, but not identical. The domain of applicability would consist of organisations in sales and manufacturing with customer service KBSs such as those in this study. The expert would judge the applicability of the model to measure KBS value according to the characteristics of the value model as formulated in Chapter 3, across a variety of organisations and domains.

Expert review may provide an adequate base upon which to establish the external validity of the model. However, it is likely that an expert reviewer may be biased and/or unable to foresee any weaknesses or strengths which may exist in the theory. This is highly likely due to the complexity of the case scenario of Organisation X and the fact that the model bridges two vastly different fields of inquiry. Due to the recent advent of KBS it is unlikely that an expert in KBS management can be found who is also an expert in psychological theory. The only accurate way to ensure external validity in the single case scenario is to wait for replication to theory as proposed by Yin (1994, p. 36) when more cases become available. Hence, expert review is not advocated in this thesis.

4.5.4 Reliability

Reliability has been defined by Yin (1994, p. 33) as:

> "....demonstration that the operations of a study - such as the data collection procedures - can be repeated, with the same results".

According to Yin (1994, p. 36):

> "The objective is to be sure that, if a later investigator followed exactly the same procedures as described by an earlier investigator and conducted the same case study all over again, the later investigator should arrive at the same findings and conclusions. (Note that the emphasis is on doing the *same* case over again, not on "replicating" the results of one case by doing another case study.) The aim of reliability is to minimise the errors and biases in a study."

Robson (1995, pp. 67-68) suggests the following causes of unreliability: subject error; subject bias; observer error; and observer bias. The occurrence of subject error is unlikely in this study due to the strict adherence to data collection guidelines offered by Ajzen and

Fishbein (1980). Moreover data collection was always done in the presence of the data collection administrator. Subject error due to the possibility that beliefs may be forgotten is unlikely. Ajzen and Fishbein (1980, p. 63) suggest that beliefs which predict and explain attitude are readily retrievable from a respondent's mind. Hence, the likelihood of forgetting such beliefs is low. Subject bias was reduced by checking the behaviours elicited from respondents with the opinion of the key informant in Procedure 6. Procedure 6 was also used to check for subject bias when measuring beliefs, attitudes, and intentions. The results were reviewed by the key informant for his opinion of their reliability. Subject bias is also possible if the respondent wants to help by making the results look favourable. Procedure 3 was used in order to reduce the likelihood of this. Respondents were instructed to be honest in the responses they gave. Furthermore, respondents were informed of the aim of the study and that the findings were not going to be used for performance evaluation. Observer error and bias was reduced by following the TRA data collection guidelines. Observer bias was further reduced by using the same data collector across all individuals.

Yin (1994, p. 37) proposes two methods for achieving reliability in case study research. The first is the use of a case study protocol. The second is the development of a case study data base. These two techniques were used to reduce error and bias on the part of the observer and subjects alike.

A case study protocol proactively increases the reliability of the results. It documents the procedures used to conduct the case study, this includes: an overview of the case study project; field procedures to be used in collecting the data; the specific case study questions; and an outline guide for the case study report (Yin 1994, p. 64). Such a case study protocol has been placed in Appendix A. It includes an: overview of the three KBSs studied within Organisation X; explanation of the field procedures used to collect the data; and the case study questions for the key informant, managers, experts, and users. It does not contain an outline guide for the case study report since this is presented in the table of contents of the thesis.

The details of the case study protocol serve as a guide for the researcher so that the subject and observer errors and biases itemised above are less likely to occur. In this way it proactively increases reliability. It can also be used as a means of assessing the reliability by an external judge. The questions used to extract the data from respondents can be scrutinised. An opinion can therefore be formed concerning the reliability of the data collection method. The data analysis procedures can similarly be examined for reliability.

Development of a case study data base involves organising the raw and processed data in a way that will in principle be retrievable by a future investigator. The items in a data base include the data in raw form such as:

- case study notes;
- case study documents;
- narratives; and
- the answers to case questions.

They also include processed items such as:

- tabular materials; and
- formulae and calculated results.

A case study data base may consist of edited and rewritten interview notes which are electronically stored or placed in an appendix of a report. Or it may exist as an organised physical set of materials, filed away for future access. In this way a data base can be used by an external judge to assess the reliability of the case study.

This approach is used in this thesis. The physical data base is too large to attach to the thesis. The results of applying the KBS value model are presented in Chapter 5 and analysed in Chapter 6. An organised physical data base of results will be kept for future reference.

4.6 Conclusion

This chapter firstly stated the propositions upon which the KBS value model will be tested. Secondly, it explained the reasons why a single embedded case study research design was chosen to test the model's propositions. The choice of a single case design was justified on the grounds that Organisation X represented an embedded critical case for testing the propositions of the KBS valuation model. The generalisability of results was also discussed and it was explained how the data collection procedures used in the study would increase the validity and reliability of the findings. The procedures used to collect the data are described in Appendix A: Case Study Protocol.

Chapter 5

Presentation of Results

5.1 Introduction

The purpose of this chapter is to present the results collected from applying the KBS value model to the KBSs at Organisation X. The procedures described in Appendix A: Case Study Protocol were followed to collect the results. There are three main results to present. First, the managerial issues concerning KBSs at Organisation X are presented. Second, the results describing the KBSs are presented. Third, the results for: beliefs, and their associated evaluations; attitude; intention; and behaviour are presented. For the convenience of the reader the raw results for these variables are presented in tabular format in Appendix B.

5.2 Managerial Issues Across the KBSs lifecycle at Organisation X

Organisation X is a large multinational with offices in over 30 countries. Its head Australian office is in Sydney, with regional offices in all major cities. It manufactures and sells a wide range of products for office, industrial, and household use. Organisation X is comprised of several divisions. Each division is responsible for the sale and manufacture of a specific and related range of products. The range of products across the divisions include: electronic data storage media, medicines, facial respirators, safety garments, paints, surgical equipment, road signs, advertisements for bulletin boards, adhesives, abrasives, and electrical insulation kits, to name 12 product types.

The key informant was a senior executive in organisation X. He was chosen because he was the senior manager responsible for the KBSs being developed. The results from applying Procedure 1, the structured interview with the key informant of the Case Study Protocol in Appendix A, will now be presented. This interview lasted for two hours and was held in the key informant's office at his request. In response to the question regarding whether KBSs existed at Organisation X, the key informant indicated that in his opinion there were. He indicated that the KBS development lifecycle used at Organisation X consisted of the following phases:

Phase 1 initial awareness on the part of a senior executive that a KBS is needed ;
Phase 2 general recognition that a need exists by the organisation;
Phase 3 cost justification, financial allocation, identification of resources;
Phase 4 KBS development;
Phase 5 KBS testing and debugging;
Phase 6 restricted internal implementation;
Phase 7 full implementation and update; and
Phase 8 KBS termination.

The key informant's responses to the question asking for the objectives of each KBS lifecycle phase are presented in Table 5.1 below. An examination of the phases listed above and the phase objectives from Table 5.1 reveals that the KBS development lifecycle model used to manage the development of its KBSs is very similar to most of the models reviewed in Chapter 2, section 2.9.

Table 5.1 Objectives of the KBS Lifecycle Phases

Phase	Objectives
Phase 1	• Understanding the business in general • Looking for productivity gains in the business • Matching KBS applications to meet needs in the business
Phase 2	• Convincing top management of the need for the KBS • Convincing users, and experts, and user management of need
Phase 3	• Receiving allocation of funding
Phase 4	• Recruitment of contractors for development • Acquisition of knowledge from experts • Design of human interface • Develop a prototype
Phase 5	• Extensive debugging by use of test cases by experts and developers • User acceptance testing
Phase 6	• Installing hardware and software for restricted internal use of six months duration • Training users • Development of a system implementation plan
Phase 7	• Hand over of KBS from contractor • Execution of implementation plan • Ongoing maintenance of the knowledge in the system
Phase 8	• Extract system with minimal impact on organisation and customers

Table 5.2, below presents the responses of the key informant when asked which groups were involved in each KBS lifecycle phase, what type of support they required, and what hindrances they faced. With the exception of Phase 5: KBS testing and debugging, a recurring hindrance across all phases is the resistance of top management to support KBS development. According to the key informant, top management consisted of the Manager of Information Technology Services; the Sales and Marketing Manager of the Division in which the KBS was to be implemented; the Manager of Financial Services; and the Organisation X General manager. These managers represent a centralised decision making

group responsible for deciding whether it is worth investing in a KBS and if it is then releasing funds for its development. The key informant explained that this resistance was due to top management's lack of computer literacy and inexperience with KBS technology Furthermore, he said that top management was unable to understand the contribution that KBSs could make to Organisation X. This resistance made it difficult to gain funds at various phases of development. As can be seen from Table 5.2, resistance from top management occurs in: Phase 2: general recognition that a need exists by the organisation; Phase 3: cost justification, financial allocation, identification of resources; Phase 4: KBS development; Phase 6: restricted internal implementation; and Phase 7: full implementation and update. In each of these phases, except Phase 2, funds need to be acquired before further development can go ahead. In Phase 2, in order to gain these funds the project is reviewed by top management. The key informant indicated that the major problem was getting top management to see the benefit of KBS technology to the organisation. This problem occurred all the way through the KBS lifecycle. He believed that if top management could see the benefit of KBS technology, then their resistance could be overcome.

In the early phases of development which include Phase 1, Phase 2, and Phase 3, the key informant indicated that he needed information on the value of the KBS which in these phases did not exist except possibly at the end of Phase 3. He relied upon information about the value of other KBSs which had been developed overseas.

Other managerial issues can be gleaned from Table 5.2. These include: the need to find replacement employees for experts during development; the need to train users; and the need to assess the legal implications of organisational decisions made by a KBS. All these were significant management issues, but the issue which recurs the most across nearly all phases is the resistance from top management to the development of KBSs. The key informant indicated that the core of top management's resistance was their difficulty in understanding how KBSs could benefit the organisation. A further examination of Table 5.2 reveals that in Phases 3 through Phase 8, users, managers, and experts are involved in the development of KBSs at Organisation X.

Table 5.2: Organisational Groups Involved in KBS Development Phases, Support they Require, and Hindrances Faced in Each Phase

Phase	Organisational Groups involved	Support Required from and by each group for KBS Success	Hindrances to Achieving Phase Objectives
Phase 1	Usually Experts	No support required. It just happens	Resistance of Top Management due to inexperience with KBS technology
Phase 2	General Manager, Financial Manager Manager of Information Technology (IT) Division Sales and Marketing Manager	General Manager, Financial Manager, IT Manager, Division Sales and Marketing Manager need information to decide if KBS has worth	No willingness from Top Management to support KBS development
	User Management	User Management needs information about the benefits of the KBS to the users	
	Experts	Experts need information about the benefits of the KBS to them	
	Project champion (could be expert, or a technical manager)	Project champion needs information which demonstrates the worth of other KBSs	
Phase 3	Project champion (could be expert, or a technical manager)	Project champion needs to predict KBS value and cost estimations, which are provided by the financial department	Access to support employees to perform value assessments. No information about the intangible benefits of the KBS
	Financial Department	No support required	
Phase 4	Users	Users need training to test prototype	IT policy makes it difficult to acquire hardware and software. There must be a good justification in order to acquire it.
	Experts	Experts need replacement employees to perform normal job duties	
	Legal Department	Need to assess copyright, legal implications of decisions made by the KBS.	
	System developers/ KBS Manager of project	Efforts of external developers and internal experts need to be coordinated. Also need to acquire the hardware and software to develop and run prototype	
Phase 5	Experts	Experts need hardware to test the KBS	
	Users	Users need training and hardware to run KBS	Resistance of users might exist
	KBS Manager	KBS Manager needs support from the developer to perform fixes	Development contract can be poorly specified
Phase 6	KBS Manager, Experts, Users, and Top Management	Need Users to test KBS in operational environment; Need to train Users; Need to get top management to accept the system for full implementation	Possible resistance of from users and top user management
	IT Department	Need the IT Department to manage implementation of KBS	IT Department is not involved in KBS development

Table 5.2 Organisational Groups Involved in KBS Development Phases, Support They Require, and Hindrances Faced in Each Phase (Continued)

Phase 7	Users	Help desk for user questions	Computer literacy of sales force Resistance from Top Management to full release of system
	KBS Manager	KBS Manager needs to coordinate KB implementation	
	Experts	Need experts to perform updates	Experts have job demands other than performing updates
Phase 8	Users	Support from IT department to remove system	Resistance to change on the part of the users

As documented in Appendix A, Procedure 1 was used to identify if the pre-conditions for testing the KBS valuation model were present at Organisation X. The first pre-condition is that the organisation has more than one KBS. The key informant identified three KBSs which were currently being developed or implemented at Organisation X. These KBSs will be described in the next section.

The second pre-condition is that a central decision making body is responsible for making KBS investment decisions instead of these decisions being made in a decentralised fashion. The key informant stated that the decision to invest in KBSs was made by several top level executives including: the Manager of Information Technology Services; the Sales and Marketing Manager of the Division in which the KBS was to be implemented; the Manager of Financial Services; and the Organisation X General Manager.

The third pre-condition was the existence of managers, users, and experts for each KBS. The key informant provided a list of the managers, users and experts for each KBS. Two of the KBSs had users, experts, and managers, while one KBS had an expert and a manager only. Despite this fact, this pre-condition is still satisfied. One rationale for this pre-condition is to ensure that none of the managers, experts, or users were outsourced from another organisation to develop, implement, maintain or use the KBS. Since this did not happen this pre-condition is met.

The fourth pre-condition stated that the managers, experts, and users should be stable for each KBS studied. The key informant stated that there were no instances where the employees he had identified in his list had been removed from any of the KBS projects.

The fifth pre-condition was that the KBS behaviours performed by managers, users, and experts were voluntary and not mandatory. The key informant stated that in all cases each employee was asked whether or not they wanted to be involved in the relevant KBS's

development. In addition, they were informed that they could be removed from the project on request with no repercussions on their careers. Hence, in the key informant's opinion, performance or non performance of behaviour was voluntary on the part of each employee.

The sixth pre-condition was that each employee has volitional control over performance of the relevant behaviour. The key informant stated that in the past there had been no instances where the experts, managers, and users were unable to perform their behaviours. Hence, the assumption of volitional control appears to at least have held in the past.

5.3 The KBSs Studied at Organisation X

The results of Procedure 2 which comprised the KBS demonstration and interview with the key informant will now be presented. This interview lasted approximately one hour. Demonstration of each KBS lasted approximately 15-20 minutes. The key informant demonstrated the KBSs using a variety of hardware on which they were installed. As each KBS was demonstrated, he answered the questions posed to him. These questions were not asked in any particular order, but were asked at appropriate times during the demonstration, or were volunteered without prompting from the interviewer. All questions pertaining to each KBS were asked and answered before the beginning of the next KBS demonstration. The results of this interview will be presented separately for each KBS.

5.3.1 KBS A

The division in which KBS A was built is responsible for manufacture, marketing, sales, and service for a wide range of electronic data storage products such as diskettes, tape cartridges, and optical disks. KBS A is a system designed to provide customers with recommendations on appropriate high voltage electrical termination kits for industrial use. It is also designed to free the expert, known as a technical services engineer, from the task of kit selection. The purpose of an electrical termination kit is to insulate the environment from the electrical current, for example at a junction box. The system asks for the amount of voltage, the type of cable the kit will be connected to, and the environmental conditions in which the kit will be used (for example, air temperature, water, soil, level of atmospheric pressure, etc.). The system then recommends approximately four kits and corresponding price information. The customer would then use this information to make a choice of the most appropriate kit. The recommendations are later printed off and mailed to the customer.

KBS A provides an itemised calculation of the price of the kit. This is much more efficient for any potential user as he/she would otherwise have to look up the price lists of each component of the cable and make the calculation manually.

The components of the kit include electrical cable, insulation material for electrical current, and material to protect the kit from it's environment. There are a total of 60 components used in the determination of a cable type and approximately 250-300 possible kits.

There are limitations to KBS A's capability, in that it can only work for relatively simple kits. The more complex enquiries still have to be handled by the expert. However, there is a large volume of simple requests.

KBS A was to be implemented in the Sales and Marketing Department of the division. At the time of study this had not yet occurred. At this time customers called the Technical Services Engineer who selected electrical kits using the knowledge residing in his mind. He handled both complex and simple requests. He asked for the amount of voltage, the type of electrical cable the kit will be connected to, and the environmental conditions in which the kit will be used (for example air, temperature, water, soil, level of atmospheric pressure, and so on). He then would describe the set of kits that would best satisfy the customer's need. Next he would determine the prices of each electrical kit and telephone the customer who could choose the desired kit, given the prices. This information would be documented by the expert and sent to the customer. Alternatively, the expert would give the customer the kit specifications over the phone as well as send a documented version, but not the price details. Instead, he would notify sales and marketing employees who would determine the prices of the various kits and call the customer with this information. The customers would then use this information to choose the kit for their needs.

If implementation was to go ahead, employees in sales and marketing would use KBS A to settle customer requests for a broad range of simple termination kits over the phone. The customer would call a 008 customer hotline to get immediate attention from a sales and marketing representative. The representative would use KBS A over the phone to quickly provide customers with a range of possible kits and pricing details, from which the customer could choose during the same phone call. Details of kit composition and pricing details would also be posted to the customer for their records or to use for making a choice among kits in their own time.

It is clear from these results that KBS A solves a difficult problem which requires the use of human expertise. The fact that it is designed to select kits which is the job of the expert confirms this. Furthermore, it is clear that it does employ knowledge of techniques,

information, heuristics, and problem solving processes that human experts use to solve such problems. The fact that it provides recommendations on kit configuration and prices indicates that it employs the problem solving processes, knowledge of techniques, and heuristics required of kit configuration. It, therefore, meets the criteria of KBS authenticity described in Procedure 2 of Appendix A.

The role of the KBS in the context of the organisation is also demonstrated from these results. KBS A aims to enhance the organisational function of selecting electrical termination kits. Selection of electrical termination kits is performed by the Technical Services Engineer liaising with the customer directly or in conjunction with sales and marketing employees. Once implemented KBS A is implemented it should allow the sales and marketing employees to perform kit selection for simple requests directly with the customer, with no role to play for the expert.

The key informant indicated that KBS A involved one expert and one manager. There was no user of KBS A, since at the time of study, the system was yet to be implemented or tested by users. There was no choice to be made among experts and managers by the key informant. There was only one expert and one manager involved in the project. The knowledge domain expert was a trained Organisation X electrical engineer from the division in which KBS A was built. The manager was a Sales and Marketing Manager from the same division and was responsible for the sales and marketing operation of that division.

The following is a summary of the key informant's response to the question about which phase KBS A was currently traversing at the time the measurements were taken.

At the time of the study a prototype of KBS A had just been developed and was not yet given to any user for trial. Prototype development was completed in 1994, just prior to the commencement of this study. This meant that at the time of measurement, the system was at the end of Phase 4: KBS Development.

5.3.2 KBS B

The division in which KBS B was built is responsible for manufacture, marketing, sales, and service for a wide range of work place safety equipment including respirators. KBS B provides customers with advice regarding respirator selection. The system asks for the types and quantity of chemicals used, the environmental work conditions in which the respirator will be applied (for example, number of windows open, and size of room) and the characteristics of the respirator user (for example, amount of facial hair, or size of

head). This information is then applied to the decision process resident in KBS B which provides a range of relevant respirator equipment and pricing details from which the customer can choose. The advice is later printed off and mailed to the customer. In addition, KBS B maintains an audit trail of customer characteristics for use by sales and marketing employees to identify new trends in the market place.

There are limitations to KBS Bs capability, in that it can only work for relatively simple requests for advice. The more complex enquiries still have to be handled by the hygienists who are expert chemical engineers in the division. However, there is a large volume of simple requests.

Prior to the implementation of KBS B, customers telephoned the hygienist who provided respirator advice using knowledge residing in her mind. She handled both simple and complex requests for advice. She would ask a customer for the types and quantity of chemicals used, the environmental work conditions in which the respirator will be applied (for example, number of windows open, and size of room) and the characteristics of the respirator user (for example, amount of facial hair, and size of head). She would then describe the set of respirators that would best satisfy the customer's need. Next she would determine the prices of each respirator and telephone the customer who could choose the desired kit, given the prices. This information would be documented by the hygienist and sent to the customer. Alternatively, the hygienist would give the customer the respirator specifications over the phone as well as send a documented version, but not the price details. Instead, she would notify sales and marketing employees who would determine the prices of the various respirators and call the customer with this information. The customers would then use this information to choose the respirator for their needs.

At the time of study KBS B was traversing Phase 6: restricted internal implementation. Upon full implementation of KBS B it is expected that advice for simple requests will be given by employees in sales and marketing through the use of KBS B. Advice for simple requests would only be given by hygienists in exceptional circumstances when sales and marketing employees are unable to attend to the requests. At the time of study a telesales and marketing consultant was one user of the system. She was responsible for taking customer enquiries concerning respirators over the telephone. Through a 008 customer hotline, customers could call her to get immediate attention. The consultant used KBS B to provide advice for the simple requests. The advice was given verbally by the consultant and the documented advice followed in the post. If the request for advice was of a complex nature and therefore not handled by KBS B, the consultant forwarded the call onto a hygienist.

At the time of this study, a sales representative was trialing KBS B with visits to customer sites as a sales tool. In this case KBS B is used to provide advice at the customers site in the same way as is done by the telesales and marketing consultant. The sales representative used a laptop computer with KBS B installed on it. The documented advice is later posted to the customer site.

It is clear from these interview results that KBS B can solve difficult problems which require the use of human expertise, since KBS B is able to give advice which was previously provided by the expert. KBS B employs knowledge of techniques, information, heuristics, and problem solving. This is clear because KBS B uses the relevant information described above and inputs it to a decision making process to provide the customer with respirators and associated prices. It, therefore, meets the criteria of KBS authenticity described in Procedure 2 of Appendix A.

The role of the KBS B in the context of the organisation is also demonstrated from these results. KBS B enhances the organisational function of providing respirator advice. Provision of advice was performed by the hygienist liaising with the customer directly or in conjunction with sales and marketing employees. Once fully implemented KBS B will allow the sales and marketing employees to provide advice for simple requests directly with the customer, with no role to play for the expert for simple requests.

