An empirical analysis of knowledge management applications

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Abstract *The aim of this paper is to improve the understanding and inter-relationship of both the people and technical aspects of knowledge management. Studies in knowledge management indicate that there can be an over-emphasis on technology to the exclusion of adequate people/quality planning, or, strong people/quality programmes from a knowledge perspective, hindered by inadequate enabling technologies. Understanding of these issues in practice and academia is currently hindered by a paucity of systematic empirical research, addressing the relationship between the cultural and technological aspects of knowledge management. A survey questionnaire was constructed and tested via a pilot phase. The questionnaire was then distributed to over 1,000 organizations, across three industrial sectors. The findings indicate that a strong relationship exists between KM and other organizational factors, namely organizational culture and internal technical culture. Further analysis of these elements revealed that factors internal to the organization are impinged upon by macro-environmental elements.*

Keywords *Knowledge management, Organizational culture, Technology, Information*

Introduction

As knowledge management (KM) has its origins in a number of related business improvement areas, such as total quality management (TQM), business process re-engineering (BPR), information systems (IS) and human resource development (HR), many organizations have found that tensions exist between knowledge-orientated applications and the progression of organizational change. This antagonism often results from either an overemphasis on technology to the exclusion of adequate people/quality planning, or, strong people/quality programmes from a knowledge perspective, hindered by inadequate enabling technologies. Understanding of these issues in practice and academia is currently hindered by a paucity of systematic empirical research, addressing the relationship between the cultural and technological aspects of KM. Thus, there is a need for a rigorous theory-building/theory-testing research program, to inform organizational application and to contribute to the body of knowledge within the KM spectrum.

The authors have been involved in an industrial/university partnership study; this resulted in the successful completion of a Doctoral thesis. The research program consisted of two parts. First, the theory-building phase was based on exploratory investigation. Research was conducted using a number of methodological approaches, such as ethnography, social constructionism, semi-structured interviews and empirical surveys. The findings from this research, of which key elements are outlined in this paper, led to the development of a prescriptive, conceptual model

for KM implementation. Second, theory-testing was conducted to test and refine the derived model using large survey empirical analysis.

The aim of this paper is to describe the KM model and to portray the results of latter part of the research, with a view to improving the understanding and inter-relationship of both the people and technical aspects of KM.

Key factors for knowledge management

To build a conceptual model for KM that adequately expressed the relationships between technological and cultural factors, an in-depth analysis of existing literature was conducted; this enabled key organizational characteristics related to KM to be identified. These factors, described as follows, are the main elements in the construction of the conceptual model.

Macro-environment

Organizations exist within an ''open'' system (Ward, 1994) where features external to the organization influence the internal operation of the organization. These influences can include takeovers, changes in legislation, market regulation/deregulation, competition, joint ventures and pressure groups. Changes in the macro-environment have a consequent effect on organizations. Obeng and Crainer (1996) describe the stages which an organization may encounter when faced with external influences. These resultant stages range from relative stability to complete chaos. Obeng and Crainer (1996) state that when an organization is existing on the edge of chaos, reacting to an unstable macro-environment, it has the ability to initiate change building on previous business improvement developments, namely, TQM and BPR initiatives.

Therefore, by addressing the continuity and tradition of existing organization states, replacing old with new, an organization will change. This change must be managed. KM offers a framework for systematic organizational change. As the core of KM is to foster collaborative practices, the application of KM should lead to the implementation of a well-managed change program, responsive to the external environment.

Organizational culture

Organizational culture as a concept is considered to be a key element of managing organizational change and renewal (Pettigrew, 1990). According to Handy (1989) and Peters and Waterman (1982), human elements comprised in culture are regarded as key determinants of both effective business performance and the management of change. Therefore, to change an organizations' culture, the people values, norms and attitudes must be amended so that they make the right contribution to the collective culture of the organization. These changes must address any inherent conflict between individual and group interests and the manner of structuring power, authority and control within the organization (Meek, 1988). Crosby (1986) states: ''Changing a culture is not a matter of teaching people a bunch of new techniques . . . it is a matter of exchanging values and providing role models . . . changing attitudes''.