The study of KBS Bs value involved two users, one expert, and one manager from the division in which it was implemented. These two users, performed different functions. As described above, one was a telesales and marketing consultant who took customer calls and the other was a sales representative who visited customer sites. The manager was responsible for the sales and marketing operation of the division. He was in charge of project management for KBS B. The knowledge domain expert was a hygienist which is a chemical engineer in the division.

5.3.3 KBS C

KBS C was built for use in a division which is responsible for manufacture, marketing, sales, and service for a wide range of electronic data storage products such as diskettes, tape cartridges, and optical disks.

KBS C was developed internally by Organisation X and is a KBS training tool designed to make sales employees and distributors learn about the technical background and functional capabilities of the product they are selling. It contains knowledge of Organisation X's data storage media such as: diskettes; tape cartridges; as well as the basics of magnetic storage.

In the future the system is planned to be expanded to include optical disks, and other data storage products.

The system is comprised of a set of tutorials containing knowledge of the technical features and functional capabilities of data storage devices. KBS C features a Graphical User Interface (GUI) and an audio component which both provide feedback to the user. Each tutorial is interactive. The user learns about features and functionality of each data storage device by clicking on the images of the device components. When an image of a data storage device component is selected with the mouse button, information about that component of the device is displayed on the screen.

The user cannot proceed through the tutorial without finding a "hidden button". This hidden button is placed on one of the device's components. When it is discovered, the user is then allowed to move on to the next tutorial. This makes the user learn by clicking on all of the components of the data storage device until the next screen button is found.

At the time of study KBS C had already been implemented. Prior to the implementation of KBS C the expert, an electrical engineer, spent a significant portion of his time conducting face to face tutorials with the Division's sales and marketing customer representative, as well as Organisation X's distributors. These distributors were employees from organisations external to Organisation X. In addition, he had to prepare new tutorials when new products were introduced. These tutorials had the same aim as KBS C. They taught individuals the features and capabilities of data storage devices. Each time new employees were hired, or changes to existing products occurred, or new products were introduced, the expert would conduct a tutorial. In addition to this, the users and expert had to schedule a meeting place and time which was mutually convenient.

Since the introduction of KBS C, the expert spends no time conducting tutorials. The only time he spends on the task of training is when updates are performed on the system. For the users, KBS C allows them to schedule their own training program.

At the time of study KBS C had been fully implemented. It had been trialed internally by the Division's sales and marketing user. It had been implemented in Organisation X's distributors.

It is clear from this interview that KBS C does solve the problem of training employees, which required the use of human expertise. It also uses knowledge of training techniques, information, and problem solving processes to train employees. It, therefore, meets the criteria of KBS authenticity described in Procedure 2 of Appendix A..

The role of KBS C in the context of the organisation is also demonstrated from these results. KBS C enhanced the organisational function of training the Division's sales and marketing customer representative. Training was performed with the expert and the employees in presheduled face to face tutorials. Once implemented KBS C allowed the Division's sales and marketing customer representative and Organisation X's distributors to perform their own training. There is no role for the expert in performing training sessions. However, he must update the tutorials in KBS C whenever information changes.

The study KBS C involved one expert, one manager and one user from the division in which it was built. The knowledge domain expert was an electrical engineer in the division. The manager was a Marketing Manager from the division responsible for the sales and marketing operations. The key informant did not need to choose among employees in order to choose the manager, user and expert, because there was one only of each.

KBS C had been implemented for eight months with one user using the system. In addition, maintenance of the knowledge had been performed on the system. This puts KBS C in Phase 6: Full Implementation and Update.

5.4 Presentation of Results for Belief, Attitude, Intention, and Behaviour

Most of the results from Procedure's 3, 4, 5 which includes the interviews and questionnaires administered to the employees are shown in Appendix B, Tables B.1 through Table B.3. The only exception to this is the employee data on age, sex, organisational position, and whether performance of behaviour was mandatory or voluntary. These results will be presented in Chapter 6, section 6.2.2 where the implications of them will be discussed.

Tables B.1 through B.1 in Appendix B show the results for each employee's beliefs and associated evaluations, attitude, intention, and behaviour. They then give a description of each belief. These tables are placed in Appendix B to enhance readability since they are quite large and printed using A3 paper.

The results for beliefs are shown in the first two columns of each table. Recall that a belief can be rated as 'slightly', 'quite', and 'extremely' and can be 'good' or 'bad'. For data analysis Ajzen and Fishbein (1980, p. 66) advocate changing these words to numbers. The possible values for each outcome belief are thus +1, +2, or +3, if the consequence of

performing the behaviour is 'good'. If the consequence of performing the behaviour is 'bad' it is rated either -1, -2, or -3. Similarly, each belief evaluation is originally rated as 'slightly', 'quite', and 'extremely' and can be 'likely' or 'unlikely'. During data analysis it then is rated as +1, +2, or +3, if it is 'likely'. If it is unlikely it is rated either -1, -2, or -3. Each belief and associated evaluation is then multiplied to form a product. The possible values for a positive belief product are: 1, 2, 3, 4, 6, and 9. For a negative belief product, the possible values are: -1, -2, -3, -4, -6, and -9. Each belief is assigned a code, such as 'B1', to uniquely identify the beliefs pertaining to an employee. Directly after this code, each belief is briefly described. Following this description, the numerical results for each belief and its associated evaluation are presented. An example of this is Table B.1 which presents the results for the KBS A manager. His first belief is coded "B1" and is described as "increased productivity of Organisation X's staff". The value for the belief is "+2" and the associated evaluation is "+2". The product of these two belief components is "4".

The results for the attitude indicators are shown in the third and fourth columns of the tables. Recall the end points on the attitude indicators included 'interesting' - 'uninteresting, 'good' - 'bad', 'wise' - 'foolish', 'rewarding' - 'unrewarding', 'pleasant' - 'unpleasant', 'fun' - 'frustrating', and 'beneficial' - 'harmful'. Each attitude indicator can be rated as 'slightly', 'quite', and 'extremely'. Like the beliefs these words are converted to numbers during data analysis. The possible range given to positive indicators is 1, 2, and 3, while that for negatively rated indicators is -1, -2, and -3. Each attitude indicator just described is labelled in column three of Tables B.1 through B.3 as follows: 'interest', 'good', 'wise', 'rewarding', 'pleasant', 'fun', and 'beneficial'. The corresponding results for each attitude indicator is listed in column four.

The intention to perform the behaviour is given in column five and six of Tables B.1 through B.3. Recall that a positive intention can be measured as 'slightly', 'quite', and 'extremely' and can be 'unlikely' or 'likely'. In data analysis these words are converted into numbers with the following range: -3, -2, -1, 1, 2, and 3. The code to indicate intention is 'int' in column five of the tables. The result for intention is given in column six.

The results for behaviour are given in columns seven and eight of the tables. In column seven each single action is coded alpha-numerically and briefly described. For example, BH1 indicates the first action taken by an individual. Recall that each single action is rated on a seven point scale ranging from 1 to 7 during data collection. The result for performance of each action is presented in column eight of the tables and may range from 1 to 7.

The purpose of this interview was to test the reliability of the answers given by the respondents with respect to the actions which indicate behaviour performance. In order to achieve this, each set of actions was shown to the key informant and he used his own judgement to determine whether the actions were an accurate representation of those indicative of performing the behaviour. He was then asked for his opinion on the accuracy of the self reports of behaviour for each employee. Any instances where he thought that a behaviour had not been performed was to be noted. He was then asked to check the beliefs in order to determine whether they were relevant to determining the value of the KBS. Specifically he was asked if the beliefs elicited were a complete reflection of the value of the KBS from the perspective of the employee's job in Organisation X. Any differences were to be jotted down. Lastly, the key informant was asked whether or not the valuations made by the employees could be used to draw comparisons across KBSs and employees.

The purpose of Procedure 6 was to test the reliability of the answers given by the respondents and the usefulness of the results for measuring value. After reviewing the results the key informant indicated that he thought the actions indicative of behavioural performance were a good reflection of those required for each employee. He indicated that the self reports of behavioural performance by each employee was accurate. After examining the beliefs the key informant stated that in his opinion, they were a good reflection of the costs and benefits of each KBS to employee jobs at the organisation. When asked whether the results were useful, he stated that they were exactly what he needed to help gain funds from top management for the further development of KBS A, B and C. He further indicated that they would be useful in making comparisons of relative value across the KBSs. Even though they were perceptions of the value of different KBSs made by different employees, he thought that they provided important information regarding how much value one system had over another system, especially since there was no other way to gain this information.

5.5 Conclusion

This chapter presented the results obtained from applying the KBS value model to the KBSs within Organisation X. The procedures in Appendix A: Case Study Protocol were used to collect the results. This chapter has also presented some findings. First, it was verified that valuation of KBSs at Organisation X is a major managerial issue. Second, it was established that the pre-conditions required for testing the value model existed in Organisation X. Third, the three KBSs comprising the study have been verified as authentic KBSs and the necessary information regarding each KBS in the context of Organisation X was described. Fourth, the results for: beliefs, and their associated

evaluations; attitude; intention; and behaviour were presented. These results will now be analysed and discussed in Chapter 6: Analysis and Interpretation of Results.

Chapter 6

Analysis and Interpretation of Results

6.1 Introduction

The purpose of this chapter is to analyse and interpret the results presented in Chapter 5. This first involves examining whether or not the propositions described in Chapter 4 hold in the data collected from Organisation X. Pattern matching techniques are used to analyse the results across the employees for: the belief component; attitude; intention; and behaviour. Value graphs for the beliefs and their associated evaluations are then constructed for each employee. Whether or not there is support for the study's propositions is then explained. Following from this the results are discussed to clarify their implications and possible interpretations. Finally, some qualifications are made on the interpretation of the results.

6.2 Analysis of Results Using Pattern Matching

Yin (1994, p. 106) states that pattern matching is an effective means of testing the internal validity in a case study. Pattern matching essentially compares the pattern of data found to exist in the data of a case study after measurements are taken, to that predicted to exist before measurements were taken. One such pattern matching technique, labelled 'non-equivalent dependent variables', applies to case studies where there are multiple possible dependent variables (*ibid.*, p. 106). In such a study, the investigator would predict a specific pattern across the independent and dependent variables before data collection began. If the predicted pattern was found and alternative patterns were not found then there is evidence to infer causal relationships between the independent and dependent variables.

6.2.1 Pattern Matching Across, Belief, Attitude, Intention, and Behaviour

In this perceived KBS value model, an employee's beliefs about performing a KBS behaviour should predict and explain his/her attitude towards performing that behaviour. Subsequently, the employee's attitude should predict and explain his/her intention to perform the behaviour. Finally, his/her intention should predict his/her performance of the

behaviour. This represents a non-equivalent dependent variables pattern as defined by Yin (1994, p. 106). First, it is clear that attitude is dependent upon belief, and intention is dependent upon attitude, while behaviour is dependent upon intention. Second, each dependent variable is non-equivalent since behaviour, attitude, intention, and attitude are different constructs.

The specific pattern predicted is as follows. If the beliefs are positive, attitude should be positive. If attitude is positive, intention should be positive. Finally, if intention is positive, behaviour should be positive. If this pattern exists and if threats to internal validity are unlikely to be present, then each preceding variable in the pattern can be used to predict and explain the variable directly subsequent to it. The threats to internal validity were specified in Chapter 4, section 4.4.2. Explanations of the tests used to during data collection to detect these threats to internal validity were given in that section. Tests applied during data analysis will be presented in this chapter.

In order to better visualise whether a pattern exists across the variables of belief, attitude, intention, and behaviour, the data presented in Tables B.1 through B.3 are presented separately in Appendix C as Figures C.1 through C.9. They are placed in Appendix C to improve the readability of the chapter. Each of these figures presents the results as a set of bar charts for each employee. The results for an employee's beliefs are presented first. They are rated on the Y axis and can range from -9 through 0, to 9. Each belief is uniquely identified by using its belief code on the X axis. An example is 'B1'. The codes used correspond to those presented in Tables B.1 through B.3. Attitude results are presented next. Each attitude indicator is identified as A1, A2, A3, A4, A5, A6, and A7 on the X axis. These correspond to the attitude indicators of 'interesting', 'good', 'wise', 'rewarding', 'pleasant', 'fun', and 'beneficial', described in column three of Tables B.1 through B.3. Attitude ranges from -3 through 0, to +3 and is rated on the Y axis. Intention is then presented and can range from -3, through 0, to +3 on the Y axis. After intention, the results for behaviour are presented. The degree to which behaviour is performed is rated on the Y axis and ranges from 1 to 7. Each single action indicating performance of the behaviour is uniquely coded on the X axis. An example for an action code is 'BH1'. These labels correspond to those used in Tables B.1 though B.3.

An examination of Figures C.1 through C.9, indicate that the predicted pattern exists across the variables for every manager, user, and expert. For each employee his/her belief set indicates an overall positive result and is associated with a positive attitude. In turn the positive result for attitude is associated with a positive intention. Finally, the positive intention is associated with a positive behaviour. This indicates that an employee's beliefs about the consequences of performing his/her KBS behaviour predicts and explains his/her

attitude to perform the behaviour. His/her attitude, in turn predicts and explains his/her intention to perform the behaviour. His/her intention, in turn predicts and explains his/her performance of the behaviour.

This general finding represents an important discovery which relates directly to Proposition 1, stated in Chapter 4, section 4.2.1. Proposition 1 states that employee beliefs represent a measure of perceived KBS value when there is a pattern of prediction from these beliefs, to attitude, to intention, and to behaviour.

There appears to be general support for Proposition 1. It is clear that a positive pattern of prediction is present across beliefs, attitude, intention, and behaviour for all employees studied. As was argued in Chapter 3, section 3.2.3 the beliefs represent an employee's conscious reasons for why he/she performed the behaviour. They are measured in degrees of advantage and disadvantage with respect to the employee's job in the organisation. The way the beliefs are measured matches the definition of perceived KBS value presented in Chapter 3, section 3.4.3. Hence, beliefs measure the perceived costs and benefits of performing a particular KBS behaviour to an employee in the context of his/her job in the organisation. Therefore, the fact that Proposition 1 holds true represents a major step forward in the measurement of KBS value. As discussed in Chapter 2, section 2.10.1 traditional and alternative valuation models are inadequate for measuring KBS value. However, these results show that it is possible to measure perceived KBS value to managers, users, and experts in the context of their jobs in Organisation X.

The main implication of this finding is that many of the inadequacies of the traditional and alternative valuation models can be overcome by the perceived KBS value model presented in this thesis. Section 6.4 below explains how and why the KBS valuation model overcomes these inadequacies. This is done by analysing the data with respect to whether Propositions 2 through Proposition 7 hold true.

Another implication of the results relating to Proposition 1 involves the novel use of TRA to measure perceived KBS value. TRA represents a well founded general psychological theory for the prediction and explanation of behavioural performance and has been applied to many domains as was explained in Chapter 2, section 2.11. The pattern of results in Figures C.1 through C.9 demonstrate that a novel adaptation to TRA has been discovered. TRA has never been adapted for the derivation of a model to measure perceived KBS value as defined in this thesis. The fact that Proposition 1 holds true supports the adaptation of TRA for measuring perceived KBS value.

6.2.2 Analysis of Threats to Internal Validity

The support found for Proposition 1 is bolstered by the likely absence of the threats to internal validity including: history; maturation; testing; mortality; selection; ambiguity; and compensatory rivalry. These threats were identified as being relevant to the KBS valuation model in Chapter 4, section 4.5.2. In order to assess the likelihood that these threats exist in this study a brief review of the propositions of TRA as adapted by the perceived KBS value model will be presented.

TRA states that any changes in a behaviour which is under volitional control is directly and only determined by intention. Since each relevant KBS behaviour was performed by each associated employee it is clearly under volitional control. The results from Procedure 1, which interviewed the key informant, support the assertion that behaviour is indeed under volitional control. Recall from Chapter 2, section 2.12.3 that past behaviour can influence performance of behaviour and intention to perform behaviour if that behaviour is addictive. Clearly, the behaviours of the expert, manager, and user employees are non-addictive. Also as reported in Chapter 2, section 2.12.3 Taylor and Todd (1995b) reported that in one information system they studied, past use influenced future use (behaviour) of users. As was argued in Chapter 4 section 4.5.2, the KBS value model assesses value via a measure of positive and negative beliefs and their associated evaluations. The positive and negative beliefs represent the costs and benefits of a KBS to an employee. A measure of past behaviour will not improve this measure of value because it does not capture any additional costs and benefits. Therefore, while the effect of past KBS behaviour may or may not affect the performance of future KBS behaviour is of little consequence to the ability of the model to assess perceived KBS value.

Recall in Chapter 3, section 3.2.1, that the KBS value model adapts TRA by omitting the normative component. Several reasons were given to justify its omission. It is expected that the subjective norm's influence upon intention is likely to be small. In Chapter 2, section 2.12.6, research in information systems across several studies found that in situations where use of an information system was voluntary, attitude was responsible for all or almost all of the influence upon intention. Subjective norm had little or no influence on intention. In situations where use of an information system was mandatory, attitude had little or no influence upon intention and the subjective norm was responsible most or almost all of the influence upon intention. Performance of the various KBS behaviours was perceived to be voluntary for all employees in the study as is shown in Table 6.1 below. Hence, it is expected that the influence of the subjective norm upon intention is likely to be very low. It is expected that attitude will provide the most significant prediction and explanation of intention. Having said this, looking at the results in Figures C.1 through

C.9 it seems reasonable to conclude that attitude does predict intention for all employees. In all cases a positive attitude is associated with a positive intention.

Table 6.1 Characteristics of Employees By Employee Type

Employees	Age	Sex	Organisational Position	Behaviour Mandatory/ Voluntary
Managers				
KBS A Manager	41 - 50	Male	Sales & Marketing Manager	Voluntary
KBS B Manager	51 - 60	Male	Sales & Marketing Manager	Voluntary
KBS C Manager	31 - 40	Male	Marketing Manager	Voluntary
Users				
KBS B User 1	21 - 30	Female	Customer Support Telephonist	Voluntary
KBS B User 2	31 - 40	Female	Senior Sales Representative	Voluntary
KBS C User	21 - 30	Female	Customer Support Telephonist	Voluntary
Experts				
KBS A Expert	41 - 50	Male	Technical Services Engineer	Voluntary
KBS B Expert	31 - 40	Female	Technical Affairs Manager	Voluntary
KBS C Expert	21 - 30	Male	Technical Services Engineer	Voluntary

Theoretically, the immediate and only determinant of attitude is behavioural belief, in TRA. The literature review in Chapter 2 section 2.12.2 indicates that it is possible that a crossover effect may exist from the normative belief construct to the attitude construct. Another crossover effect may exist from the behavioural belief construct to the subjective norm. There is no evidence that these effects occur in computer related studies using TRA. Even if these effects did exist in the KBS value model, there is no expectation that they would compromise internal validity. The crossover effect from the normative belief construct to attitude works by adding to the influence of the behavioural belief construct upon attitude. This means that if the behavioural belief construct was positive, the crossover effect if present, would add to the positive influence of behavioural beliefs upon attitude. This is not an issue for internal validity. Since the KBS behaviour of the employees was universally perceived to be voluntary, the influence of the normative component upon attitude is likely to be very low. Hence, even if present, any such crossover effect is likely to have a minimal influence upon attitude. Moreover, the influence upon attitude of this crossover affect, by its nature, would be in the same direction as the influence of the behavioural belief component. The only result being to reinforce the already positive prediction of the belief construct upon attitude.

Consider the likelihood that history, maturation, and testing may have influenced the results. These threats refer to changes in the environment, and employees that may have occurred during the course of the study. Such changes are due to external variables and these are not expected to influence attitude, intention or behaviour directly. Consistently, research has shown that such external variables have no significant direct relationship between any of these variables (Ajzen and Fishbein 1980, p. 82). Accordingly, in the KBS value model any such changes will only be directly reflected in the belief construct of the model.

The results for beliefs in the first column of Tables B.1, through to Table B.3, demonstrate that there are no instances where an employee's outcome belief is at odds with his/her associated belief evaluation. That is, there are no cases of a positive or negative outcome belief being associated with a negative or neutral belief evaluation. Such occurrences would indicate that an employee's belief set had changed from the time of belief elicitation and the time when belief, attitude, intention, and behaviour were rated. Any such change in employee behavioural belief would be expected to alter if changes resulted due to the effects of history, maturation, or testing. The fact that the behavioural beliefs did not alter strongly suggests that no changes in the environment, nor within the employees themselves affected the results. On the contrary, changes due to history, maturation, and testing may have occurred with the effect of introducing additional beliefs into an individual's belief set. This effect cannot be detected using the above strategy. Despite this, the time between elicitation of beliefs and rating of them was no more than three days across all employees. It is unlikely that beliefs could have changed significantly in that time. The fact that all of the originally elicited beliefs were still held over this span of time supports this. Therefore, threats due to history, maturation, and testing are likely to be very low. In addition to this, there were no major changes in Organisation X pertaining to its policy, programs, staff, or structure during the period of study.

In this case study the selection threat to internal validity refers to the possibility that differences in the employees and KBSs already existed before the study began. In particular, these differences may have affected prediction and explanation from beliefs to attitude, intention, and behaviour. If any such differences did exist, and did influence the results, it is expected that they would influence the belief component directly. Any influences of these differences upon attitude, intention, and behaviour would be indirect, through their influence upon belief. If the selection threat exists, it would be manifested in differences between the beliefs of individuals of the same type or individuals belonging to a particular KBS. TRA identifies several possible differences that may exist in individuals (Ajzen and Fishbein 1980, p. 84). These differences are termed external variables and include demographic variables, attitudes toward the target of the investigation, and

personality traits. Specific variables of a demographic nature include: sex, age, occupation, socio-economic status, religion, and education. Attitudes toward the target of the investigation refers to the person or object under consideration. Such variables may include attitude toward a person, or a machine, or an institution. In this study the objects under consideration are the three KBSs. Specific variables relating to personality traits include introversion, extroversion, neuroticism, authoritarianism, and dominance. Another external variable which is specific to this study and may differ across employees includes position in the organisation. External variables which may differ across KBSs include: lifecycle phase a KBS was traversing; type of KBS; function of the KBS; and limitations of the KBS. It is possible that these variables may have differed across the employees and KBSs of this study.

Not all of the external variables identified by TRA have been measured by the KBS value model. Procedures 1, 2 and 3, in Appendix A, were used to measure some of these variables. Those variables that were measured are listed in Tables 6.1 above and 6.2 below. Table 6.1 lists the differences and similarities across managers, users, and experts concerning, age, sex, organisational position and whether performing behaviour was voluntary or mandatory. Table 6.2 lists differences and similarities across KBSs with respect to: lifecycle phase a KBS was traversing; KBS type; function of the KBS; and limitations of the KBS. These tables indicate that there are differences across employees and KBSs. For instance in Table 6.1, age, sex and organisational position varies across employees. Even when looking at a particular group, there is a significant difference in these variables. The data in Table 6.2 indicates that there is significant difference in KBS type, the function performed by each KBS, the limitations of each KBS, and the phase that each KBS was traversing. If any of these variables had an influence upon belief, this would be reflected as different beliefs across the employees. In fact there are differences between employees in terms of the number of beliefs, types of beliefs, and strength to which beliefs are held. These differences are attributable to the influence of the external variables. However, the pattern across belief, attitude, intention, and behaviour holds for every employee despite any of the noted differences in the external variables. Therefore, it can be concluded that the external variables have not affected the main result. That is, there is still prediction and explanation across belief, attitude, intention, and behaviour, despite any possible influence of the external variables upon an employee's beliefs. In addition, as is shown in Table 6.1 above, in all employees performance of the behaviours was considered to be voluntary and not mandatory. This indicates that it is highly likely that the belief component, and attitude are the determinates of intention, leaving the normative component with little or no affect upon intention.

Table 6.2 KBS Characteristics

KBS Characteristics	KBS A	KBS B	KBS C
Type of KBS	Customer Service Support	Customer Service Support	Employee Training
Function performed	Gives product configuration advice and prices to customers	Gives product selection advice and prices to customers	Trains customer support representatives in product features
Limitations	Can only be used for simple customer requests	Can only be used for simple customer requests	No limitations
Phase Traversing	KBS Development	Restricted implementation and update	Full implementation and update

The scales used to compare beliefs to attitude and intention to behaviour are not identical. Belief is rated on a scale ranging from -9 through 0, to 9, while the scale for attitude ranges from -3 though 0, to 3. Intention is rated on a scale ranging from -3 through 0, to 3, while the scale for behaviour ranges from 0 to 7. The variances in the scales is not a serious concern. It is clear that a positive pattern does exist across the results despite the scale variances.

A small amount of measurement error is expected to affect the results. For instance, the KBS A expert in Appendix C, Figure C.2, exhibits an overall moderately positive belief set, with most beliefs rated at 4. His attitude would be expected to be slightly positive and thus rated at about 1 for the attitude indicators. While attitude is positive, four of the indicators are rated as 0, with the remaining three rated either 1 or 2. Such a slightly positive attitude would be expected to predict a slightly positive intention. However, intention is rated as quite likely, or 2. Finally, this intention would be expected to predict a moderately positive performance of the behaviour. Performance of behaviour is rated at 7 for all behaviour indicators. The variation in these results is interpreted as slight and it is to be expected. Such slight variation in the results occurs across all of the employee's studied. The rest of the employees display relatively minor variations as can be observed in Figures in Appendix C.

The specific actions pertaining to the KBS behaviour of a particular individual are displayed in Column 8 of Tables B.1 through B.3 in Appendix B. It is clear that there are differences in the number of actions for each employee of a particular type. For example, the actions pertaining to managerial support vary across the managers of the three KBSs. As was reported in Chapter 5, section 5.4 these actions were assessed by the key informant using Procedure 6 in Appendix A. In all cases he approved the actions as being representative of the behaviours of each employee. Looking at the actions it is clear that there is a high degree of similarity across the types of action performed. For instance, all managers indicated that experts would have to provide knowledge.

6.3 Analysis of Employee Belief Data

Chapter 4 presented seven propositions with regard to employee beliefs. These were:

Proposition 1 Employee beliefs represent a measure of perceived KBS value when there is a pattern of prediction from these beliefs, to attitude, to intention, and to behaviour.

Proposition 2 Employee beliefs provide a disaggregated measure of perceived costs and benefits of a KBS.

Proposition 3 The employee beliefs are a disaggregated representation of both perceived intangible and tangible costs and benefits rather than an aggregated representation.

Proposition 4

- A finances category is more advantageous than a cost category because there may be financial benefits as well as costs associated with a KBS.
- Expert, user, and manager beliefs will fit into the value categories of time, finances, and quality.
- These categories are mutually exclusive with respect to belief classification with the effect that the chances of dual classification of any belief is unlikely.

Proposition 5 The KBS value model can measure perceived intangible and tangible value during early lifecycle phases by measuring expert, user, and manager beliefs during these phases.

Proposition 6 Together the beliefs of the user, expert, and manager of a KBS will measure the perceived value of a KBS to the organisation as well as the individual jobs of each employee.

Proposition 7 Managers can determine the comparative perceived value across multiple KBSs by examining the employee beliefs which are presented in the KBS value graphs.

Analysis of the data has already been performed with respect to Proposition 1 and evidence was presented to show that this proposition holds true. The data from the case study will now be used to analyse whether or not the remaining six propositions hold.

KBS value graphs were constructed for each employee. They are presented in Appendix D as Tables D.1 through D.9 to enhance the readability of this chapter. In Appendix D KBS A value graphs are presented first, followed by the value graphs of KBS B and KBS C. A separate table is used to present the results for each manager, user, and expert.

6.3.1 Analysis of Results for Proposition 2

The results show support for Proposition 2, that the employee beliefs provide a measure of disaggregated perceived costs and benefits. Clearly, the valuations presented in Tables D.1 through D.9 of Appendix D are disaggregated. Perceived KBS value is not measured as a single number. It is instead represented by a set of disaggregated perceived costs and benefits which are measured by degree and likelihood.

6.3.2 Analysis of Results for Proposition 3

The data show support for Proposition 3 that employee beliefs measure both perceived tangible and intangible costs and benefits pertaining to a KBS. An examination of the value graphs in Appendix D reveals that many employees perceived financial costs and benefits from the KBSs. Many employees perceived costs and benefits pertaining to time. All employees perceived costs and benefits pertaining to quality. The descriptions of the costs and benefits provide the basis for determining if each is a tangible or an intangible.

6.3.3 Analysis of Results for Proposition 4

There is support for part one of Proposition 4 which states that a finances category is more advantageous than a cost category. The results in Appendix D show that the managers of KBS A, B, and C as well as the sales representative user of KBS B all perceive financial benefits from the respective KBSs. Part two of Proposition 4 is also supported. All of the employee beliefs can be classified into the categories of time, finances, and quality as is shown in the Appendix D value graphs. There are no beliefs which cannot be classified into one of these categories. Finally, there is support for the part three of Proposition 4 which states that time, finances, and quality provide a mutually exclusive set of categories for classifying employee costs and benefits. An examination of the beliefs in the value graphs of Appendix D demonstrates that the categories are mutually exclusive. That is, all beliefs that can be classified into one and only one of the

value categories. This result is significant because the general KBS costs and benefits derived from the literature are also able to be classified into these categories.

6.3.4 Analysis of Results for Proposition 5

There is partial support for Proposition 5 that employee beliefs can be used to measure perceived tangible and intangible value during early lifecycle phases by measuring expert, user, and manager beliefs during these phases. The value graphs in Appendix D for KBS A demonstrate that the KBS value model did provide valuations from the manager, and expert during the development of a prototype. However, since users had not yet used the system, full testing of the proposition was not possible.

6.3.5 Analysis of Results for Proposition 6

Testing Proposition 6 that employee beliefs measure perceived costs and benefits to employee jobs and the organisation requires a comparison of the employee beliefs and the expected costs and benefits of KBSs to organisations identified from the literature. Table 3.1 of Chapter 3 lists the costs and benefits of KBSs to the organisation derived from the literature. Table 6.3 lists the costs and benefits derived from the literature and compares them to representative costs and benefits elicited from the employees. The comparison is stratified by the value categories of time, finances, and quality. Table 6.3 shows that the generic costs and benefits of KBSs as is evidenced in the literature review in Chapter 2, section 2.4.1. Chapter 2, section 2.10 demonstrated that the traditional and alternative valuation models used to measure the contribution of these costs and benefits to KBS value are inadequate. So on the one hand those costs and benefits which pertain to KBSs have already been discovered. However, on the other hand, present models for valuation are unable to assess the contribution that they make to the value of a KBS. A major objective of this study is to propose a model for assessing perceived KBS value which is capable of assessing the perceived costs and benefits to an organisation which are generally associated with KBSs. The comparisons made in Table 6.3 indicate that the perceived costs and benefits of a KBS to the jobs of the expert, manager, and user employees closely mirror those identified in the literature as costs and benefits of KBSs to organisations. The beliefs of the expert, manager, and user employees identify the perceived costs and benefits of a KBS to their jobs. These are almost exactly the same costs and benefits reported in the literature as being costs and benefits to an organisation. Therefore, Proposition 6 is supported.

Table 6.3 Literature Costs and Benefits Vs Case Study Costs and Benefits

Literature Time Costs/Benefits	Examples of Case Study Time Costs/Benefits	Literature Finances Costs/Benefits	Examples of Case Study Finances Costs/Benefits	Literature Quality Costs/Benefits	Examples of Case Study Quality Costs/Benefits
Reduced down time		use of less expensive equipment		increased output	
reduced response time	KBS B quick response to a need	high cost of development	KBS B high cost of HW/SW	improved decision quality	KBS B provides correct advice
lengthy development time	length of time to develop KBS B	cost of personnel		capturing scarce expertise	better utilisation of KBS B expert
lengthy time to extract knowledge from experts	KBS C providing knowledge requires a lot of expert's time	cost of software and hardware	KBS B high cost of HW/SW	increased flexibility in decisions made	KBS B provides a range of alternative products
relieving experts of tedious tasks	KBS B simple questions answered	cost of user training		operation in a hazardous environment	
speedier solutions	KBS B will settle calls quickly	cost of operating KBS		working with incomplete and uncertain information	
increased productivity	KBS A increased productivity of Organisation X staff	cost of updating		difficulty in extracting knowledge from experts	
reduced order cycle time		decreased personnel required		difficulty in selling KBSs to management	
		labour savings	KBS A will increase sales	KBS functions in a narrow domain	KBS B won't answer complex questions
		salary savings		dissemination and preservation of scarce expertise	KBS C increases the reach of Organisation X training
				more consistent problem solving	KBS B provides consistent advice
				improved decisions by non-experts	KBS B Sales staff now give advice
				improved training	KBS C taught you to identify products
				reduced errors	KBS A provides the correct material in kits
				improved customer service	KBS A will improve customer service
				improved accuracy and reliability of decision making	KBS B provides consistent advice
				documented organisational knowledge	KBS B provides documented advice

6.3.6 Analysis of Results for Proposition 7

Proposition 7 states that managers can determine the comparative perceived value across multiple KBSs by examining the employee beliefs which are presented in the KBS value graphs. Clearly, the KBS value graphs can be used to make comparisons of the perceived KBS value across several KBSs. Indeed, from the results of Procedure 6 the key informant reported that they were very useful for making such comparisons. However, caution should be exercised with respect to any comparisons made. According to TRA, an individual's beliefs are determined by his/her past experiences, and exposure to various types of information. Therefore, all or some subset of the external variables outlined in section 6.2.2 might have an influence an employee's set of beliefs. Tables B.1 through B.3 in Appendix B clearly show the degree of variance in beliefs across the data.

In the case of the KBS managers there is variance in terms of the number of beliefs, and the strength of the belief evaluations. For instance, the KBS manager has 3 beliefs, while the KBS B manager has 11, and the KBS C manager has 7. All managers have beliefs in each of the categories as is displayed in the KBS value graphs in Appendix D. KBS B manager has the largest number of beliefs and his quality beliefs are held more strongly than those of the managers in either KBS A or KBS C. There is less variance in the time and finance categories, but KBS A manager has more beliefs in both categories than the other two managers. All managers hold beliefs regarding the financial benefit of the system. All managers hold beliefs about time savings resulting from using the KBSs. Some of the variances between beliefs are clearly due to differences in the type of KBS. Table 6.2 above highlights this point. KBS C trains users in product features, while KBSs A and B both provide product advice directly to customers. Hence, KBS C manager would not be expected to hold the same types of quality beliefs as those held by the other two managers. Other variances like the number and types of beliefs held by the managers of KBSs A and B may not be due to such differences. For instance, only KBS B manager holds a belief related to development cost. It might be expected that all managers would hold such a belief. Moreover, KBSs A and B are both customer service systems which provide customers with details of products. Ideally, since KBSs A and B were of the same type the managers might be expected to elicit the same beliefs. However, there were significant differences between KBS A and B. KBS A was traversing the KBS development phase, while KBS B was in restricted implementation and use. It might be that if the KBS A manager had the benefit of seeing KBS B used in production, he may have held comparatively more beliefs regarding the KBS. Alternatively, KBS A manager may not have believed that KBS A possessed any of the other costs and benefits that KBS B possessed.

These differences in beliefs between the managers of KBS A and KBS B may indicate the presence of maturation effects. A maturation effect may exist because KBS B manager has had comparatively more time and experience with KBS B, hence enabling him to conceive and develop his beliefs as well as refine existing beliefs.

As can be seen in the KBS value graphs of Appendix D, in the case of the users, there is less variance in terms of the number of beliefs held. The KBS B telephonist holds 7 beliefs, while KBS B sales representative holds 5 beliefs, and KBS C user holds 7 beliefs. Looking at the KBS B users, the telephonist holds her beliefs more strongly than the sales representative. The telephonist does not perceive any financial benefits, while the sales representative does perceive an increase in sales resulting from the system. There is also variance in the quality beliefs across the two KBS B users. Only the telephonist holds beliefs related to the management of customer and market information, and the transfer of decision making from the experts to the sales and marketing department. The time beliefs differ between the two users. The telephonist perceives a benefit in the time taken to settle calls, while the sales representative perceives a cost in the time taken to enter the data. These differences could be due to the fact that the jobs of the users are different. The sales representative visits clients face to face, while the telephonist takes customer calls.

Comparing the KBS C user to the others reveals several differences. KBS C user has no financial beliefs. This is to be expected since KBS C is not used directly with the customer to make product sales. The KBS C user does have several quality beliefs, but they are different from the beliefs of the other two users. Again this is to be expected since the benefits of KBS C are mainly in employee training, while KBS Bs benefits relate to providing the customer with product advice.

An examination of the KBS value graphs in Appendix D for the experts reveals many differences and similarities in their beliefs. All experts have time benefits relating to more time for other job functions. The KBS B and C experts have time costs relating to time spent on providing knowledge for development and testing. The KBS A expert does not have this cost. This probably results from the fact that KBS A is still a prototype system in which further development is required and significant updates have not been performed. None of the experts have financial costs or benefits. This is to be expected since, the jobs of the experts have little to do with the sales and marketing operations of the organisation. There are differences and similarities across the experts with regard to quality. KBS A and B experts have many similarities. Both believe that the users will be able to provide customers with advice by using the system. Both believe that system updates will enable the system to continue functioning. This is in contrast to the quality beliefs held by the KBS C expert. He holds many beliefs which the other two do not. Many of these are

related to the fact that KBS C performs a training function, while the other systems provide customer advice. Hence, many of KBS C expert's beliefs concern benefits relating to improvements in user training. However, KBS C does share the same belief regarding maintenance as the other experts which is that system updates will enable the system to continue functioning.

On the whole there are more similarities between the experts than there are differences. This is in contrast to the results for the users and managers. The implications and usefulness of these results for comparing the perceived value across KBSs will now be discussed in section 6.4 below.

6.4 Interpretation of Results

The results indicate support for all of the study's propositions, with partial support for Proposition 5 concerning valuation in early lifecycle phases. Since users had not yet used the system, full testing of the proposition was not possible. Despite this, measurements of perceived costs and benefits of KBS A were able to be taken from the manager and expert. It is important to note that traditional and alternative models are unable to provide information on the costs and benefits of a KBS in the early lifecycle phases. Therefore, even though the KBS valuation model was unable to measure value from all perspectives in the case of KBS A, it still provides more information on value in early lifecycle phases than that provided by traditional and alternative models. Moreover, it is clear from the findings of KBS B, and C, that the model provides a measure of perceived intangible and tangible value in later lifecycle phases. Again, the traditional and alternative models are unable to provide measures of intangible value in any lifecycle phase.

In regard to the main proposition, Proposition 1, the evidence shows that a pattern of positive prediction and explanation can be inferred across belief, attitude, intention and behaviour for each employee. This finding resembles those of other related studies (Hartwick and Barki, 1994) (Mathieson 1993) (Davis *et al.* 1989).

From theoretical standpoint of TRA, a person's cognitive, or conscious, reasons for why he/she performs a behaviour is represented by the belief construct. In other words, the beliefs provide the reasons for why a behaviour is ultimately performed or not performed. If an employee involved with a KBS development project performs his/her KBS behaviour, there must be a perceived value to that employee in the context of his/her job which is derived from performance of the behaviour. A rational employee would not perform a behaviour unless the behaviour had a positive value in the context of his/her

job. However, the performance of the behaviour itself does not provide a rich measure of perceived value. It does indicate that performance of a KBS behaviour has value, but does not identify the reasons for why the KBS is perceived to have value. The belief component identifies each reason for performing or not performing the KBS behaviour. It also measures the relative contribution of each positive and negative belief to the performance of the behaviour. Hence, it measures the perceived costs and benefits of performing the KBS behaviour, in the context of the employee's job in an organisation. The way the belief construct is formulated and measured closely parallels the definition of perceived KBS value presented in Chapter 3, section 3.4.3. Therefore, the beliefs and associated evaluations of employees involved with a KBS provide the foundation for assessing perceived KBS value (Clark and Soliman 1999, p. 69).

As was argued in Chapter 2, sections 2.4, 2.5 and 2.7, when making decisions, managers require information on intangibles and tangibles which is disaggregated, and based upon employee perceptions. There was support in the results that employee beliefs represent perceptions of intangible as well as tangible costs and benefits. The results also show that these perceived costs and benefits were disaggregated and that they measure perceived value both to the organisation and to each employee's job. The belief results as discussed in section 6.3.6, showed that some variation was evident in both the number and essence of beliefs held by employees of the same type across different systems. As was explained in sections 6.2.2 and 6.3.6, the amount of variance may be due to a variety of external variables including differences between KBSs and differences across individual employees.

These variations in beliefs suggests the possibility that the KBS valuation model may not identify all relevant costs and benefits pertaining to a KBS. It is logical to assume that whenever perceptions held by employees about anything in an organisation are measured, external variables may influence the responses given. Despite this managers regularly rely upon employee perception based information as input into making decisions (Mintzberg 1994, p. 258). For the reasons discussed in Chapter 2, sections 2.4, 2.5, and 2.7 use of quantified information alone is inadequate for making decisions because it is: often erroneous and needs to be checked for accuracy against employee perceptions; too aggregated to be useful in decision making; does not include an assessment of intangibles; and usually arrives too late to be useful in decision making (*ibid.*, p. 258). Hence, employee perceptions help fill an information gap commonly experienced by managers.

In the case of KBS valuation it might be argued that employee perceptions of KBS value, like the quantified information generated by traditional and alternative models, may also be inaccurate. However, the same advantages of employee perceptions over quantified

information listed above and discussed in Chapter 2, apply to KBS valuation. First, employee perceptions provide another perspective by which quantitative results generated by traditional valuation models can be compared for accuracy. Second, employee perceptions provide the only means of assessing tangible value during the prototype phase (albeit only through expert and manager perceptions as the results show). Third, perceptions represent the only means of assessing contribution to KBS value from intangibles. Fourth, measurement of employee perceptions also present managers with disaggregated information on a KBSs costs and benefits. Fifth, measurement of KBS value using employee perceptions can be performed very quickly, thus providing managers with valuations whenever they are needed. Traditional and current alternative valuation models possess none of these capabilities in the case of KBS valuation. It may or may not be that using employee perceptions of value are influenced by external variables. However, they do provide a measure of the value of a KBS which matches the decision making needs of management, beyond what is provided by traditional and alternative models. Hence, the key informant's opinion that the results were very useful in making comparisons across the value of the KBSs has credibility beyond his own perception.

The possible influence of the external variables upon beliefs has an implication for the use of the model to compare the value of multiple KBSs. In situations where there are multiple KBSs separate employees are likely to be assessing the value of each system. The value of each KBS naturally may be expected to vary due to the differences in the functions performed by each system. The value of each KBS may also vary because of the possible influence of any external variables upon each employee. While it is desirable to measure variances in value due to differences in the KBSs, it is less desirable to measure variances in value due to differences in employees. Because of this any comparisons of value using different employees across multiple KBSs should be done with caution. It should be noted that the influence of these external variables upon employee beliefs amounts to the same concept labelled as human subjectivity by Smith and Dagli (1992, p. 69) as discussed in Chapter 2, section 2.10.3. Furthermore, all alternative models are similarly afflicted by the influence of such human subjectivity since they use appointed human valuators to assess system value. The KBS value model has a significant strength over existing alternative models in that it uses informed employees as valuators. Alternative models use an independent observer with little or no experience of the KBSs in the context of a particular organisation. The KBS valuation model uses employees who perform jobs directly related to the organisational costs and benefits of the KBS. They are therefore well informed about the costs and benefits of the KBS. They can likely produce a better valuation than an independent observer.

Application of the KBS value model to the three KBSs included in the Organisation X case study show a pattern of positive results across all employees. These results generally support the propositions of the KBS value model and indicate that analytical generalisation, of the KBS value model has been achieved. As discussed in Chapter 4, section 4.3 according to (Yin 1994, p 36) analytical generalisation occurs when a particular set of results from a case study generalise to a theory. In this study the KBS value model represents the theory to which the results have been generalised. Since the results support the theory of the KBS value model, the theory can be used to identify other cases to which the results can be generalised. In other words, organisations that meet the pre-conditions for testing the KBS value model which were explained in Chapter 4, section 4.3.1 would represent cases for which the KBS value model can be applied.