Smiricich (1983) classifies culture in two ways. First, something the organization ''has'' and can control or direct at will. Second, something the organization ''is''. Kilmann *et al.* (1986) develop this view by describing culture as something that lies between what is formally agreed and what actually takes place. The same principle can apply to KM. First, an organization can have a knowledge culture where KM is expressed through the application of various knowledge initiatives, tools and techniques. Second, an organization can ''be'' a knowledge organization. This entity occurs when KM is totally ingrained within the operations of the organization. Hence, a knowledge culture has been adopted throughout the organization.

“ KM should lead to the implementation of a well-managed change program, responsive to the external environment. ”

Thus knowledge-orientated culture challenges people to share knowledge throughout the organization (Davenport and Prusak, 1998). A culture of confidence and trust is required to encourage the application and development of knowledge within an organization (Scarborough *et al.*, 1999).

People

People, or employees, in an organization usually conform to the culture of the organization. Changes in an organizations' culture places demands on employees to change their mindsets and break with past traditions. Thus, within the field of organizational change resulting from KM, human issues must be considered as a key factor.

This consideration has given rise to the ''knowledge worker'' in organizations. Key influences on this concept are increased information technology, a shift in markets away from labor intensive manufacturing and an increase in third level education opportunities (Zuboff, 1988; Burgoyne and Reynolds, 1998; Scarborough *et al.*, 1999). Although the concept of knowledge workers has existed for some time, very few organizations have systematically defined this role. Amongst those organizations which have advanced the role of knowledge workers, a new range of job titles have emerged, such as chief knowledge officers, community of practice coordinators and chief learning officers.

Much of the work of KM takes place in organizational projects (Davenport and Prusak, 1998). Within such projects Davenport *et al.* (1996) suggest the characteristics of successful KM teams. These have clearly defined objectives, adequate resources and focus on knowledge, with a team orientation.

Effective dialogue within a KM team is essential if knowledge is to be embodied and disseminated (Demerest, 1997). Peters (1992) calls for ''less formal meetings and a more effective flow of dialog in organizations''.

Phillips (1994) believes this can be developed by creating trusting and meaningful relationships within the team. Burgoyne and Reynolds (1998) see the need to use dialog to facilitate processes directed at the creation, questioning and development of knowledge in organizations. Webber (1993) also views dialog among team members as a key part of KM: ''Dialog and conversations are the most important form of work. Conversations are the way knowledge workers discover what they know and share it with their colleagues''.

Quintas *et al.* (1997) see effective dialogue developing the ''corporate memory'' of the organization.

Technology

KM seeks to develop a strategy for the capture, use and transfer of knowledge across the organization, to improve efficiency and increase competitive edge (Demerest, 1997). It is concerned with embracing a diversity of knowledge sources and cultivating knowledge wherever it resides. Technology can be viewed as both a key contributor and enabler to the field of KM (Davenport and Prusak, 1998). This perspective is related to technological ability in capturing data, information, and knowledge that surpasses human capacity in absorbing and analyzing these, in a focused manner (Shenk, 1997). Richards (1998) supports this point: ''Our technological capability has outpaced our social capability. This makes us look like social incompetents in charge of increasingly under utilized knowledge''.

As technological developments become more advanced in application and utilization, it is emerging that employees who have access to technologies that detect and manage business opportunities, will have the distinct advantage of exploiting market shifts. Martin (1998) emphasizes this point: ''Human expertise is amplified by computers. Software is an encapsulation of knowledge. Knowledge, constantly renewed and enhanced, is the primary source of competitive advantage''.

Although the technological arena has received much publicity in recent years, confusion still exists over its implications for KM. One of the main reasons for this has been the re-packaging of software applications under the KM label. While KM technologies may incorporate

> “ Human issues must be considered as a key factor. ”

characteristics of traditional data and information technologies, they also extend these capabilities. Knowledge technologies attempt to push users to think beyond their current boundaries, thus facilitating organizational activity, promoting continuous improvement and growth through innovation.