The results indicate that there were no employees with a pattern of negative beliefs, negative attitude, negative intention, and non-performance of behaviour. It is proposed that this result was obtained because each employee simply believed that each KBS had a positive value in the context of his/her job in Organisation X. An unlikely alternative explanation might be that employee performance of KBS behaviour was a mandatory requirement by the key informant or some higher superior and that this requirement caused the employees to perform the behaviour. If this was the case, it would be expected that the employee's normative component would be highly positive. This in turn would have a high positive influence upon intention which would reinforce the positive influence of attitude upon intention. However, all respondents including the key informant stated that performance of KBS behaviour was voluntary. As discussed in Chapter 2, evidence exists to suggest that if performance of behaviour is voluntary, the normative component has little or no influence upon intention. Therefore, it is unlikely that the positive results found across all employees was the result of a requirement to perform the KBS behaviour.

6.5 Other Interpretations of the Results for Managing KBSs

The results show that if the users, experts, and managers have overall positive beliefs about performing their KBS behaviours, their attitudes will be positive. Consequently, they will intend to perform the behaviour. If it is under the volitional control of the employee, the behaviour will be performed. If these behaviours are performed the KBS has a high chance of being successful and the organisation may therefore derive benefits from KBSs. An employee's beliefs are the major driving force behind his/her decision to perform his/her KBS behaviour. Across all employees and all KBSs studied,

performance of an employee's behaviour was associated with a set of positive beliefs. Hence, the results suggest that it may be critical to the success of the KBS to educate employees of the KBSs benefits to their jobs and to the organisation of performing the KBS behaviour. If the beliefs held by the employees were negative, then it would be unlikely that they would perform their respective behaviours resulting in a failed KBS.

The results have yet another important interpretation. They indicate areas where employees require support designed to help them perform their respective KBS behaviours. For instance, in the case of KBS B and KBS C, the experts found the process of providing KBS knowledge very taxing in terms of time and effort expended in providing their knowledge. Hence, support was needed during provision of knowledge, possibly in the form of a well designed knowledge acquisition methodology. The users of KBS B and KBS C indicated that training was time consuming. The users of KBS B found that using the system was frustrating when customers had a complex question which the KBS could not handle. This suggests that KBS users in general may benefit from well designed training sessions whereby they are taught strategies for dealing with these types of system limitations.

6.6 Qualifications

An important qualification of the findings from this study concerns the circumstances to which the results can be generalised. As discussed in Chapter 4, section 4.3 the propositions of the KBS valuation model were tested by applying the model to the KBSs in Organisation X. Finding support for these propositions by testing them represents analytical generalisation of the KBS valuation model. As mentioned earlier according to Yin (1994, p. 36) analytical generalisation occurs when a particular set of results from a case study generalise to a theory.

Analytical generalisation, then, occurs when the results of a case study support the propositions of the theory being tested. In this study the KBS value model represents a theory to which the results from the Organisation X case study have been generalised. In other words, the results from the Organisation X case study support the propositions of KBS value model. Because of this the model should be applicable to other organisations which share the same characteristics as Organisation X. These organisational characteristics were discussed in Chapter 4, section 4.3.1, but were labelled pre-conditions for testing the perceived KBS value model. The model is applicable to organisations in which these pre-conditions are met. The pre-conditions include the following which are expanded upon below:

- the existence of manager, user, and expert employees involved in the development of the KBS;
- stable manager, user, and expert employees;
- voluntary performance of KBS behaviour by employees;
- volitional control of employees in performing KBS behaviour;
- organisations which are developing two or more KBSs; and
- organisations characterised by a centralised decision making body.

6.6.1 The Existence of Manager, User, and Expert Employees Involved in the Development of the KBS

According to the KBS value model, managers, users, and experts represent the necessary perspectives for assessing the value of a KBS to an organisation. Some organisations may outsource the development of the system. In this case, the manager and/or the expert may be acting as consultants to the organisation. In such a scenario, these consultants would not be able to place a value upon the KBS in the context of manager and expert jobs, within the organisation. Due to the fact that they were consultants, would preclude them from having enough knowledge of the costs and benefits of the KBS to the manager's job or the expert's job within the organisation.

In the case of KBS A the results showed that the user did not have a role to play in the prototype phase at Organisation X. If this is the situation at other organisations, the KBS value model may have to be augmented to exclude valuation by the user in this phase. The application of the model would still be expected to yield useful KBS valuations over those provided by traditional and alternative models because the value perceptions of the manager and expert are able to be measured in the prototype phase..

6.6.2 Stable Manager, User, and Expert Employees

The KBS value model requires stable managers, users, and experts to ensure a reliable assessment of KBS value. This excludes organisations where previous experts, managers, and users have been replaced as a result of attrition, by new employees or current employees who are unfamiliar with the KBS. Using such employees may jeopardise the valuation of any KBS because they would be unable to give an informed valuation due to their unfamiliarity with the system.

6.6.3 Voluntary Performance of KBS Behaviour by Employees

Employee behaviours with respect to the KBSs at Organisation X were voluntary and not mandatory. For KBSs in which behaviour is mandatory, employees may perform the behaviour because it is a job requirement and not because of a positive pattern across belief, attitude, intention, and behaviour. Hence, the conclusions drawn for KBSs where employee behaviour is voluntary may not be generalisable to situations where KBS behaviour is mandatory. Furthermore, in situations where involvement is mandatory, it would be expected that the normative component would explain and predict most of the influence upon intention. However, even in this scenario, measurement of the behavioural beliefs would be expected to provide information on the perceived costs and benefits of performing the behaviour. Hence, the model may still be useful in these situations.

6.6.4 Volitional Control of Employees in Performing KBS Behaviour

In this study the KBS value model was applied to KBSs in which volitional control was present. Situations where volitional control is absent are characterised by an inability of the employee to perform the relevant KBS behaviour. In these situations since the behaviour is not performed, there is no clear measure of the KBSs perceived value to an employee. In situations where behaviour is voluntary and under the employee's volitional control, if the behaviour is performed the KBS must have a perceived value, otherwise the behaviour would not be performed. If the behaviour is voluntary, but volitional control is absent, behaviour will not be completed even if the employee intends to perform it. Hence, there will be no clear measure of whether or not the KBS has value. Because of this, the results of this study are only strictly generalisable to KBSs where volitional control is present.

In the absence of volitional control the model might still be applicable to voluntary situations, but with qualifications to the conclusions drawn. In these situations, an employee's intention to perform a behaviour might be used to determine if the KBS has a perceived value. The rationale for using intention might be that if an employee intends to perform his/her KBS behaviour, the KBS must have a perceived value. If he/she did not intend to perform the behaviour, it would have a negligible perceived value. In this situation, an assessment of perceived value might be determined by measuring behavioural beliefs. While this may appear logical, there is dilemma in using intention to confirm the value as measured by behavioural beliefs. This dilemma stems from the fact that since the behaviour has never actually been performed, it is impossible to conclude that an employee derived value from a KBS. That is, since the behaviour was not

performed, no value was derived from the KBS and therefore, it has no value to the employee's job and the organisation. Hence, a measure of perceived value at the level of intention to perform the behaviour should be interpreted with caution.

6.6.5 Organisations which are Developing Two or More KBSs

Proposition 7 stated that managers can assess the comparative value of two or more KBSs by comparing KBS value graphs from two or more KBSs. While this was a pre-condition for testing the KBS valuation model, it is not necessary for applying it to other organisations. The model is still applicable to organisations which may have only one KBS. The information generated from application of the model to a sole KBS can still be useful in making investment decisions. When applied to one KBS, the model will still measure contribution from intangibles, as well as tangibles in the early lifecycle phases. The results of the Organisation X case study indicate that as long as the other pre-conditions are met, the KBS value model should be able to measure the perceived value of one KBS in an organisation. However, if two or more KBSs exist in an organisation, then the results of this study show that if all the other pre-conditions listed here are present, the KBS value model should enable a manager to make subjective comparisons across KBSs, albeit with caution.

It is envisaged that the decision making manager will use his/her own judgement when comparing multiple KBS projects in order to determine which KBS will make the best investment. He/she may be guided by an organisational standard for using the KBS value graphs. Such a standard may consider ranking projects by a particular employee group or by a particular value category, or even some combination thereof (Clark and Soliman 1997, p. 38). For example, at a certain organisation it may be the case that the user groups potentially derive most of the value from KBSs. In this case the decision making manager could rank projects in terms of the relative value derived from the user groups. The KBS with the highest value to the users could then be ranked highest and thus chosen for investment. Alternatively, the standard at an organisation could be to choose KBSs which have the highest qualitative value. This standard may be derived from the fact that KBSs possess mainly qualitative benefits. The KBS with the highest qualitative benefit could be chosen. A combination of employee group and value category may also be used as a standard. It may be the case that the organisation is interested in developing a KBS which has the high qualitative value to the experts and users. In this case the decision making manager could rank the projects on the qualitative value to the users and experts. The standard may be that only KBSs will be developed which have been rated as quite or extremely beneficial in the qualitative category for the expert and user groups, with no corresponding qualitative costs.

The criteria upon which the KBS projects have been chosen for investment could be used as a benchmark in a process of tracking their value as they traverse the KBS lifecycle phases. For example, if the qualitative value to the experts and users falls below the quite beneficial level at say Phase 7 (which involves ongoing maintenance of a KBS) of Table 5.1, a decision could be made to cease maintenance and shelve the project.

Over time as an organisation develops more KBSs, it is envisaged that an organisational standard for using the KBS valuation method would evolve. This standard could be based upon the results of applying the method to previous KBSs with similar characteristics to KBS projects currently being proposed. If the valuation of a proposed KBS yields results similar to that of a previously successful KBS of the same characteristics, this information could be used to make the decision to invest or not in the current KBS.

6.6.6 Organisations Characterised by a Centralised Decision Making Body

In order for Proposition 7 to be tested an organisation had to be recruited which was characterised by a centralised decision making body responsible for making the decision to invest in two or more KBSs. The results from this case study indicate that the KBS value model is applicable for organisations which are characterised by a centralised decision making body. The centralised decision making body can use the value graphs to make subjective comparisons across KBSs with caution as indicated in 6.6.5 above.

Despite this, a centralised decision making body is not a necessary pre-condition for applying the model to an organisation which is characterised by decentralised decision making. An organisation characterised by decentralised decision making and funding allocation whereby only one KBS was being developed per decentralised entity would not be comparing multiple KBSs in order to choose the KBS with the most value. However, the information generated from application of the model to a sole KBS can still be useful in making investment decisions even in such decentralised decision making situations. When applied to one KBS, the model will still measure contribution from intangibles, as well as tangibles in the early lifecycle phases. The results of the Organisation X case study indicate that as long as the other pre-conditions are met the KBS value model should be able to measure the perceived value of one KBS.

6.6.7 Other Qualifications

KBSs A and B were both directly related to improving the service to customers of Organisation X. KBS C was directly related to training customer service employees in product knowledge. Therefore, the results pertain to customer service KBSs and training KBSs. Other types of KBSs exist including those designed for: solving scheduling problems; equipment fault diagnosis; strategic decision making; and financial risk assessment, to name four types. Since the study's results are generalisable across two KBS types, it would suggest that the model is probably applicable across a wider range of KBSs. Future research should be designed to confirm the applicability of the model to a wide range of KBSs.

The results for behaviour are based upon self reports. This may be of concern due to the possibility that self reports may be altered to more favourably reflect performance of the employee's behaviour. Despite this possibility self reports have been extensively used in numerous applications of TRA. Furthermore, the use of self reports in TRA has provided accurate results according to Ajzen and Fishbein (1980, p.38). The procedures used to elicit self reports of behaviour from KBS employees followed the guidelines specified in TRA. Therefore, there is little reason to suspect that they would be inaccurate.

6.7 Conclusion

The purpose of this chapter was to analyse and interpret the results of applying the KBS value model to Organisation X. Pattern matching was the main data analysis technique used. The results of this showed general support for the propositions of the model. There were two exceptions to this. First, partial support was found for Proposition 5. Second, caution should be exercised with the findings of Proposition 7 concerning comparing the perceived value of multiple KBSs. Interpretations for the results concerning the management of KBSs were discussed. Finally, qualifications regarding the limitations of the results of the study were discussed.

Chapter 7

Conclusions and Recommendations

7.1 Introduction

The aims of this thesis were two fold. The first aim was to develop a model designed to assess the value of KBSs as perceived by the key employees involved in its lifecycle. The second aim was to provide the results of a case study used to analyse the model in an organisational setting. This chapter will draw conclusions regarding the achievement of these aims and identify future research directions.

7.2 Justification for a KBS Valuation Model

KBS technology has the potential to significantly automate decision making at the operational and strategic levels of an organisation. Therefore, it can offer organisations substantial strategic advantage, as well as gains in operational effectiveness and efficiency. In order to receive these gains KBS development projects usually require significant investments in organisational finances as well as human and technical resources. In addition, there is a high incidence of failure among KBS projects. As a result, when considering investment in a KBS, managers are faced with a difficult investment decision.

To make KBS investment decisions managers have had to rely upon traditional valuation models which were adopted by KBS development methodologies. Such traditional models give an incomplete valuation for a variety of reasons. Specifically, they do not measure: disaggregated costs and benefits; intangible costs and benefits; the contribution to value from tangible costs and benefits during the KBS prototyping phase; and perceptions of employees regarding the value of a KBS. In order to make the best possible investment decision, managers require this information. Alternative valuation models exist which attempt to overcome some of these inadequacies. However, they are unsuitable for application to the valuation of KBSs because they have been designed for valuation of conventional information systems. Most importantly, they cannot measure: intangible costs and benefits which are peculiar to KBSs alone; and perceptions of key employees regarding the value of a KBS. In addition, these models use the perceptions of an appointed valuator, and they do not employ a well founded psychological model with which to elicit and rate value perceptions.

7.3 Contributions of the KBS Valuation Model

This thesis has proposed a model specifically designed for assessing perceived KBS value. Its main feature is the use of expert, manager, and user employees to assess KBS value. These employees perform the jobs in the organisation that are affected by KBS development. It is in the context of these jobs that the KBSs costs and benefits will become manifest. These employees are thus in a position to observe first hand, the costs and benefits of the KBS to the organisation. Reliability and validity of the valuation results is enhanced by adapting TRA to guide the elicitation and rating of the costs and benefits. The model captures disaggregated intangible and tangible costs and benefits, and therefore provides detailed information to managers. The costs and benefits are classified into value categories of time, finances, or quality. These value categories are representative of KBS projects and are meaningful to managers. The valuation information is presented in the form of KBS value graphs which enable managers to easily interpret the findings and make informed investment decisions. This approach provides an innovative, comprehensive, and lucid means of measuring the value of KBS development projects. It bridges significant gaps in the valuation of KBSs by addressing the problems inherent with current valuation approaches. Finally, it offers managers a practical solution to the problem of assessing the value of KBS investments.

7.4 Format of the Study's Design and its Results

The thesis presented seven propositions with regard to employee beliefs. These were:

Proposition 1 Employee beliefs represent a measure of perceived KBS value when there is a pattern of prediction from these beliefs, to attitude, to intention, and to behaviour.

Proposition 2 Employee beliefs provide a disaggregated measure of perceived costs and benefits of a KBS.

Proposition 3 The employee beliefs are a disaggregated representation of both intangible and tangible costs and benefits rather than an aggregated representation.

Proposition 4
- A finances category is more advantageous than a cost category because there may be financial benefits as well as costs associated with a KBS.

- Expert, user, and manager beliefs will fit into the value categories of time, finances, and quality.

- These categories are mutually exclusive with respect to belief classification with the effect that the chances of dual classification of any belief is unlikely.

Proposition 5 The KBS value model can measure intangible and tangible value during early lifecycle phases by measuring expert, user, and manager beliefs during these phases.

Proposition 6 Together the beliefs of the user, expert, and manager of a KBS will measure the value of a KBS to the organisation as well as the individual jobs of each employee.

Proposition 7 Managers can determine the comparative perceived value across multiple KBSs by examining the employee beliefs which are presented in the KBS value graphs.

To test these propositions of the KBS value model a single embedded critical case study design was formulated at an organisation called Organisation X. Organisation X is a large multinational which manufactures and sells a variety of products ranging from chemicals, household cleaning products, office supplies, data storage devices, to medicines. At the time of study, Organisation X possessed three KBSs. One system was a customer service system which was referred to as KBS A, and was built for a division in Organisation X. Another customer service system named KBS B, was built for another division. A training system for customer support representatives named KBS C, was built for a third division.

Support was found for all propositions. While support was found for Proposition 7, the results should be interpreted with caution. While comparisons of value across multiple KBSs could be made, inconsistencies might arise due to differences in the way employees rate costs and benefits. Despite such possible inconsistencies, the model is still able to provide information on KBS value which would otherwise be unobtainable. Qualified support was found for Proposition 5. This proposition was only partially testable due to the fact that the users were not able to use the KBS C. However, the results from the expert, and manager do indicate support for the proposition.

7.5 Limitations of the Research

One limitation of the research concerns the use of a single case study to test the validity of the KBS valuation model. The reasons for using a single embedded case study research methodology to test the model were described and justified in Chapter 4. A single case was justified upon evidence that Organisation X and its three KBSs A, B and C, represented both a critical case and a revelatory case as proposed by Yin (1994, pp. 38-44). Furthermore, as justified by Yin (1994, p. 36) and argued in Chapter 4 section 4.3, the use of Organisation X as a single embedded case study represents an instance of analytical generalisation and not statistical generalisation. In statistical generalisation the researcher is attempting to test a theory by applying it to a sample. If the sample is correctly selected, and the results are supportive of the theory, then the theory can be deemed generalisable to the population represented by the sample. Conversely, in analytical generalisation the researcher is attempting to test a theory by applying it to particular case study or experiment. If the results of the case study support the theory then the theory is deemed to be valid. If the results of the case study show that the theory is valid, then the theory can be used to identify other similar cases in which the results can be repeated. As described in Chapter 6 evidence was found to support all of the model's propositions with the qualifications presented in Chapter 6, section 6.6 and section 7.4 above. Despite being an appropriate research design for testing the validity of the KBS value model, the use of a single case design does embody certain inherent limitations as it was applied to Organisation X. Firstly, the results as presented in Chapter 5 show that the key informant chosen was responsible for the KBSs being developed. Hence, it may be argued that a bias might have been introduced because he had a stake in the success of the KBSs. A manifestation of such a bias may be the selection of users, experts, and managers that would be supportive of the KBSs. This might explain the positive results for the variables across all employees. It is important to note that there is no evidence that such a bias exists. Despite this the major limitation regarding the generalisation of the results as stated in Chapter 6 section 6.5, is that there is no negative pattern of results across any of the employees. In order to overcome this limitation the model needs to be tested using a case where there is a negative pattern of results across the variables for each employee involved in a KBS. It is recognised that in order to fully test the generalisability of the KBS value model such an organisation is required. It is envisaged that in future the KBS value model will become widely adapted by organisations making KBS investment decisions. Once this occurs, it is expected that more cases of KBSs with either a positive pattern of results or a negative pattern will be available. These cases can then be used to further enhance the generalisability of the model.

7.6 Avenues for Future Research

A major area for future research involves investigation into the external variables influencing employee beliefs. The investigation could begin by identifying all external variables which could possibly affect beliefs. Experiments could then be devised with the aim of determining which variables are more significant than others in various KBS development situations. The outcome would be the identification of external variables which are responsible for influencing beliefs of users, experts, and managers in organisations where development of KBSs is occurring. Such information may be useful in determining if certain beliefs are associated with certain external variables. The reasons for why this thesis did not investigate the effects of external variables are detailed in Chapter 4, section 4.3. In essence, such an investigation is beyond the scope of this study.

The model could be applied to KBS development projects where employees did not perform their KBS behaviours, but had volitional control over performance of the behaviours. In this case it is expected that non-performance of behaviour would be associated with negative beliefs, negative attitude, and negative intention to perform the behaviour. In situations of non-performance a KBS would fail because users would not use the system, experts would not provide knowledge, and managers would not provide managerial support. Hence, applying the model to such a situation would provide useful information on why KBSs fail in organisations.

From the results it seems reasonable to assume that a positive belief set of an employee will be associated with positive attitudes, intention, and behaviour. On the contrary, a negative belief set should be associated with negative attitude, negative intention and non-performance of behaviour. It is probable that if the behaviour is not performed by one or more of the employee types, the KBS would have little or no value to the organisation. An area of investigation, therefore, could involve the design of a method to change employee beliefs. That is, employees could be educated in the benefits of a KBS so that their negative beliefs are replaced with positive beliefs. An experiment could be designed around a KBS characterised by experts, managers, and users with negative beliefs. Associated with these negative beliefs would be corresponding negative values for attitude, and intention and non-performance of behaviour. An education program could then be devised which attempts to change these negative beliefs. The results of the program would need to be logged in terms of beliefs, attitude, intention, and behaviour. If the results were favourable, there would be evidence that educating employees in the benefits of KBSs increases the chances that they will perform the KBS behaviours.

The KBS value model could be applied to a decision making environment whereby it is used in conjunction with traditional valuation models, in order to assess its relative merits. Since traditional models cannot assess intangibles, but the KBS valuation model can, it would be interesting to examine the utility of using both approaches in tandem. Since traditional models cannot assess tangible value in the prototype phase, the examination would require a situation in which a KBS was already past the prototype phase. Related to this, an examination of the utility of the KBS valuation model in the prototype phase could also be performed.

The model could be applied to a longitudinal study where the value of one KBS was measured during each phase of development. Such an investigation would be useful for drawing important conclusions about how the perceived value of a KBS might evolve as it traverses the lifecycle phases.

Many organisations outsource development of KBSs. By doing so, external knowledge engineers are used to develop the system. Recognising this the KBS value model was developed to only measure value to the expert, manager and user employee types. KBS technology is evolving at a rapid pace. New techniques are altering the way these systems are developed and implemented. Development shells allow experts to develop their own KBSs, without the need for knowledge engineers to elicit knowledge from them. A development method called "ripple down rules" engineered by Compton *et al.* (1991) is already being used in some organisations to revolutionise development and maintenance. "Ripple down rules" allows fast and accurate development and maintenance of systems. It works by intelligently updating sequences of rules when changes occur in the knowledge. When a change is identified in a rule it is implemented. Automatically, subsequent rules in the sequence are updated to inherit the knowledge of the updated rule if they require it. "Ripple down rule" technology has been used successfully in several development projects and looks set to be used more widely. If successful, it may mean a significant decrease in the role of knowledge engineers in KBS introduction, thus possibly removing them from the process altogether.

Technological innovation such as "ripple down rules" and KBS development shells appear to be transforming the development of KBSs in the way 4GL's (Fourth Generation Languages) and 5GL's (Fifth Generation Languages) have transformed much of traditional IS development. That is, by eliminating the role of knowledge engineers in the development process. This has a potential impact upon the role of the expert in valuation. Recall that under the current model expert beliefs are elicited regarding advantages and disadvantages of providing knowledge for the KBS. In systems which are developed using these new technologies, beliefs regarding the advantages and

disadvantages of representing and implementing the knowledge (using, for example, "ripple down rules") would also have to be elicited from the expert. These beliefs may have an impact on the value of the KBS to the expert since there may be costs and benefits of actually developing the system as opposed to providing knowledge for development.

It is possible that scenarios may arise whereby an expert is the user and also possibly the manager responsible for introducing the KBS. In this case and its derivatives, the way of eliciting beliefs may need to change. It is suggested that three different sets of interview and questionnaire be used. Although the order may be unimportant, in the first set the beliefs regarding KBS use be elicited, followed by beliefs regarding knowledge provision, and finally, beliefs regarding managerial support for introduction. In situations where the expert is also the knowledge engineer, a separate set of questions should be administered to elicit the beliefs regarding knowledge representation and implementation. In this way the value of a system across the various roles of introduction could be determined.

Potentially, KBSs can enhance both the internal and external operations of an organisation (Turban 1995, p. 809). For example, KBS C was a training KBS, which improved the knowledge of customer support employees regarding data storage products, such as digital tapes, compact disks, and floppy disks. KBS C was also sold to distributors so that they could learn more about Organisation X's data storage products. Organisation X's strategy was to entice them to acquire more product knowledge, so that when a customer of the distributor called to make an order, the distributor would know more about Organisation X's products, than that of other suppliers. By offering more knowledge about Organisation X's products, the distributor would in effect entice the customer to buy Organisation X's products. In KBS B, customer's are provided with advice on respiratory equipment. The KBS has internal uses as well. The expert is freed from providing certain types of advice. Sales and Marketing employees are given the capability to provide advice, thereby gaining a valuable sales and marketing tool.

The point of the above paragraph is to outline a scenario whereby a KBS has value to people inside and outside of the organisation. The KBS value model currently handles internal valuation. Future research should develop its potential to measure perceived value to those affected by it outside the organisation. To achieve this would require identification of people directly affected by the system. People who knew what the system did and could place a value upon it based on their interactions with it. Distributors in the example above, could be treated as external users. They could be asked to list

advantages and disadvantages of using the system in their job as a distributor. Customers could be polled in terms of their interaction with the system to gain advice. A customer telephoning Organisation X to use KBS B, for example, could be asked to list the advantages and disadvantages to him/her of calling an Organisation X customer representative to gain advice on respiratory equipment for purchase. A customer's or distributor's valuation of the system could be invaluable to management keen to obtain funding for other similar systems or to evaluate current systems being used in the organisation.

Appendix A

Case Study Protocol

A.1 Introduction

The purpose of this Appendix is to detail the procedures used to collect the data at Organisation X. It represents a case study protocol as described in Chapter 4 and proposed by Yin (1994, p. 64) which aims to establish the reliability of the KBS value model. It consists of a case study overview; the field procedures used to collect the data; and the case questions for the respondents involved in the study.

A.2 Case Study Overview

Organisation X is a large multinational which manufactures and sells a variety of products ranging from chemicals, household cleaning products, office supplies, data storage devices, to medicines. At the time of study, Organisation X possessed three KBSs in various stages of development. One system was a customer service system which was referred to as KBS A, was built for a division in Organisation X. Another customer service system named KBS B, was built for a second division. A training system for customer support representatives named KBS C, was built for a third division.

The data collection method consisted of a series of structured and unstructured interviews and structured questionnaires which were administered to employees of Organisation X, by the data collector and author. The employees included the study's key informant, and managers, experts, and users from the three KBSs. These interviews and questionnaires followed a natural sequence. The questions asked in each interview and questionnaire are documented in the case study protocol of Appendix A. The three KBSs are called KBS A, B, and C respectively. KBS A was a customer support system designed to provide customers with advice regarding electrical insulation kits which best suited their needs and associated pricing details. There was one expert and one manager associated with the system both of whom were male. KBS B was a customer support system which provided documented advice to customers on the best facial respirator for their needs and pricing details. There was one expert, one manager, and two users associated with KBS B. The expert was female, the manager was male, and both users were female. One user was a telesales consultant, while the other was a visiting sales representative. KBS C trained

users regarding the features of electronic storage products. There was one expert, one manager, and one user associated with KBS C. The expert was male, the manager was male, and the user was female. Excluding the key informant there were nine individuals interviewed. The key informant was a senior executive responsible for the performance of several divisions within Organisation X. In particular he was the overseer of the KBSs studied in this case. He was chosen as a key informant because of his knowledge of the KBSs and the employees involved with them. Further information regarding these KBSs and the employees associated with them is reported in Chapter 6: Presentation of Results.

A.3 Data Collection Procedures

A.3.1 Procedure 1: A Structured Interview with the Key Informant

A structured interview was held with the key informant of Organisation X in order to determine the following:

- whether KBSs were being developed at Organisation X;
- to identify the experts, users, managers involved with each KBS;
- what KBS lifecycle model was used at Organisation X;
- based upon the lifecycle model used, which of these lifecycle phases did the managers, users, and experts perform their respective KBS behaviours
- what the major KBS management issues were at Organisation X; and
- whether the pre-conditions for use of Organisation X as a case study were met.

To identify whether KBSs were used at Organisation X, the key informant was asked, if in his opinion, KBSs were being developed at Organisation X. He was then asked to specify the names of the KBSs and the managers, experts, and users of each KBS. To identify the KBS lifecycle model used, the key informant was asked to list the lifecycle phases as he perceived them in use at Organisation X.

The following questions were asked for two reasons. First, to determine what the KBS managerial issues were at Organisation X. Second, to determine in which lifecycle phases the experts, managers, and users perform their KBS behaviours. For each lifecycle phase the key informant was asked what the phase objective was, or what the phase objectives were in situations where phases had multiple objectives. He was then asked to identify: which employee groups were involved in each lifecycle phase; what type of support they

required to achieve the phase objective(s); and what organisational factors hindered achieving the phase objective(s).

To examine whether the pre-conditions for testing the KBS valuation model were present at Organisation X, the key informant was asked several questions in accordance with the pre-conditions discussed in Chapter 4, section 4.2.1. In accordance with the first pre-condition he was asked how many KBSs were being developed or used at Organisation X. In accordance with the second pre-condition he was asked whether the decision to build KBSs was made by a centralised decision making body, or whether it was a decentralised decision. In accordance with the third pre-condition, he was asked to confirm whether any of the managers, experts, and users for each KBS being developed at Organisation X were obtained by outsourcing them from another organisation. In accordance with the fourth pre-condition he was asked whether any of the managers, experts, and users had been replaced by those currently involved with the KBSs. In accordance with the fifth pre-condition, he was asked whether performance of behaviour by the managers, experts, and users was mandatory or voluntary. In accordance with the sixth proposition he was asked whether there were any situations in which any of the managers, experts, and users were stopped from performing the behaviours.

A.3.2 Procedure 2: An Unstructured Interview / Demonstration With the Key Informant

An unstructured interview was held with the key informant in which the KBSs were demonstrated. The aim of this interview was to:

- identify the KBSs at Organisation X with a demonstration of each system;
- ascertain the authenticity of the KBSs studied;
- locate which lifecycle phase that each KBS was currently traversing;
- determine what organisational task(s) each KBS is designed to support;
- determine how each organisational task is/was performed before implementation of the KBS; and
- determine how each organisational task was/will be performed after implementation of the KBS.

As each KBS was demonstrated, questions regarding the above aims were asked. To identify the KBS projects at Organisation X, the key informant was asked to give an overview of the KBSs in the context of the division in which each was to be used. To determine the authenticity of each KBS, the key informant was asked whether the KBS solved difficult problems which require the use of human expertise. He was also asked

whether each KBS employs knowledge of techniques, information, heuristics, and problem solving processes that human experts use to solve such problems. These questions were derived from the definition provided by Prerau (1991, p.3) which was quoted in Chapter 1 section 1.1. In the context of the lifecycle model used at Organisation X, the key informant was then asked to identify the KBS lifecycle phase that each KBS was currently traversing. For each KBS he was asked to describe the organisational task or tasks that the KBS was designed to improve. He was then asked to describe how each task is or was performed before implementation. Finally he was asked how each task is or will be performed after implementation. These questions were not asked in any particular order, but were asked at appropriate times during the demonstration, or were volunteered without prompting from the interviewer.

A.3.3 Procedure 3: A Structured Interview for Managers, Experts, and Users

Following this a structured interview was conducted with each employee. Its purpose was to elicit from each expert, manager, and user his/her:

- age;
- sex;
- position in Organisation X;
- role in the KBS lifecycle;
- beliefs regarding the positive and negative consequences of performing the KBS behaviour ; and
- actions indicative of performing KBS behaviour.

The respondents were asked for their age, sex, and organisational position. The purpose of this was to accurately identify each respondent. These variables represent external variables which could influence beliefs held by an employee. It is not the purpose of the case study to ascertain which external beliefs may influence employee beliefs. However, measurement of these variables may help to identify whether or not differences in these external variables coincide with differences in the beliefs elicited. The role of each respondent was elicited by asking them to describe what role they played in the KBSs lifecycle. Before they were asked this question the phases of the lifecycle was presented to them so that they knew what the term KBS lifecycle meant in the context of Organisation X. This question was asked to verify that each employee in fact was an expert, manager, or user as identified by the key informant.

To reduce the threat of compensatory rivalry, the aim of the study was revealed to each respondent and he/she was informed that the results of the study were not going to be used to evaluate his/her performance. Respondents were also instructed to provide answers which were truthful and honest. All this was intended to overcome any feelings on the part of the respondent of being treated special and therefore giving untruthful results. In addition, the location and time of interview was scheduled at a time and place where the respondent felt most comfortable.

A.3.3.1 Elicitation of Beliefs and Evaluations

In order to elicit outcome beliefs and actions the guidelines provided by TRA were adopted (Ajzen and Fishbein 1980). To elicit beliefs each respondent was asked to list the advantages and disadvantages of performing behaviour related to the KBS in the context of his/her job at Organisation X and the KBS lifecycle. Phrasing the questions using these terms ensures that the outcome beliefs elicited adhere to the requirements of measuring beliefs specified by TRA. That is, beliefs are measured in terms of behaviour, context, target, and time. TRA imposes this requirement to help ensure construct validity is achieved. The wording of the questions varied for each employee type to reflect differences in behaviour, context, target, and time. The precise questions will now be presented.

For the manager the following questions were asked:

> "Please list what you believe are the advantages to you of providing your managerial support for the introduction of (KBS name) in the context of your job in the division."
>
> and
>
> "Please list what you believe are the disadvantages to you of providing your managerial support for the introduction of (KBS name) in the context of your job, in the division."

After these questions are read, but before they are answered it is explained to the manager that the phrase:

> "providing your managerial support during the introduction of (KBS name)"

refers to the phases of the KBS lifecycle in which he/she provides managerial support. The phases are not listed in the question. This is to reduce the number of words in the question and to reduce confusion on the part of the manager about what the question asks.

The phases in which managerial support are to be provided were elicited from the key informant and are listed separately for his perusal. After this, the manager is asked to answer the two questions.

For a user the following questions were asked:

> "Please list what you believe are the advantages of your using (KBS name) during its introduction in the context of your job, in the division."
>
> and
>
> "Please list what you believe are the disadvantages of your using (KBS name) during its introduction in the context of your job, in the division."

After these questions are read, but before they are answered it is explained to the user that the phrase:

> "your using (KBS name) during its introduction"

refers to the KBS lifecycle phases in which he/she uses the KBS. The phases are not listed in the question for the same reasons that were explained in the case of the manager. The phases in which he/she uses the KBS were determined during the initial interview with the key informant and are listed separately for his/her perusal. After this exercise the user is asked to answer the questions.

For the expert the following questions were asked:

> "Please list what you believe are the advantages to you of providing your domain knowledge for development and testing of (KBS name) during its lifecycle in the context of your job, in the division."
>
> and
>
> "Please list what you believe are the disadvantages to you of providing your domain knowledge for development and testing of (KBS name) during its lifecycle in the context of your job, in the division."

After these questions are read, but before they are answered it is explained to the expert that the phrase:

"providing your domain knowledge for development and testing of (KBS name)"

refers to the phases in which he/she provides and tests domain knowledge for the KBS. The phases are not listed in the question for the same reasons given in the cases of manager and user. The phases in which he/she provides his/her domain knowledge to the KBS were determined during the initial interview with the key informant and are listed separately for his perusal. Following elicitation of beliefs each respondent was asked if there was anything else he/she associated with performing his/her KBS behaviour. This question follows the TRA guidelines (Ajzen and Fishbein 1980). The purpose of this question was to test whether there was any other factors which the respondent perceived would affect his ability to perform the KBS behaviour. Hence, it is a check designed to test the construct validity of the instrument.

A.3.3.2 Elicitation of Actions Indicating Behavioural Performance

In order to elicit the actions which correspond to performance of KBS behaviour, a separate set of questions was used. The requirements of behaviour, time, target, context as specified by TRA were followed in the design of the question. For the manager the question was:

"If you were to provide your support for the introduction of (KBS name), within your division, what would be the major actions that you would take to provide such support?"

For the user the question was:

"Please list the specific tasks in your job that you could use (KBS name) to complete?"

For the expert the question was:

"If you were providing your knowledge for the development and testing of (KBS name), what would be the major actions that you would take to provide the domain knowledge?"

A.3.4 Procedure 4: An unstructured Informal interview with Managers, Users, and Experts

An unstructured informal interview with each respondent was held directly after the structured interview to:

- determine if performing KBS behaviour was perceived to be voluntary or mandatory by the respondent; and
- ensure that the interviewer understood the beliefs and behaviours elicited by each employee.

Each respondent was asked to state whether performance of their KBS behaviour was a requirement of their job or was one of free choice. This was done to determine whether performance of the behaviour was mandatory or voluntary. This question was asked in order to verify whether the fifth pre-condition discussed in Chapter 4 section 4.2.1 was met. If it is mandatory, as discussed in Chapter 3, then intention to perform the behaviour, may not be due to the belief and attitude, but due to the will of the employee's supervisor. The interviewer's interpretation of the beliefs elicited was checked in order to verify that his understanding was identical to the respondent's. This was done to ensure that beliefs could be accurately classified into the time, finances, and quality categories during data analysis. The interviewer's interpretation of the actions indicating performance of behaviour were also checked to ensure that they were identical to the respondent's. Any differences were noted and the respondent's interpretation was clarified with a written note.

A.3.5 Procedure 5: Structured Questionnaires for Each Respondent

A questionnaire was given to each user, expert, and manager of the three KBSs to rate:

- outcome beliefs and their associated evaluations; and
- attitude, intention, and performance of behaviour.

A.3.5.1 Procedures for Rating Beliefs and Belief Evaluations

In order to rate beliefs, attitude, intention, and behaviour and evaluations the TRA guidelines were followed (Ajzen and Fishbein, 1980). Once again these guidelines were followed because the scales used have been tested and found to provide reliable and valid results (Ajzen and Fishbein, 1980). The following scale was used for beliefs:

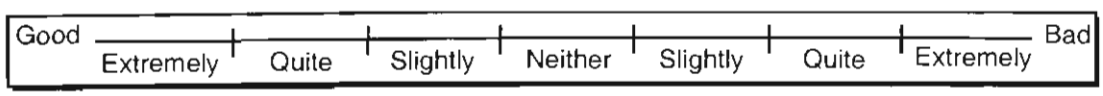

Figure A.1: Scale Used to Measure Outcome Beliefs

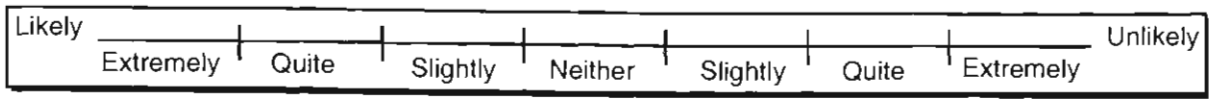

Figure A.2: Scale Used to Measure Belief Evaluations

These scales were used regardless of whether the belief and associated evaluation was positive or negative. The rationale provided by TRA is that this is an opportunity for the respondent to disagree with beliefs which he earlier elicited. The interviews for rating these beliefs were conducted no more than two or three days after the previous interview for eliciting the beliefs and behaviours. Therefore, it is a test of whether the beliefs previously elicited are still relevant, at the time of this subsequent interview.

A.3.5.2 Procedures for Rating Attitude

Attitude towards a KBS behaviour is elicited and rated using the format and indicators specified by Ajzen and Fishbein (1980) which include the following items:

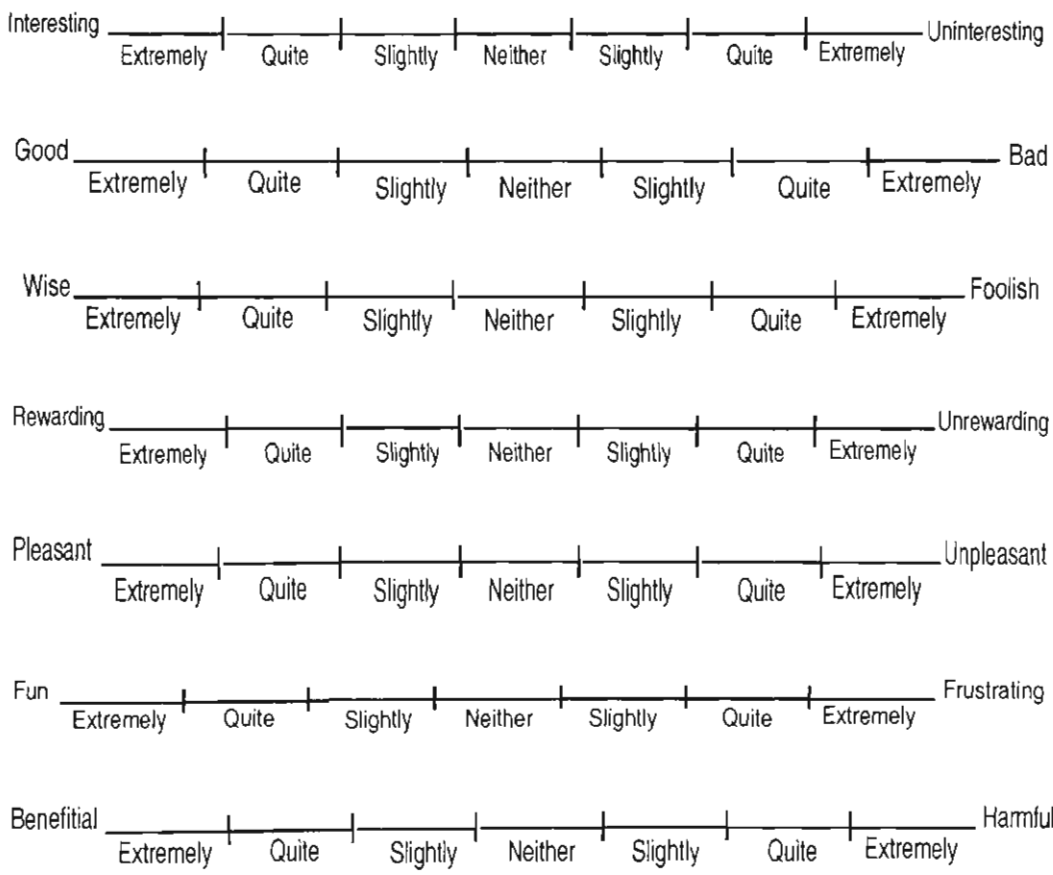

Figure A.3: Scales Used to Measure Attitude

These attitude indicators have been found to be valid and reliable in the measurement of a person's attitude toward performing behaviour (Ajzen and Fishbein, 1980). Measurement

of attitude again follows the TRA guidelines. Before rating his/her attitude each respondent is given an instruction to do so in terms of time, behaviour, target and context. Rating of attitude is thus tailored to each respondent. The manager is instructed as follows:

"Please rate your opinion on the scales below with the following statement:

'Providing your support for the introduction of (KBS name) is:'"

For the User the question is:

"Please rate your opinion on the scales below with the following statement:

'Your use of (KBS name) is:'"

For the expert the instructions are:

"Please rate your opinion on the scales below with the following statement:

'Providing your domain knowledge for the development and testing of (KBS name) is:'"

In order to simplify reading of the questions for attitude the target, and behaviour elements was included only. Since the questionnaire was administered by the investigator, it was explained to the respondents that they were to answer the question: in the context of their job in the division; and with respect to the phases of the KBS lifecycle in which they performed their respective behaviours.

A.3.5.3 Procedures for Rating Intention

The intentions of the respondents to perform their KBS behaviours were rated using the format and guidelines specified by TRA (Ajzen and Fishbein 1980). The scale used for measuring intention to perform a behaviour was:

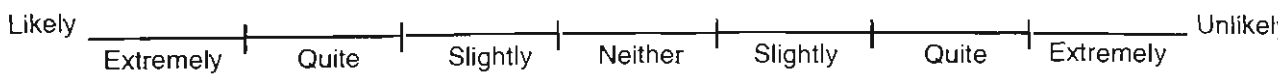

Figure A.4: Scale Used to Measure Intention

The phrase preceding the scale for a manager is:

> "I intend to continue to provide my managerial support for the introduction of (KBS name)"

The phrase preceding the scale for a user is:

> "I intend to continue to use (KBS name)."

The phrase preceding the scale for an expert is:

> "I intend to continue to provide my domain knowledge for the development and testing of (KBS name)."

In order to simplify reading of the questions for intention, the target, and behaviour elements were included only. Since the questionnaire was administered by the investigator, it was explained to the respondents that they were to answer the question: in the context of their job in the division; and with respect to the phases of the KBS lifecycle in which they performed their respective behaviours.