Explicit and systematic management of knowledge has emerged as a result of several developments, including that of information communication technology (ICT). Technology within KM can be seen to have evolved through three phases, namely mainframe, personal computer (PC) and networking (Davis, 1994; Abecker *et al.*, 1987; Peppard, 1993; Sprague and Watson, 1997). While the three areas are cumulative and inter-dependent, the latter has become the dominant model, offering a widely inter-connected macro-environment that influences business opportunity and strategy (Ward and Griffiths, 1996; Wiseman, 1986). Contributory factors to this evolutionary process include:

- standardization which gave rise to new customizable, technological mass market;
- operating systems functional within familiar environments through graphical user interfaces (GUIs);
- a shift from bespoke applications to new generic software tools customizable by the user;
- significantly reduced I.T. costs thus allowing individuals and small to medium sized enterprises (SMEs) to participate in the technological revolution;
- networks that provide accessible and empowered channels of communication; and
- an increase in ICT literacy.

In today's knowledge-intensive organizations the primary objective of ICT is to lead users to the information they need. This includes creating, gathering, storing, accessing and making available the right information that will result in insight for the organizations' users (Davenport and Prusak, 1998). Thus, the pervasive use of information technology in organizations, qualifies it as a natural medium for information flow (Borghoff and Pareschi, 1999).

The main challenges facing organizational change and development are threefold: knowledge discovery, corporate collaboration, and rapid decision making (Curley, 1998). In addition, recent infrastructure changes have made a significant and positive impact on an organization's ability and desire to manage knowledge. Thus, there is a need to comprehend the extent to which knowledge can be shared throughout an organization. A study from the American Productivity and Quality Centre (1997) highlights this point. Results from the study portray that organizations embarking on KM initiatives feel that a suitable IT infrastructure must be established to enable them to successfully accomplish their goals.

Technology alone will not lead to a KM culture (Davenport and Prusak, 1998). However, a well-designed, standardized, fully implemented technical infrastructure for KM can improve information processing capabilities, knowledge discovery, project collaboration and rapid decision making within organizations. This in turn encourages a cultural shift, as stated by Lank (1997): ''The organizations that are best at knowledge sharing are not necessarily those with the best technology infrastructure. But they do have a culture of teamwork and trust. If you have that culture and put in tools to help knowledge flow quickly around the organization, you have a hugely powerful combination''.

Theory building research methodology

Identification of the key literary components of KM facilitated further research via a series of exploratory survey-based, ethnographic, and social constructionist research studies. The first element of this study involved using an investigative questionnaire to survey the scope of KM in regard to key trends. The survey data was used purely for quantitative analysis and not to

establish reasons and meanings. The questionnaire was based on key areas of interest in KM identified from the literature study, namely:

- defining KM;
- business benefits and KM;
- knowledge capture;
- people development and KM;
- technology, tools and techniques; and
- future trends.

A total of 296 questionnaires were distributed to organizations that had developed TQM programmes and were therefore more likely to have considered KM.

From analysis of the survey data, key elements of KM in the participant organizations were identified. To probe the reasons and meanings relating to each area it was decided to use qualitative participative workshops at this stage in the research process. The survey data had already shown who was willing to participate in the workshops, which were run as a social constuctionist approach (where the group negotiate meaning in relation to a topic or issue, Easterby-Smith and Thorpe, 1997). This approach is consistent with the overall idea of constructing knowledge socially. Throughout this period of data gathering and analysis a university/industry partnership with a leading organization in the field of KM enabled the researchers to gather valuable ethnographic data.

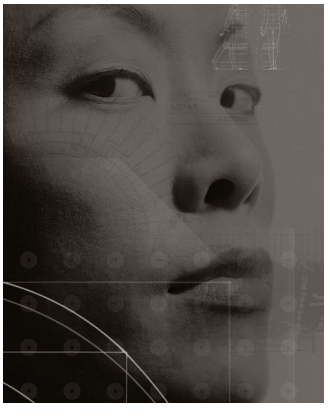
All of the above data is not presented in this paper, due to space constraints; further information on the results of this process can be obtained from McAdam and McCreedy (1999, 2000).

The MeCTIP model

Application of the key factors uncovered via the exploratory research enabled a prescriptive, conceptual model of KM to be postulated. This model is known as the MeCTIP model.

The MeCTIP model aims to portray the transformation of organizations by prescribing source-level improvements that will contribute to knowledge-based activities. Therefore, the MeCTIP model not only describes current organization standing but predicts how organizations can optimize business performance through KM implementation. Five factors that influence adoption of KM within organizations were outlined; these five were used to build the MeCTIP model. The name of the model is an acronym of the components of the model, namely:

Me macro environment;
C culture;
T technology;
I information; and
P people.

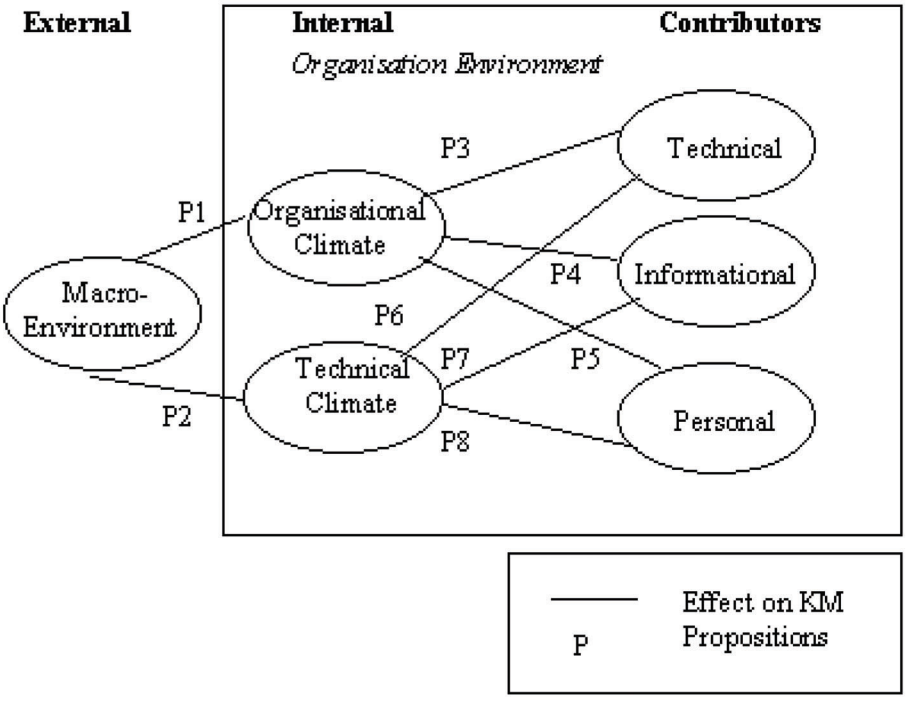


The MeCTIP model is shown in Figure 1.

Within the context of the model constructs are defined as:

- **Macro-environment** – includes economic, technical and social agents of change. These include globalization, technological development, partnerships and alliances, customer-focus knowledge markets and rise of the electronic economy.
- **Organizational climate** – includes organizational structure, strategy, goals, culture, employee emancipation, change management and business improvement initiatives.
- **Internal technical climate** – includes technological infrastructure and response to technical change.
- **Technical contributors** – includes system standardization and compatibility, technical usability, and technological tools for KM.

Figure 1 MeCTIP model



- **Informational contributors** – includes information fatique, infofamine, infoglut, knowledge silos and power-bases and information auditing.
- **Personal contributors** – includes knowledge roles and skills, motivation and self-reflection, empowerment, learning networks and communities of practice, dialogue, collaboration and innovation.