A.3.5.4 Procedures for Rating Performance of Behaviour

Rating of the performance of behaviour was achieved by asking each individual to rate his/her performance of the actions elicited from them in the first interview and verified by the key informant. Perceived performance of each behaviour was rated using the following scale

Not at All — To a Great Extent

1---------2---------3---------4---------5---------6---------7

Figure A.5: The Scale Used to Measure Performance of Behaviour

Each type of respondent was given tailored instructions for rating performance of each action. The instructions for the manager were:

"The diagram below lists possible actions that as a manager you could perform during the introduction of (KBS name). Please indicate the extent to which you have undertaken each action"

The instructions for the user were:

"The diagram below lists the tasks that could be completed through the use of (KBS name). These tasks could also be completed through means other than (KBS name). Please indicate the degree to which you use (KBS name) to complete these tasks."

The instructions for an expert were:

"The diagram below lists possible actions that as an expert you could take to provide domain knowledge for development and testing of (KBS name). Please indicate the extent to which you have undertaken each action."

Again, in order to simplify reading of the questions for behaviour, target, time, and context elements were included variously across the employee types. Since the questionnaire was administered by the investigator, where these elements are missing, respondents were verbally instructed to consider them. For instance, the context of employee job in the division was not included in any question. It was explained to the respondents that they were to answer the question in the context of their job in the division. Similarly, there was no written instruction to the user to consider use during the KBS lifecycle phases.

A.3.6 Procedure 6: Unstructured Interview With Key Informant

An unstructured interview was held with the key informant to:

- judge whether the actions of the respondents were indicative of the respective KBS behaviours;
- judge whether the beliefs were relevant; and
- determine usefulness of study results.

The purpose of this interview was to test the reliability of the answers given by the respondents with respect to the actions which indicate behaviour performance. In order to achieve this, each set of actions was shown to the key informant and he used his own judgement to determine whether the actions were an accurate representation of those indicative of performing the behaviour. He was then asked for his opinion on the

accuracy of the self reports of behaviour for each employee. Any instances where he thought that a behaviour had not been performed was to be noted. He was then asked to check the beliefs in order to determine whether they were relevant to determining the value of the KBS. Specifically he was asked if the beliefs elicited were a complete reflection of the value of the KBS from the perspective of the employee's job in Organisation X. Any differences were to be jotted down. Lastly the key informant was asked whether or not the valuations made by the employees could be used to draw comparisons across KBSs and employees.

Appendix B
Tabular Presentation of the Results Across the Variables for the Employees Studied

Table B.1 Results for KBS A Manager and Expert Employees

KBS A Manager							
Manager Beliefs	**Belief Results**	**Attitude Manager**	**Attitude Results**	**Intention Manager**	**Intention Results**	**Manager Actions**	**Action Results**
B1 Increase productivity of Organisation X staff +2 +2	4	Interest	2	Int	2	BH1 Ensure sufficient hardware and software	4
B2 KBS A will increase sales of electrical termination kits +1 +1	1	Good	3			BH2 Arrange for training of sales and marketing staff to use KBS A	5
B3 KBS A will improve customer service by providing advice over the phone +2 +2	4	Wise	2			BH3 Ensure a mechanism is in place to perform maintenance of KBS B's knowledge	4
		Rewarding	1				
		Pleasant	2				
		Fun	2				
		Beneficial	3				
Total	9	**Total**	15	**Total**	2	**Total**	13

KBS A Expert							
Expert Beliefs	**Belief Results**	**Attitude Expert**	**Attitude Results**	**Intention Expert**	**Intention Results**	**Expert Actions**	**Action Results**
B1 Providing knowledge ensures that the correct material will be incorporated into the kits +2 +2	4	Interest	0	Int	2	BH1 Ensure kit components accommodate the specifications	7
B2 Non technical users understand system parameters +2 +2	4	Good	0			BH2 ensure bill of materials is correct/complete	7
B3 Non technical users know correct information +2 +1	2	Wise	1			BH3 Ensure the correct designation of kits	7
B4 Less involvement by technical services in kit selection +2 +2	4	Rewarding	0				
B5 Non technical users might recommend wrong kit -2 +1	-2	Pleasant	1				
B6 Non technical users might input incorrect information -1 +1	-1	Fun	0				
B7 Providing knowledge to maintain KBS A will ensure the correct update of new products +2 +2	4	Beneficial	2				
B8 Providing knowlege to maintain KBS A will ensure the correct input of new materials +2 +2	4						
Total	19	**Total**	4	**Total**	2	**Total**	21

Table B.2 Results for KBS B Manager, User, and Expert Employees

KBS B Manager							
Manager Beliefs	**Belief Results**	**Attitude Manager**	**Attitude Results**	**Intention Manager**	**Intention Results**	**Manager Actions**	**Action Results**
B1 KBS B will provide a quick response to the customer's need +1 +1	1	Interest	2	Int	3	BH1 Examine ways for funding of KBS B	6
B2 KBS B enables better utilisation of Technical Services personnel +3 +2	6	Good	3			BH2 Ensure that system is user friendly	6
B3 KBS B will increase control over the end users +2 +2	4	Wise	2			BH3 Provide and seek out skills for development	5
B4 KBS B can be used as a sales tool by sales representatives +3 +2	6	Rewarding	3			BH4 Decide on how best to sell KBS B to Managment	6
B5 KBS B provides documented advice to customers +3 +3	9	Pleasant	2			BH5 Get support of all relevant parties to continue	5
B6 KBS B identifies new business leads +3+3	9	Fun	-1			BH6 Discover relevant add on costs of implementation	3
B7 KBS B will increase sales of Organisation X's respirators +2 +2	4	Beneficial	3			BH7 Make sure the expert provides the knowledge	6
B8 KBS B improves customer service +3 +3	9					BH8 Make arrangements for extended trial period	4
B9 There is a time delay in KBS B's response -1 +1	-1						
B10 There will be a high cost of hardware and software to implement KBS B -1 +2	-2						
B11 The training time for sales representatives to use KBS B will be lengthy -1 +2	-2						
Total	**43**	**Total**	**14**	**Total**	**3**	**Total**	**41**

KBS B User 1 Telephonist							
User 1 Beliefs	**Belief Results**	**Attitude User 1**	**Attitude Results**	**Intention User 1**	**Intention Results**	**User 1 Actions**	**Action Results**
B1 KBS B allows sales and marketing employees now take customer questions on respirators +2 +2	4	Interest	2	Int	3	BH1Using KBS B to make customer recommendations	5
B2 KBS B provides consistent advice on respirators +3 +3	9	Good	2			BH2 Using KBS B to obtain customer details	5
B3 KBS B enables markets to be targeted +3 +3	9	Wise	3			BH3 Providing customer with report	7
B4 KBS B allows sales and marketing employees to settle customer calls quickly +2+2	4	Rewarding	2				
B5 KBS B collect customer information +3 +3	9	Pleasant	1				
B6 KBS B provides documented recommendations to customers +3 +3	9	Fun	-1				
B7 KBS B Will not answer all calls, some calls are transferred to technical services -2+2	-4	Beneficial	3				
Total	**40**	**Total**	**12**	**Total**	**3**	**Total**	**17**

KBS B User 2 Sales Representative							
User 2 Beliefs	**Belief Results**	**Attitude User 2**	**Attitude Results**	**Intention User 2**	**Intention Results**	**User 2 Actions**	**Action Results**
B1 KBS B will increase sales of respiratory equipment +2 +2	4	Interest	2	Int	3	BH1 Using KBS B to make customer recommendations	5
B2 KBS B provides the correct information to customers +3 +3	9	Good	2			BH2 Using KBS B to obtain customer details	1
B3 KBS B provides the customer with a range of alternative respirators from which to choose +2+2	4	Wise	1			BH3 Providing customer with report	6
B4 KBS B provides the correct product, but at times the customer desires another product -1 +1	-1	Rewarding	2				
B5 It takes a long time to enter data into KBS B -1 +1	-1	Pleasant	2				
		Fun	1				
		Beneficial	3				
Total	**15**	**Total**	**13**	**Total**	**3**	**Total**	**12**

KBS B Expert							
Expert Beliefs	**Belief Results**	**Attitude Expert**	**AttitudeResults**	**Intention Expert**	**Intention Results**	**Expert Actions**	**Action Results**
B1 KBS B frees up time to work on other tasks +2 +3	6	Interest	3	Int	3	BH1 Describe decision process to developers	7
B2 KBS B answers simple customer questions about the best respirators for their needs +2 +3	6	Good	3			BH2 Ensure all understand final product	6
B3 Providing knowledge for development proved that the expert's knowledge is correct +3 +3	9	Wise	3			BH3 Keep up to date on consultants progress	7
B4 KBS B enables sales and marketing employees to provide respirator advice +3 +3	9	Rewarding	3			BH4 Test during development	7
B5 Providing knowledge for development was very time consuming -2 +1	-2	Pleasant	2			BH5 Provide clear summaries, flow charts	6
B6 Providing knowledge for maintenance ensures that KBS B will still save time for the expert +3 +2	6	Fun	2				
B7 Providing knowledge for maintenance ensures that sales & marketing still handle customers +3 +3	9	Beneficial	3				
B8 Providing knowledge for maintenance gives the expert control of future versions of KBS B +2 +2	4						
B9 Providing knowledge for the maintenance of KBS B will consume more of the expert's time -2 +3	-6						
Total	**41**	**Total**	**19**	**Total**	**3**	**Total**	**33**

Table B.3 Results for KBS C Manager, User, and Expert Employees

KBS C Manager							
Manager Beliefs	**Belief Results**	**Attitude Manager**	**AttitudeR esults**	**Intention Manager**	**IntentionR esults**	**Manager Actions**	**Action Results**
		Interest	3	Int	1	BH1 Ensure that a task force is set up to drive system release	5
B1 KBS C reduces the amount of time spent by sales employees in product training +2 +1	2	Good	2			BH2 Ensure maintenance of KBS C takes place	6
B2 KBS C ensures that Organisation X gets the premium price for its data storage products +2 +2	4	Wise	2			BH3 Ensure buy in by all departments	4
B3 KBS C allows for product differentiation +3 +1	3	Rewarding	2				
B4 KBS C helps to provide a qualified Organisation X sales force +2 +2	4	Pleasant	2				
B5 KBS C helps to provide a qualified distributor sales force +2 +2	4	Fun	3				
B6 KBS C helps to enhance Organisation X's professional image +2 +1	2	Beneficial	2				
B7 KBS C helps to maintain Organisation X's market leadership in data storage products +2 +2	4						
Total	**23**	**Total**	**16**	**Total**	**1**	**Total**	**15**

KBS C User							
User Beliefs	**Belief Results**	**Attitude User**	**Attitude Results**	**Intention User**	**Intention Results**	**User Actions**	**Action Results**
B1 KBS C taught me to identify data storage products +2 +2	4	Interest	3	Int	2	BH1 KBS C is used to answer customer questions regarding data storage products	3
B2 KBS C taught me to know the capability of data storage products +2+2	4	Good	3			BH2 KBS C is used in learning information regarding data storage products	5
B3 KBS C expanded my knowledge of data storage products +2 +3	6	Rewarding	3				
B4 KBS C helps me to understand what knowledgable customers are talking about +2 +2	4	Pleasant	2				
B5 KBS C makes my job more interesting +2+2	4	Fun	3				
B6 KBS C enables me to answer more questions +2 +1	2	Beneficial	3				
Total	**24**	**Total**	**17**	**Total**	**2**	**Total**	**8**

KBS C Expert							
Expert Beliefs	**Belief Results**	**Attitude Expert**	**Attitude Results**	**Intention Expert**	**Intention Results**	**Expert Actions**	**Action Results**
B1 KBS C relieves me of spending time on repetitious training +2 +2	4	Interest	3	Int	3	BH1 Define the audience to be trained	7
B2 KBS C allows me more time to spend on business development +2 +2	4	Good	3			BH2 Define the level of knowledge required	7
B3 KBS C increases reach of Organisation X's training to include distributors +2 +2	4	Wise	3			BH3 Develop a story board	6
B4 KBS C reduces boredom in my job +2 +2	4	Rewarding	2			BH4 Compile the literature on training	7
B5 KBS C has enhanced my standing in Organisation X +2 +2	4	Pleasant	2			BH5 Dictate the information according to the story board	6
B6 KBS C has broadened my qualifications in the area of computer based training+3 +3	9	Fun	2			BH6 arrange for an outside contractor for development	6
B7 KBS C has sharpened my knowledge of data storage products +1 +1	1	Beneficial	3				
B8 KBS C ensures that the knowledge of data storage products is consistent for all users +2 +2	4						
B9 Development of KBS C required a lot of my time -3 +3	-9						
B10 Development of KBS C reduced the amount of time for other job functions -3+3	-9						
B11 There is a lot of pressure to update KBS C for subsequent releases -2 +2	-4						
B12 Providing knowledge for maintenance motivates me to keep up to date +1 +2	2						
B13 Providing knowledge for maintenance enables me to keep in touch with the computer based training world +2 +2	4						
B14 Providing knowledge for the maintenance of KBS C means easier distribution of new knowledge to users +2 +2	4						
Total	**22**	**Total**	**18**	**Total**	**3**	**Total**	**39**