The MeCTIP model, as shown in Figure 1, first portrays the relationships between external and internal factors of an organization (P1 and P2); an event occurring in the macro-environment (external to organization) may impact upon the organizational and technical characteristics of the business. Second, Figure 1 presents relationships internal to the organization environment. A change in organizational and/or technical events can affect internal characteristics that contribute to KM, namely, people, information and technology (P3-P8). Thus, the MeCTIP model is beneficial to KM research as it clearly outlines key components of the field and the relationships that exist between these elements. The impact of KM activity within a particular area can be determined quickly, for example, a change in the macro-environment (such as the introduction of the Internet) that impinges upon organizational climate, may cause a direct effect on technical, informational and personal elements of the organization (P1, P3, P4 and P5).

Theory testing research methodology

To test the validity of theory of the MeCTIP model, a tool for measuring the relationships between the various KM components was devised. This paper-based tool, entitled ''Benchmarking knowledge management'' took the form of a postal questionnaire. This study undertook a traditional, cross-sectional approach to survey implementation. To gain an understanding of how empirical research had previously been applied within the KM field, an extensive literature review was conducted, along with secondary exploratory research. This process highlighted limited theoretical support for research of this kind within the KM arena, thus outlining the difficulty of justifying any broad research findings. Another factor to be considered is the fact that each industrial sector must operate within its own unique environment. Thus, cross-sectional results on a broad scale KM study would not be valid, under

scrutiny, as generalizable to all industrial sectors. To overcome this limitation the survey population was reduced to a more controlled group. Concentration was awarded to three industrial sectors, namely, engineering, retailing and technology.

The ''Benchmarking knowledge management'' questionnaire consisted of 34 questions subdivided into 11 sections (see Table I). A comment section was also included to offer respondents the opportunity to express views on the questionnaire in general or on a specific area that they felt had not been adequately addressed. To select sample candidates a number of trade directories were referred to. These included *The Times Top 1,000 British Companies*, *Major and Minor Companies in the UK*, *Kompass – A Directory of UK Companies*, *The Top 100 Northern Ireland Business Directory* and *Who's Who in Business 2000*. Organizations within the chosen three industrial sectors were selected at random from these sources. Contact details of suitable organizations, such as industrial sector, name of organization, address, postcode, telephone number, activity of organization and key personnel were entered into a database held on Microsoft Access version 7.0.

From the total list of entries six batch files were devised in alphabetical order. This process facilitated administering the survey. First, organizations in each batch were contacted by telephone to confirm contact details and to introduce the survey. This technique has successfully been applied by a number of researchers. One example is that of Jobber *et al.* (1985) who raised response rates from 27 percent to 43 percent by the use of a prior telephone call to a sample of quality control managers. The survey was then sent via the postal service; each package was marked for the attention of the managing director to be distributed as appropriate. A covering letter on University letterhead, a pre-paid envelope and a questionnaire were mailed to 1,004 organizations selected from the sample framework.

If questionnaires were not completed and returned by the specified deadline follow up action was taken. This included telephone contact and a second mailing to non-respondents. The second mailing included a revised cover letter, a copy of the original letter, a pre-paid envelope and a copy of the questionnaire. Through the use of a special coding system on the questionnaire, all non-respondents could be identified. This avoided unnecessary mailing to those who had already responded.

In an attempt to further increase the response rate, the small incentive of a copy of the research findings was promised to the candidates on receipt of their completed questionnaire. From this report each organization is able to benchmark their original answers against industrial peers. In addition each respondent was entered into a raffle for a free ''electronic commerce short course'' courtesy of the University of Ulster. The offer of a small token gift has been known to increase survey response rates (Heberlein and Baugartner, 1978).

Pilot study

To pre-test the mail questionnaire, a pilot study was undertaken. First, the questionnaire was subjected to critical review by five academics from within the fields of marketing, business and

Table I Analysis of questionnaire

Sections	*Heading*	*No of questions*
A	General information	2
B	Using information effectively	1
C	ICT	5
D	How we work in this company	1 (3 subsections)
E	Organization strategy	6
F	Organization structure	1
G	Decision making	2
H	Changing work practices	1
I	Training and development	5
J	Appraisal systems	4
K	Background information	6

management and informatics. Following the necessary revisions, the survey was piloted with eight organizations; a total of 21 practitioners took part in the review process. The organizations selected were representative of the population being subjected to the survey. To gain an accurate and valid critique of the questionnaire, organizational members at management, middle management, and administration level were selected as part of the pilot group. This gave an insight into issues of concern for organizational, group and individual levels. Only minor changes were required to the questionnaire after this stage.