Appendix C
Pattern of Results Across the Variables for the Employees Studied

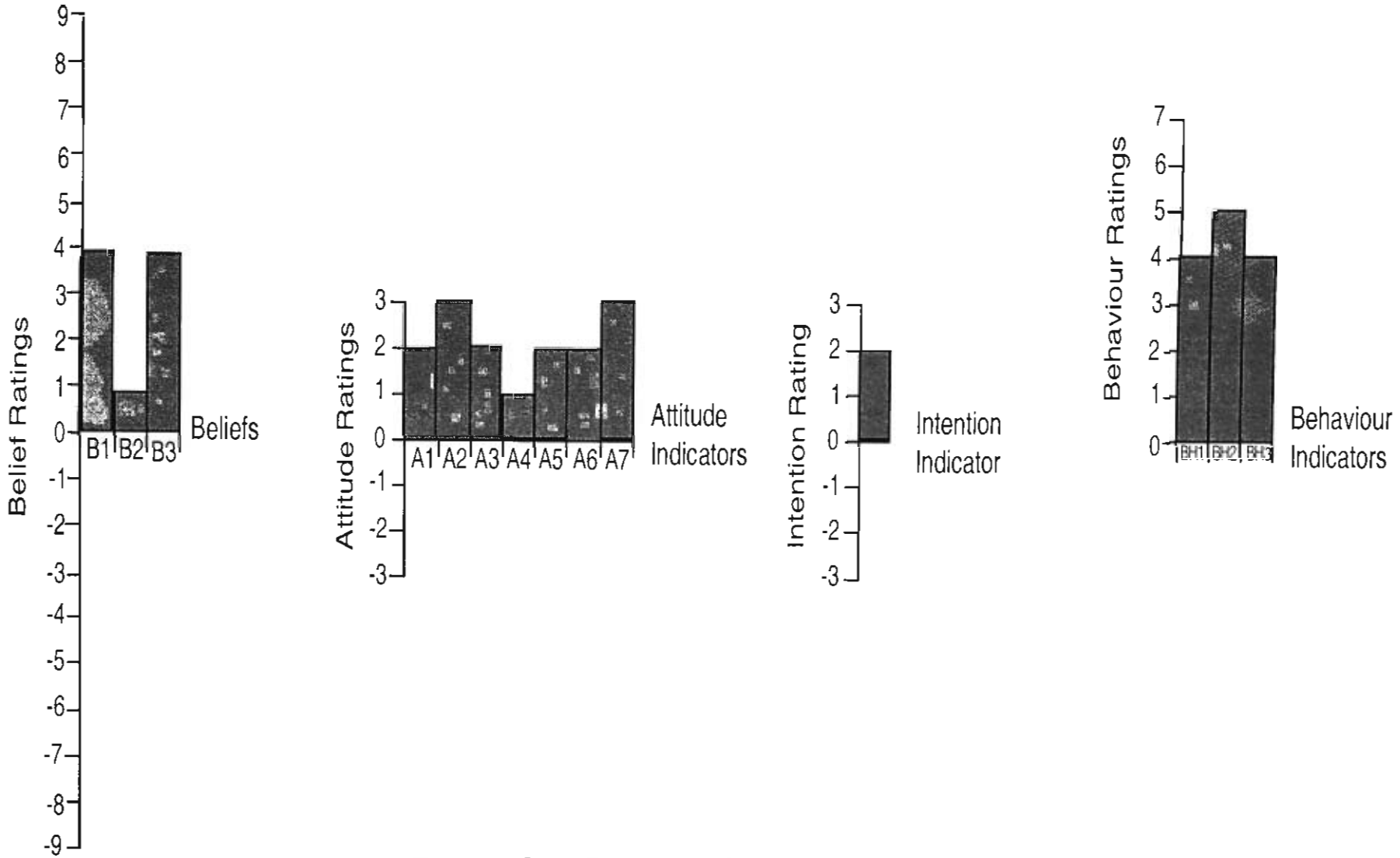

Figure C.1: Pattern of Results for KBS A Manager

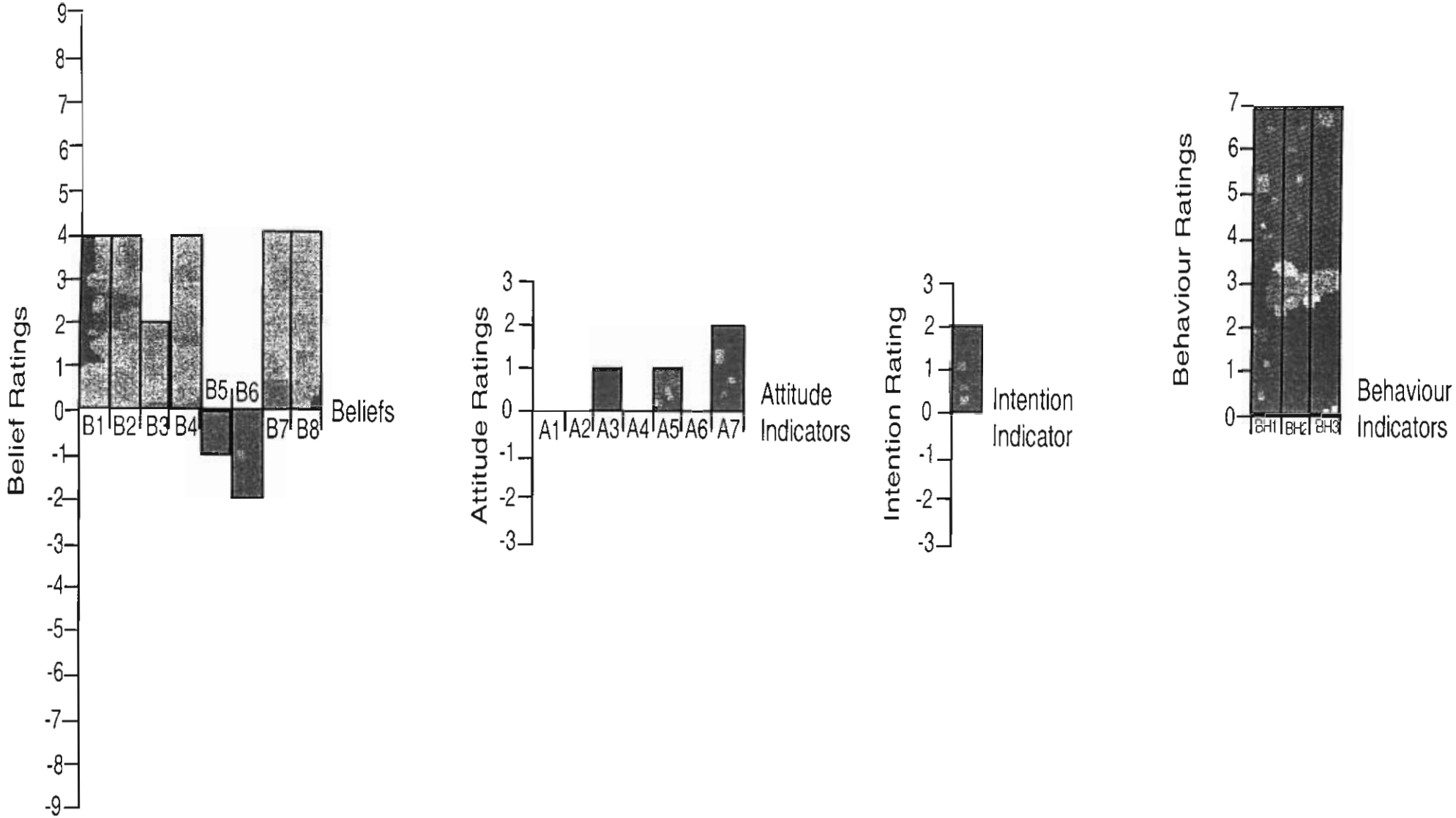

Figure C.2: Pattern of Results for KBS A Expert

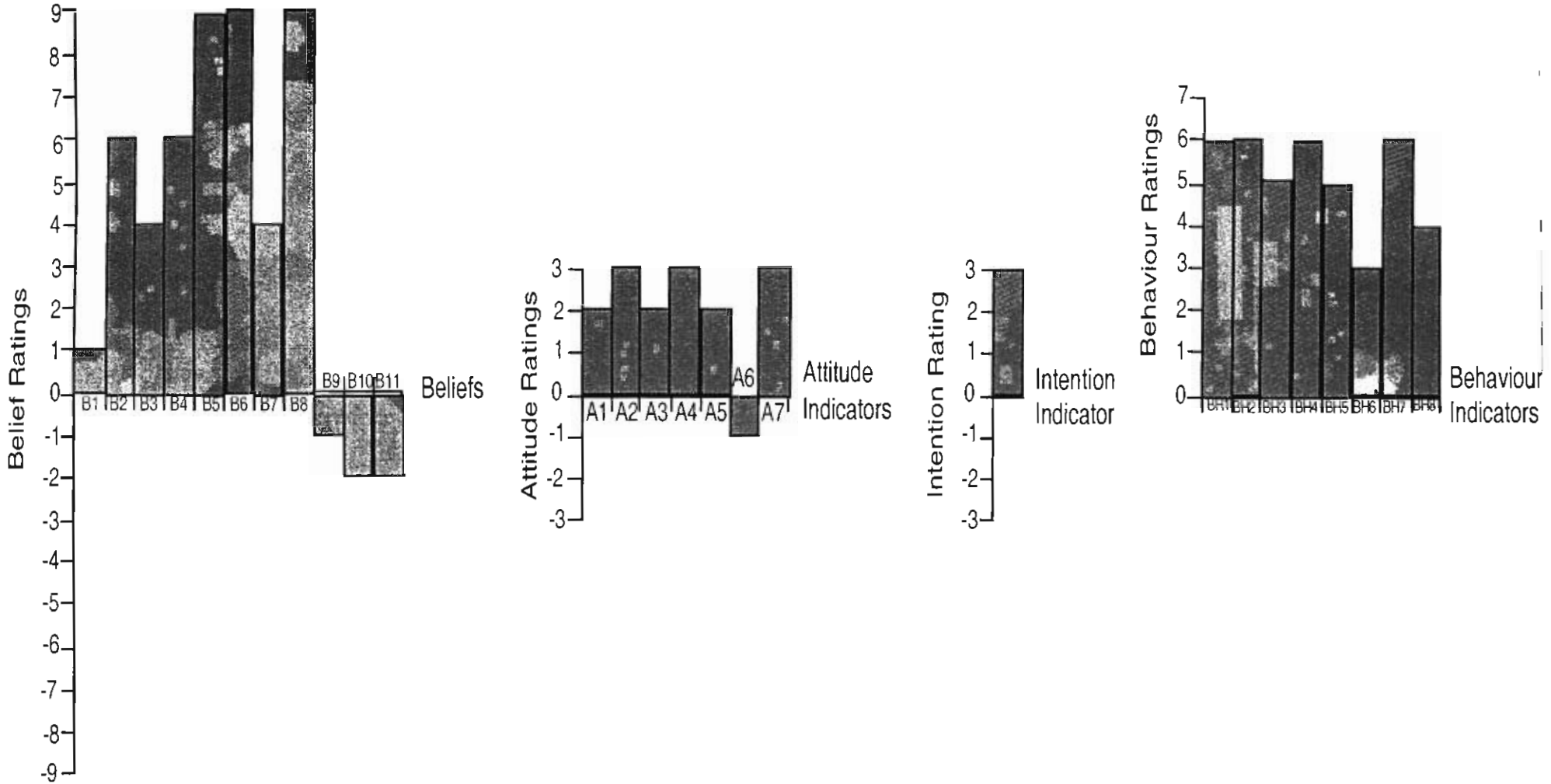

Figure C.3: Pattern of Results for KBS B Manager

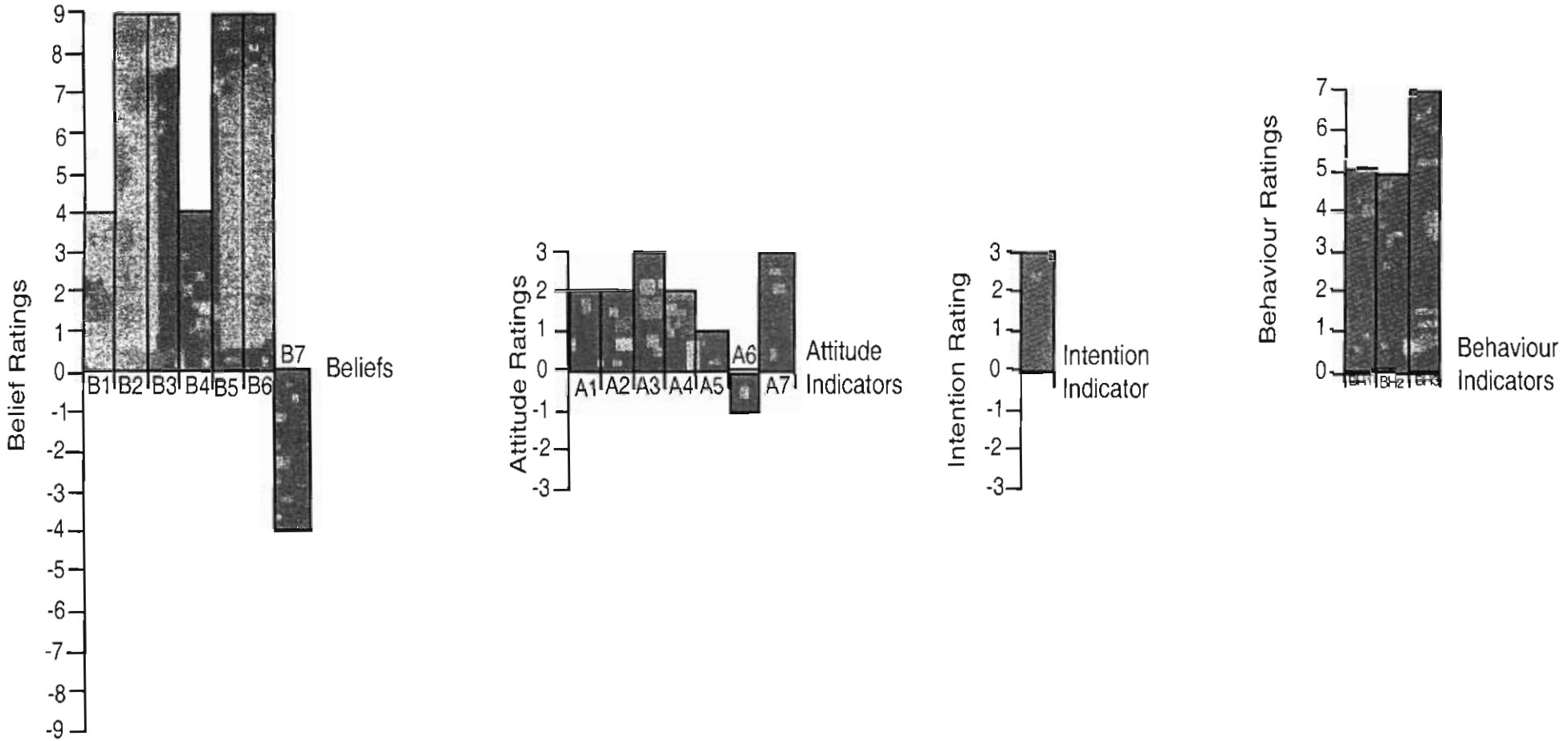

Figure C.4: Pattern of Results for KBS B Telephonist User

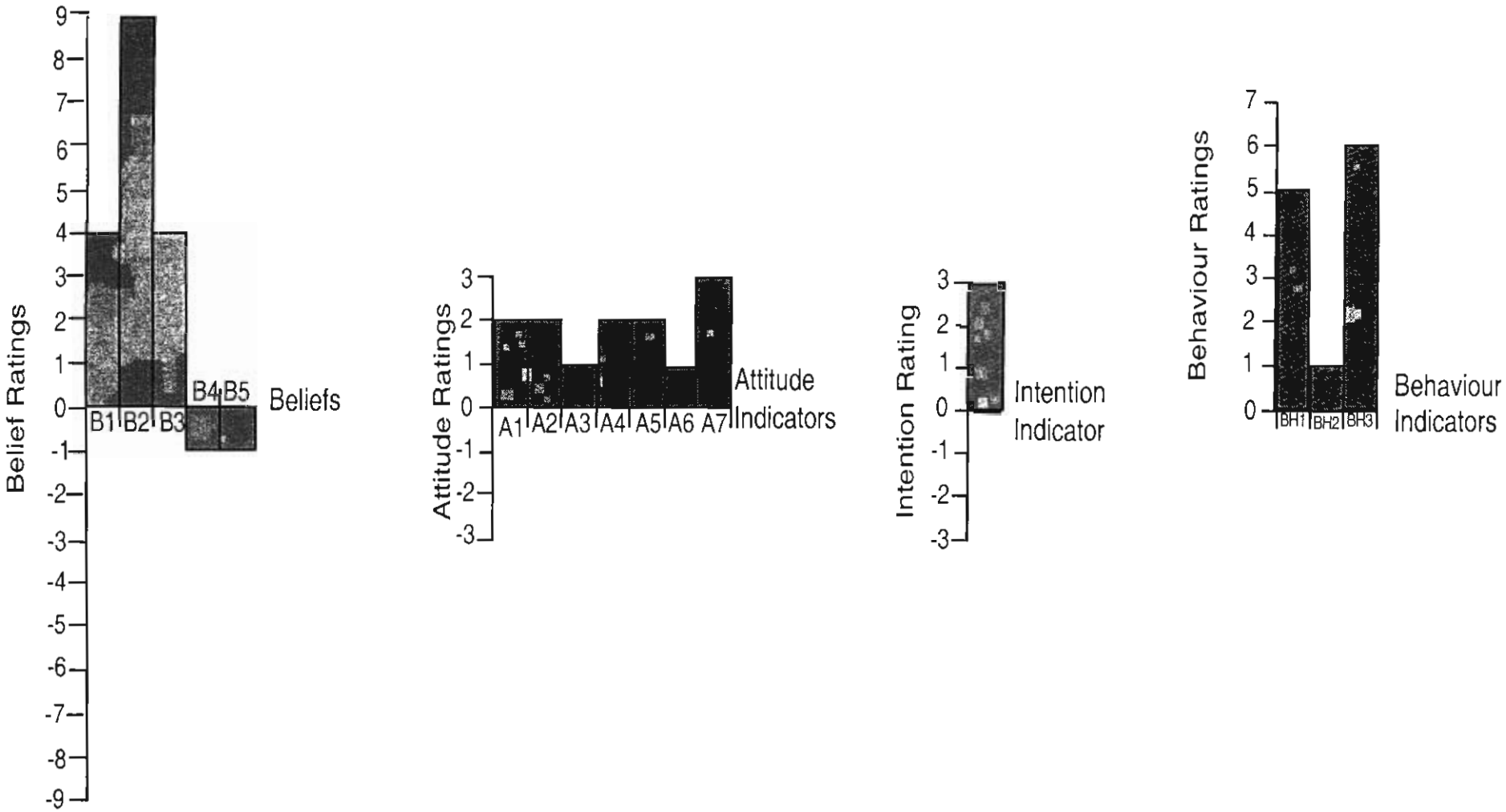

Figure C.5: Pattern of Results for KBS B Sales Representative User

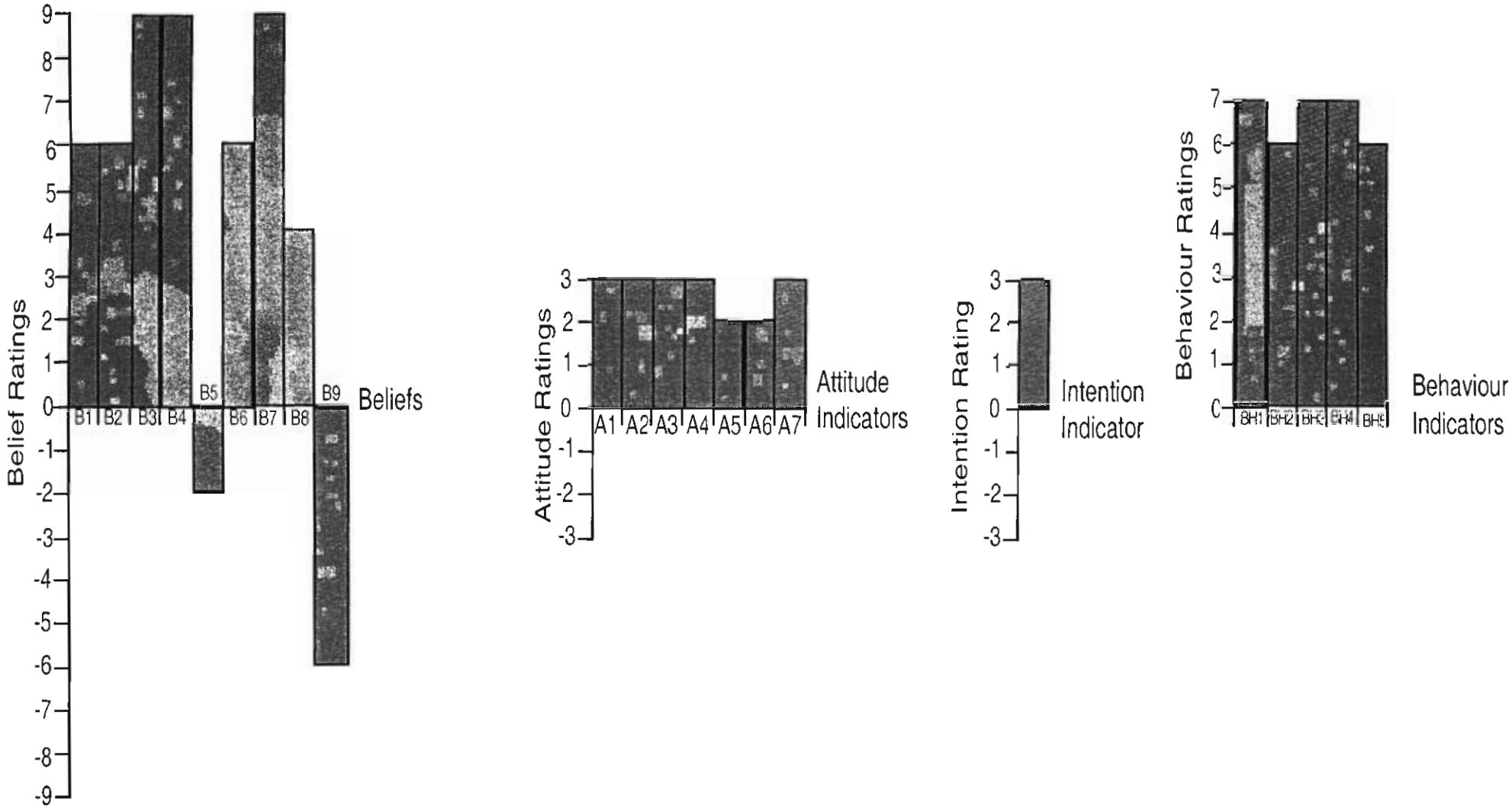

Figure C.6: Pattern of Results for KBS B Expert

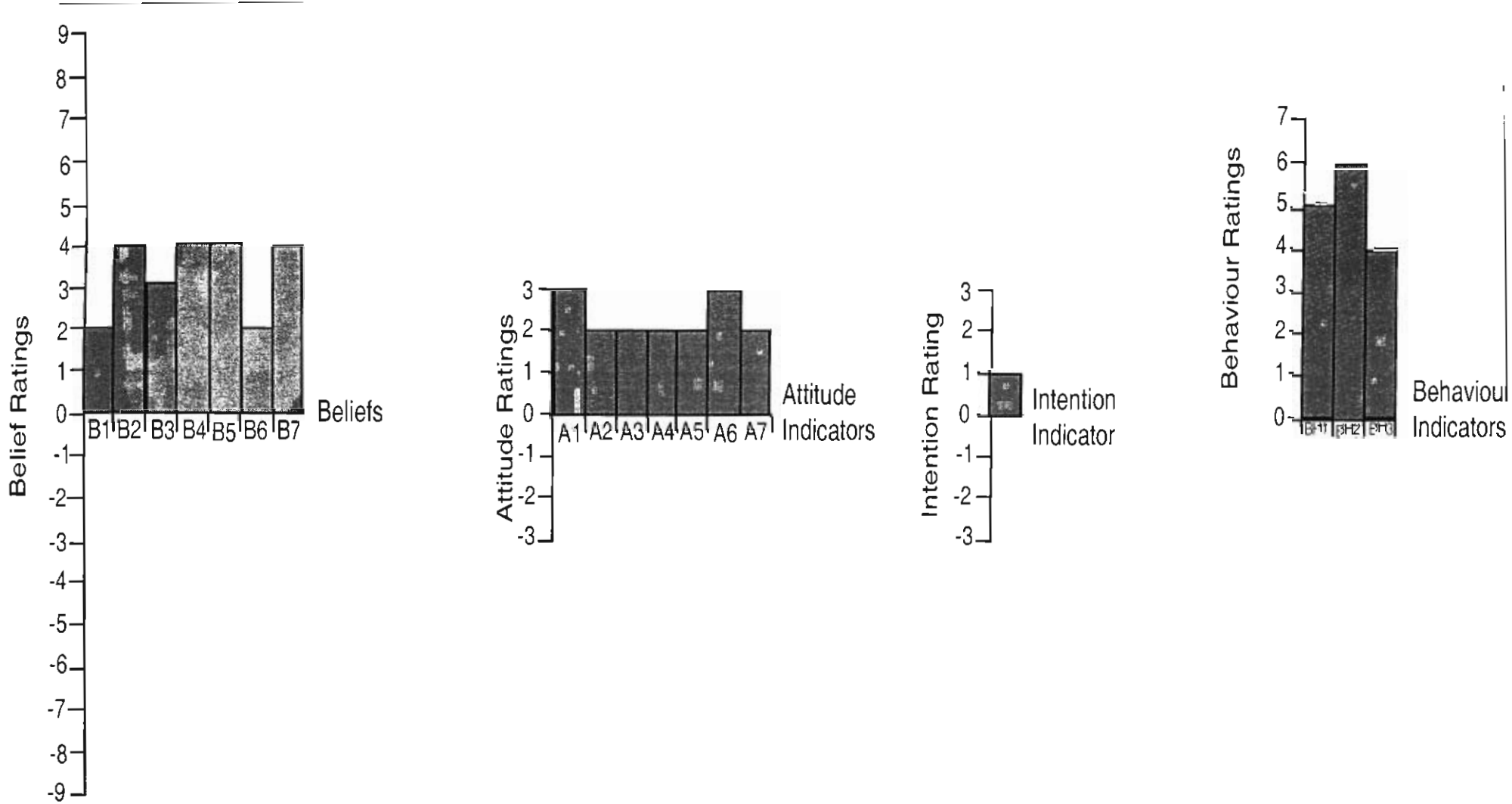

Figure C.7: Pattern of Results for KBS C Manager

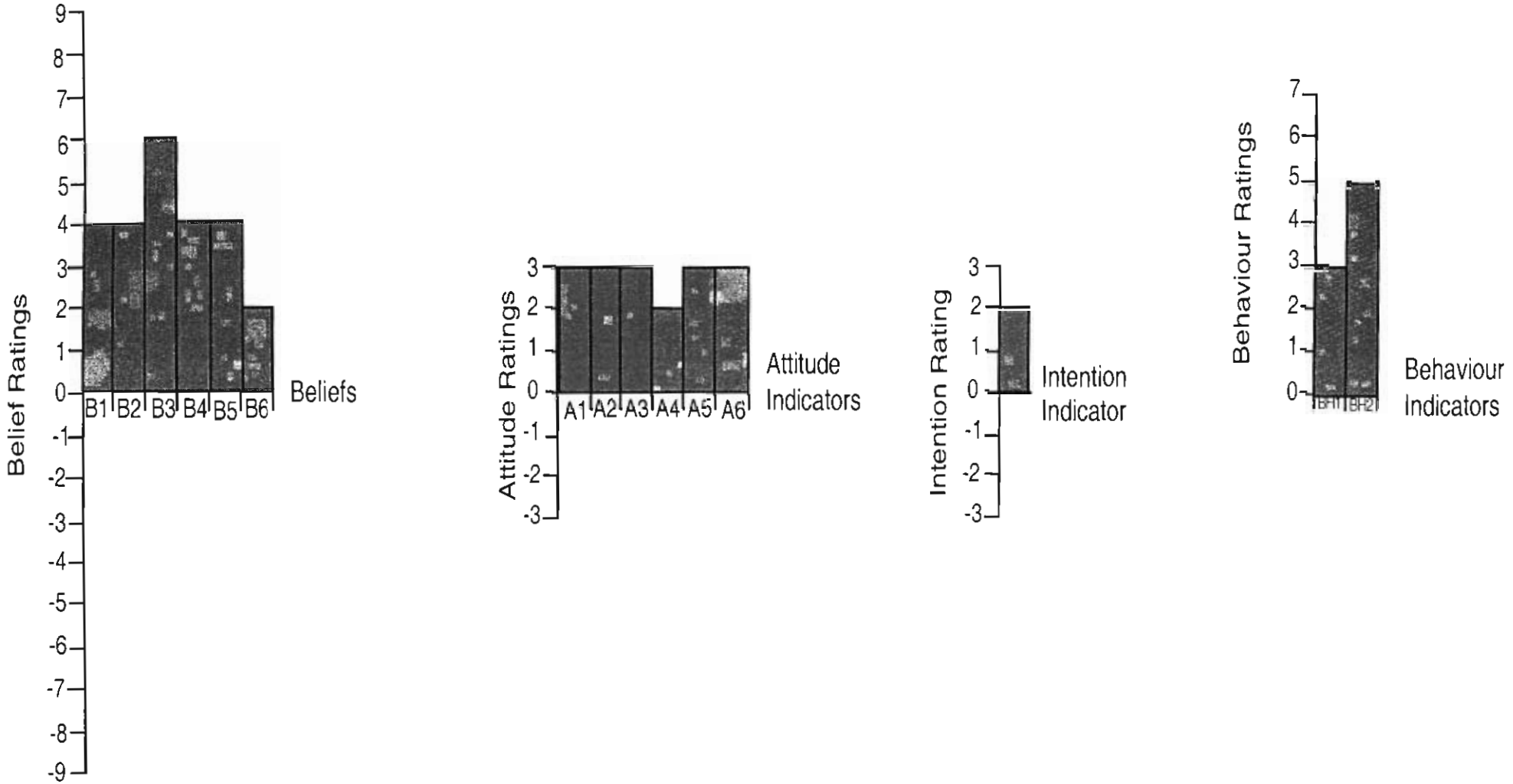

Figure C.8: Pattern of Results for KBS C User

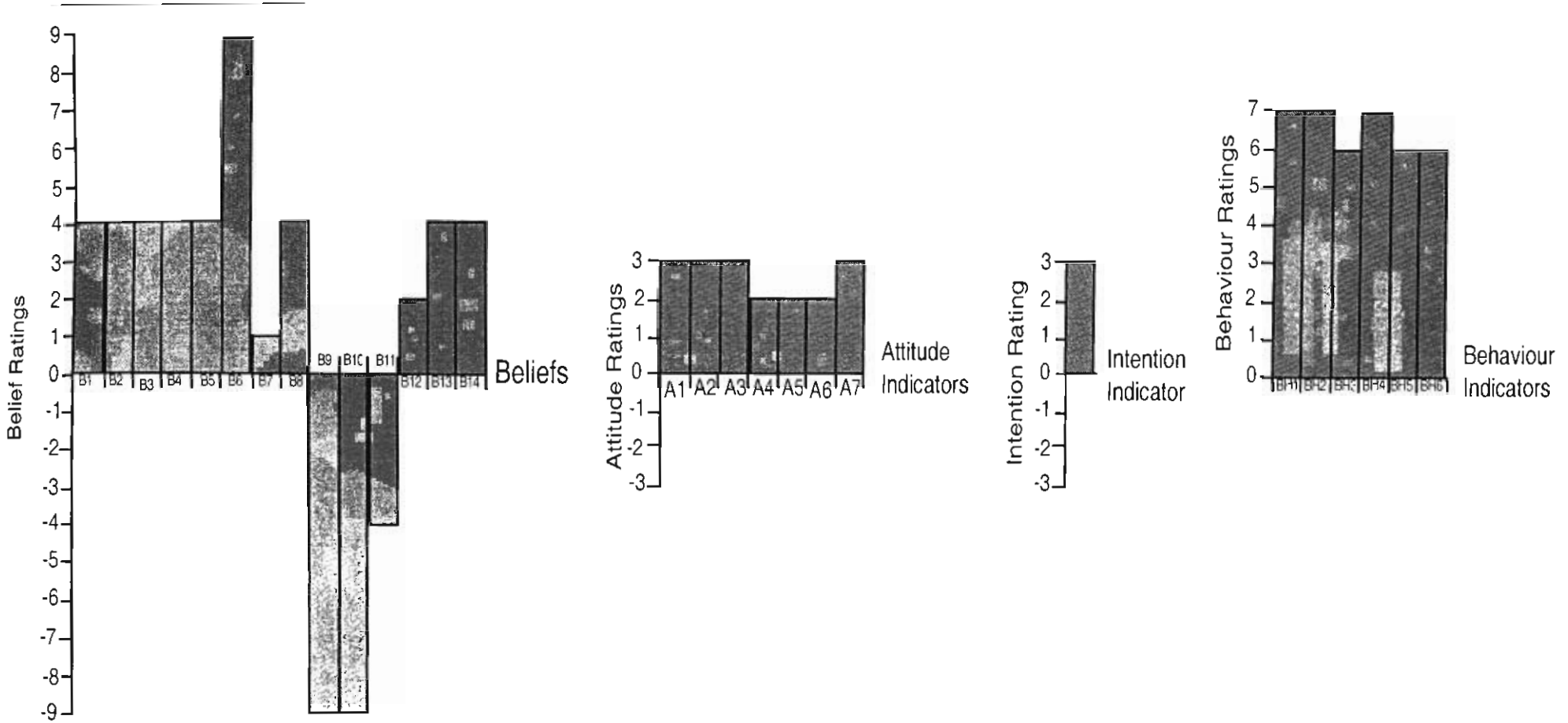

Figure C.9: Pattern of Results for KBS C Expert

Appendix D

KBS Value Graphs

Table D.1 KBS Value Graph for KBS A Manager

KBS A Manager	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
B1 KBS A will increase productivity of Organisation X staff						
Finance						
B2 KBS A will increase sales of electrical termination kits						
Quality						
B3 KBS A will improve customer service by providing advice over the phone						

Key

Cost/Benefit is slightly likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is extremely likely to occur

Table D.2 KBS Value Graph for KBS A Expert

KBS A Expert	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
B4 Less involvement by experts in kit selection						
Finance						
No Costs or Benefits						
Quality						
B2 Non technical users will understand the system's parameters						
B3 Non tech users know the correct information for using the system						
B1 Providing knowledge ensures that the correct material will be incorporated into kits						
B7 Providing knowledge to maintain KBS A will ensure the correct update of new products						
B8 Providing knowledge to maintain KBS A will ensure the correct input of new materials						
B5 Non technical users might input the incorrect information						
B6 Non Technical users might recommend the wrong kits						

Key

Cost/Benefit is slightly likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is extremely likely to occur

Table D.3 KBS Value Graph for KBS B Manager

KBS B Manager	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
B1 KBS B will provide a quick response to the customer's need						
B9 There is a time delay in KBS Bs response						
B11 The training time for sales representatives to use KBS B will be lengthy						
Finance						
B7 KBS B will Increase sales of Organisation X's respirators						
B10 There will be a high cost of hardware and software to implement KBS B						
Quality						
B5 KBS B provides documented product advice to customers						
B8 KBS B improves customer service						
B6 KBS B identifies new business leads						
B4 KBS B can be used as a sales tool by sales representatives						
B3 KBS B will increase control over end users						
B2 KBS B enables better utilisation of Technical Services personnel						

Key

Cost/Benefit is slightly likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is extremely likely to occur

Table D.4 KBS Value Graph for KBS B Telephonist User

KBS B Telephonist User	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
B4 KBS B allows sales and marketing employees to settle customer calls quickly						
Finance						
No costs or benefits						
Quality						
B6 KBS B provides documented recommendations to customers						
B7 KBS B will not answer all calls, some calls are transferred to technical services						
B2 KBS B provides consistent advice on respirators						
B1 Sales and marketing employees can now take customer questions on respirators						
B3 KBS B enables markets to be targeted						
B5 KBS B collects customer information						

Key

Cost/Benefit is slightly likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is extremely likely to occur

Table D.5 KBS Value Graph for KBS B Sales Representative User

KBS B User Sales Representative	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
B5 It takes a long time to enter in data to KBS B						
Finance						
B1 KBS B will Increase sales of respirator equipment						
Quality						
B2 KBS B provides correct information to customers						
B3 KBS B provides the customer with a range of alternative respirators to choose						
B4 KBS B provides the correct product, but at times the customer desires another product						

Key

Cost/Benefit is slightly likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is extremely likely to occur

Table D.6 KBS Value Graph for KBS B Expert

KBS B Expert	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
B1 KBS B frees up time to work on other tasks						
B6 Providing knowledge for maintenance will continue to save time for the expert						
B5 Providing knowledge for development was very time consuming						
B9 Providing knowledge for the maintenance of KBS B consumes time for other tasks						
Finance						
No costs or benefits						
Quality						
B2 KBS B answers simple customer questions about the best respirator for their needs						
B3 Providing knowledge for development proved that expert's knowledge is correct						
B4 KBS B enables customer service employees to provide respirator advice						
B7 Providing knowledge for maintenance means that sales staff can continue to give advice						
B8 Providing knowledge for maintenance gives the expert control of future versions of KBS B						

Key

Cost/Benefit is slightly likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is extremely likely to occur

Table D.7 KBS Value Graph for KBS C Manager

KBS C Manager	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
B1 KBS C reduces the amount of time spent by sales employees in product training						
Finance						
B2 KBS C ensures that Organisation X gets the premium price for its data storage products						
Quality						
B3 KBS C allows for product differentiation						
B4 KBS C helps to provide a qualified Organisation X sales force						
B5 KBS C helps to provide a qualified distributor sales force						
B6 KBS C helps to enhance Organisation X's professional image						
B7 KBS C helps to maintain Organisation X's market leadership in data storage products						

Key

Cost/Benefit is slightly likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is extremely likely to occur

Table D.8 KBS Value Graph for KBS C User

KBS C User	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
No Costs or Benefits						
Finance						
No Costs or Benefits						
Quality						
B1 KBS C taught me how to identify data storage products						
B2 KBS C taught me to know the capability of data storage products						
B3 KBS C expanded my knowledge of data storage products						
B4 KBS C helps me to understand what knowledgable customers are talking about						
B5 KBS C makes my job more interesting						
B6 KBS C enables me to answer more questions						

Key

Cost/Benefit is slightly likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is extremely likely to occur

Table D.9 KBS Value Graph for KBS C Expert

KBS C Expert	Value Ratings					
	Cost			Benefit		
	Extremely Costly	Quite Costly	Slightly Costly	Slightly Beneficial	Quite Beneficial	Extremely Beneficial
Time						
B1 KBS C relieves me of spending time on repetitious training						
B2 KBS C allows me more time to spend on business development						
B9 Development of KBS C required a lot of my time						
B10 Development of KBS C reduced the amount of time for other job functions						
B11 There is a lot of time pressure to update KBS C for subsequent releases						
Finance						
No Costs or Benefits						
Quality						
B3 KBS C increases reach of Organisation X's training to include distributors						
B4 KBS C reduces boredom in my job						
B5 KBS C has enhanced my standing in Organisation X						
B6 KBS C has broadened my qualifications in the area of Computer Based Training						
B7 KBS C has sharpened my knowledge of data storage products						
B8 KBS C ensures that the knowledge of data storage products is consistent for all users						
B12 Providing knowledge for maintenance motivates me to keep up-to-date						
B13 Providing knowledge for maintenance enables me to keep in touch with CBT[1] world						
B14 Providing knowledge for maintenance means easier distribution of new knowledge						

Key

Cost/Benefit is slightly likely to occur

Cost/Benefit is quite likely to occur

Cost/Benefit is extremely likely to occur

1 Computer Based Training (CBT)

Bibliography

Ajzen, I. (1988), *Attitudes, Personality, and Behaviour*, Open University Press, Milton Keynes.

Ajzen, I. and Fishbein, M. (1980), *Understanding Attitudes and Predicting Social Behavior*, Prentice-Hall, New Jersey.

Arkush, E. and Stanton, S. (1988), "Measuring the value of end-user computing", *Journal of Information Systems Management*, Vol 5 No 4, pp. 62-63.

Bentler, P. and Speckart, G. (1979), "Models of attitude-behaviour relations", *Psychological Review*, Vol 86 No 5, pp. 452-464.

Browne, M. (1993), *Organizational Decision Making and Information*, Ablex, New Jersey.

Canada, J. and Sullivan, W. (1990), "Persistent pitfalls and applicable approaches for justification of advanced manufacturing systems", *Engineering Costs & Production Economics*, Vol 18 No 3, pp. 247-253.

Clark, J. and Soliman, F. (1999), "A graphical method for assessing knowledge-based systems investments", *Journal of Logistics and Information Management*, Special Issue on IT/IS Investment Decision Making, Vol 12 Nos 1/2, pp. 63-77.

Clark, J. and Soliman, F. (1998), "A method in the valuation of expert systems - MEVES", *Proceedings of the 4th World Congress on Expert Systems*, Mexico City, Mexico, 16-20 March, pp. 428-433.

Clark, J. and Soliman, F. (1997), "Application of a method for measuring the value of knowledge-based systems to key employees", *Journal of Systems and Information Technology*, Vol 1 No 2, pp. 23-40.

Clark, J. and Soliman, F. (1996), "Appraising knowledge based system investments", *Proceedings of the Third European Conference on the Evaluation of Information Technology*, Bath, UK, 29 November, pp. 143-154.

Clark, J. and Soliman, F. (1995), "A conceptual model of the acceptance and organisational impact of knowledge-based systems", *Proceedings of the 1995 Pan Pacific Conference on Information Systems*, Singapore, 29 June - 2 July, pp. 248-253.

Clark, J. and Debenham, J. (1994), "The knowledge audit", *Robotics & Computer-Integrated Manufacturing*, Vol. 11, No 3, pp. 201 - 211.

Clark, J. (1992), "A framework for comparing knowledge based system design methodologies", *Proceedings of the 5th Australian Joint Conference on Artificial Intelligence*, Hobart, Australia, 16-18 November, pp. 311-316.

Compton, P. Edwards, G. Kang, B. Malor, R. Menzies, T. Preston, P. Srinivasan, A. and Sammut, C. (1991), "Ripple down rules: possibilities and limitations", *Proceedings of the Sixth AAAI Knowledge Acquisition for Knowledge-Based Systems Workshop*, Bannf, Canada, 10-15 July, pp. 6-20.

Corsten, H. and Will, T. (1995), "Integrated production concepts - structural reasons for superior competitive performance", *Management International Review* , Vol 35 No 1, pp. 68-88.

Cronk, M. and Fitzgerald, E. (1997), "A conceptual framework for furthering understanding of 'IT business value' and its dimensions", *Proceedings of the Pacific Asia Conference on Information Systems*, Brisbane, Australia, 1-5 April, pp. 405-413.

Davis, F. Bagozzi, R. and Warshaw, P. (1989), "User acceptance of computer technology: a comparison of two theoretical models", *Management Science*, Vol 35 No 8, pp. 982-1003.

Debenham, J. (1989), *Knowledge Systems Design*, Prentice Hall, Sydney.

Duchessi, P. O'Keefe, R. and O'Leary, D. (1993), "A research perspective: artificial intelligence, management and organizations", *Intelligent Systems in Accounting, Finance and Management*, Vol 2 No 5, pp. 151-159.

Eagly, A. and Chaiken, S. (1993), *The Psychology of Attitudes*, Harcourt Brace Jovanovich, Fort Worth.

Fishbein, M. and Ajzen, I. (1975), *Belief, Attitude, Intention, and Behavior : An Introduction to Theory and Research*, Addison-Wesley, Massachusetts.

Ford, J. (1994), "Evaluating Investment in IT", *Australian Accountant*, Vol. 64 No 11, pp. 23-28.

Gur-Arie, O., Durand R., and Beardon W., (1979), "Attitudinal and normative dimensions of opinion leaders and nonleaders", *Journal of Psychology*, Vol 91 No 5, pp. 305-312.

Hamilton, S. and Chervany, N. (1981a), "Evaluating information system effectiveness - part I: comparing evaluator viewpoints", *MIS Quarterly* Vol 5 No 4, pp. 55-69.

Hamilton, S. and Chervany, N. (1981 b), " Evaluating information system effectiveness - part II: comparing evaluator viewpoints", *MIS Quarterly* Vol 5 No 4, pp. 79-87

Harmon, P. Maus, R. and Morrissey, W. (1988), *Expert Systems Tools & Applications*, John Wiley & Sons, New York.

Hartwick, J. and Barki, H. (1994), "Explaining the role of user participation in information system use", *Management Science*, Vol 40 No 4, pp. 440-465.

Hauser, R. and Hebert, F. (1992), "Managerial issues in expert system implementation", *SAM Advanced Management Journal*, Vol 57 No 1, pp. 10-15.

Hayes-Roth, F. and Jacobstein, N. (1994), "The state of knowledge based systems", *Communications of the ACM*, Vol 37 No 3, pp. 27-39.

Judd, C., Smith, E. and Kidder, L. (1991), *Research Methods in Social Relations*, Holt Rinehart and Winstone, Fort Worth.

Kahn A, (1992), "Managing knowledge-based systems development using standard life-cycle techniques", in Turban, E, and Liebowitz, J. (Eds.), *Managing Expert Systems*, Idea Group Publishing, Harrisburg, pp. 120-159.

Keen, P. (1981), "Value analysis: justifying decision support systems". *MIS Quarterly*, Vol 5 No 1, pp. 1-15.

Kemerer, C., (1998), "Investigate all Options: Real-Options Analysis May Help Justify New Projects", *Information Week*, No 679 p. 170.

Lin, B. (1991), "Evaluating the investment in knowledge-based systems", *Human Systems Management*, Vol 10 No 2, pp. 91-106.

Mathieson, K. (1991), "Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior", *Information Systems Research*, Vol 2 No 3, pp. 173-191.

Maximov, J. and Gottschlich, H. (1993), "Time-cost-quality leadership: new ways to gain sustainable competitive advantage in retailing", *International Journal of Retailing & Distribution Management* , Vol 21 No 4, pp. 3-12.

Mazumdar, T. (1993), "A value-based orientation to new product planning", *Journal of Consumer Marketing*; Vol 10 No 1, pp. 28-41.

Meyer, M. and Curly, K. (1991), "An Applied framework for classifying the complexity of knowledge-based systems", *MIS Quarterly*, Vol 15 No 4, pp. 454-472.

Miniard P., and Cohen J., (1981), "An examination of the Fishbein-Ajzen behavioral intentions model's concepts and measures", *Journal of Experimental Social Psychology*, Vol 17 No 3, pp. 309-339.

Miniard, P. and Cohen, J. (1979), "Isolating attitudinal and normative influences in behavioural intentions models", *Journal of Marketing Research*, Vol 16 No 2, pp. 102-110.

Mintzberg, H. (1994), *The Rise and Fall of Strategic Planning*, Prentice Hall, London.

Mitev, N. (1996), "Convergence and divergence in information systems and knowledge based systems development methodologies: a Case for integrated strategic planning", *European Journal of Information Systems*, Vol No. 4, pp. 237-247.

Monczka, R. and Trent, R. (1991), "Evolving sourcing strategies for the 1990's" *International Journal of Physical Distribution & Logistics Management*, Vol 21 No 5, pp. 4-12.

Morgan, D. (1991), *Focus Groups as Qualitative Research*, Sage, Thousand Oaks.

Mumford, E. (1987), "Managerial expert systems and organizational change: some critical research issues", in Boland, R. and Hirschheim, R. (eds.), *Critical Issues in Information Systems Research*, John Wiley & Sons, Chichester, pp. 135-155.

Nelson, C. (1986), " A scoring model for flexible manufacturing systems project selection", *European Journal of Operational Research*, Vol 24 No 3, pp. 346-359.

O'Keefe, R. (1989), "The evaluation of decision-aiding systems: guidelines and methods", *Information & Management,* Vol 17 No 4, pp. 217-226.

O'Leary, D. and Turban, E. (1987), "The organizational impact of expert systems", *Human Systems Management*, Vol 7 No 1, pp. 11-19.

Oliver, R. and Bearden, W. (1985), "Crossover effects in the theory of reasoned action: a moderating influence attempt", *Journal of Consumer Research*, Vol 12 No 12, pp. 324-340.

Pengelly, A. Norris, M. and Higham, R. (1993), "Software modelling and measurement: a QMS case study", *Information and Software Technology*, Vol 35 No 6, pp. 375-380.

Pienaar, A. Kruger, P. and Adenorff, K. (1986), "An evaluation model for quantifying system value", *IIE Transactions*, Vol 18, No 1, pp. 10-15.

Prerau, D. (1990), *Developing Expert Systems: Proven Techniques for Business and Industry*, Addison-Wesley, Massachusetts.

Reddy, N. (1991), "Defining product value in industrial markets", *Management Decision*, Vol 29 No 1, pp. 14-19.

Robson, C. (1995), *Real World Research: A Resource for Social Scientists and Practitioner-Researchers*, Blackwell Publishers, Massachusetts.

Ross, L. (1977), "The intuitive psychologist and his shortcomings", in Berkowitz, L. (Ed.), *Advances in Experimental Social Psychology* Vol. 10, Academic Press, New York, pp. 173-220.

Ryan, M. (1982) "Behavioral intention formation: the interdependency of attitudinal and social influence variables", *Journal of Consumer Research*, Vol 9 No 12, pp. 263-278.

Sharman, P. (1995), "How to implement performance measurement in your organization", *Cost & Management*, Vol 69 No 4, pp. 33-38.

Sheppard, B. Hartwick, J. and Warshaw, P. (1988), "The theory of reasoned action: a meta-analysis of past research with recommendations for modifications and future research", *Journal of Consumer Research*, Vol 15 No 12, pp. 325-343.

Shimp, T. and Kavas, A. (1984), "The theory of reasoned action applied to coupon usage", *Journal of Consumer Research*, Vol 11 No 12, pp. 795-809.

Smith, A. and Dagli, C. (1992), "Analysis of worth" in Turban, E. and Liebowitz, J. (Eds.), *Managing Expert Systems*, Idea Group Publishing, Harrisburg, pp. 60 - 83.

Stockdale, A. and Wood, A. (1992), "Building a small expert system for a routine task: a case study", *Management Decision* , Vol 30 No 3, pp. 46-48.

Sullivan, W. (1986), "Models IEs can use to include strategic, non-monetary factors in automation decisions", *Industrial Engineering*, Vol 18, No. 3, pp. 42-51.

Sviokla, J. (1990), "An examination of the impact of expert systems on the firm: the case of XCON", *MIS Quarterly*, Vol 14 No 2, pp. 127-140.

Sykes, W. (1990), "Validity and Reliability in Qualitative Market Research: A Review of the Literature", *Journal of the Market Research Society*, Vol 32 No 3, pp. 289-328.

Szilagyi, A. (1988), *Management & Performance*, Scott, Forresman and Company, Glenview.

Taylor, B. and Graham, C. (1992), "Information for strategic management", *Management Accounting*, Vol 70 No 1, pp. 52-54.

Taylor, S. and Todd, P. (1995 a), "Decomposition and crossover effects in the theory of planned behaviour: a study of consumer adoption intentions", *International Journal of Research in Marketing*, Vol 12 No 2, pp. 137-155.

Taylor, S. and Todd, P. (1995 b), "Assessing IT usage: the role of prior experience", *MIS Quarterly*, Vol 19 No 4, pp. 561-570.

Troxler, J. and Blank, L. (1989), "A comprehensive methodology for manufacturing system evaluation and comparison", *Journal of Manufacturing Systems*, Vol 8 No 3, pp. 175-183.

Turban, E. (1988), "Review of expert systems technology", *IEEE Transactions on Engineering Management*, Vol 35 No 2, pp. 71-81.

Turban, E. (1995), *Decision Support and Expert Systems: Management Support Systems*, Macmillan, New York.

Walczak, S. and McNally, K. (1998), "An object-oriented approach to graphical knowledge acquisition", *Proceedings of the 4th World Congress on Expert Systems*, Mexico City, Mexico, 16-20 March, pp. 495-499.

Warshaw, P. (1980), "A new model for predicting behavioral intentions: an alternative to Fishbein", *Journal of Marketing Research*, Vol 17 No 5, pp. 153-172.

Weitz, R. and De Meyer, A. (1990), "Managing expert systems: a framework and case study", *Information & Management*, Vol 19 No 2, pp. 115-131.

Yin, R. (1989), *Case Study Research Design and Methods*, Sage, Thousand Oaks.

Yin, R. (1994), *Case Study Research Design and Methods*, Sage, Thousand Oaks.

Zeithaml, V. (1988), "Consumer perceptions of price, quality, and value: a means-end model and synthesis of evidence", *Journal of Marketing*, Vol 52 No 7, pp. 2-22.