Survey response

The usable response rate for the KM survey, after completion of the follow-up mailings, is 9 percent of the population. This figure is reflective of the immaturity of the KM field. A total of 61 percent of respondents voluntarily identified themselves by requesting survey results. This figure reflects respondents have a high level of interest in the subject area. Table II illustrates a breakdown of survey responses.

A concern to all researchers is the matter of explaining non-respondents. From Table I we can extract that the total number of non-respondents was 860. This represented 86 percent of the total population. Written replies were received from 42 non-respondents stating that it was company policy not to complete surveys. A total of 14 organizations no longer existed when contacted by telephone follow up. Others, contacted by follow up action, offered vague promises to complete the questionnaires but failed to do by the final submission deadline.

Data analysis – descriptive statistics

To provide statistical support for research propositions and questions, data gathered for the research was analyzed using a number of statistical techniques processed through SPSS version 9. Standard procedures for data entry and cleaning were applied. General descriptive statistics were selected as the appropriate analytical tool for a number of the questions. The remainder of this section refers to the results of descriptive analysis. Statistical application of this type permits summarization of complex data to facilitate data interpretation (Rose and Sullivan, 1993).

Figures 2 and 3 display in pictorial format the frequency/percentage distributions of organizations that responded to the survey. These are displayed on the basis of industrial sector and number of employees respectively. The respondents belonged to two main industrial sectors, namely engineering (39 percent) and technology (32 percent). Retail organizations accounted for 18 percent of the total population. The remaining 11 percent were formed by organizations that could not be easily categorized under one of the three headings but still contributed to the sample, for example an organization that retails technological products.

The majority of respondents were from either small-medium sized organizations (31 percent) or large corporations (34 percent). This indicates that these types of organizations are more focused on incorporating Knowledge Management. This could be contributed to the

Table II Survey response rates

Batch no.	*Alphabetical letters*	*Number of organization*	*Number of responses*	*Number completed*	*Number uncompleted*
1	A-B	152	28	16	12
2	C-E	200	33	19	14
3	F-I	181	21	15	6
4	J-N	179	25	15	10
5	O-R	109	8	7	1
6	S-Z	183	29	16	13
Total		1,004	144	88	56

Percentage of total responses = 14.34
Percentage of usable responses = 8.76

Figure 2 Number of employees

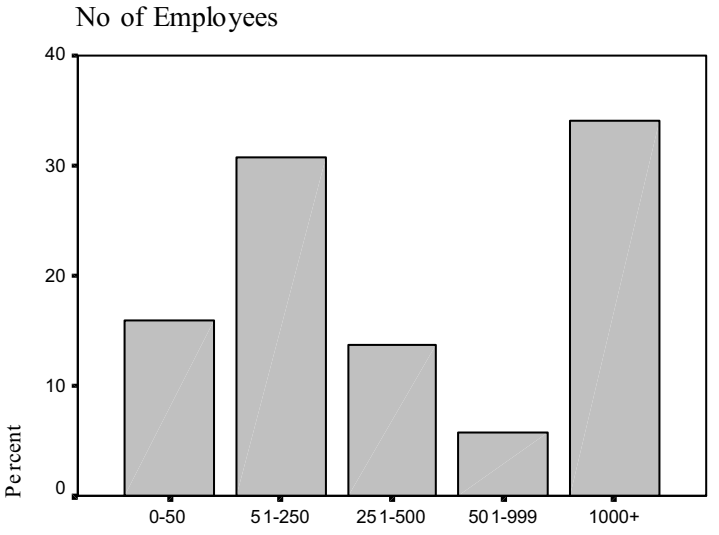
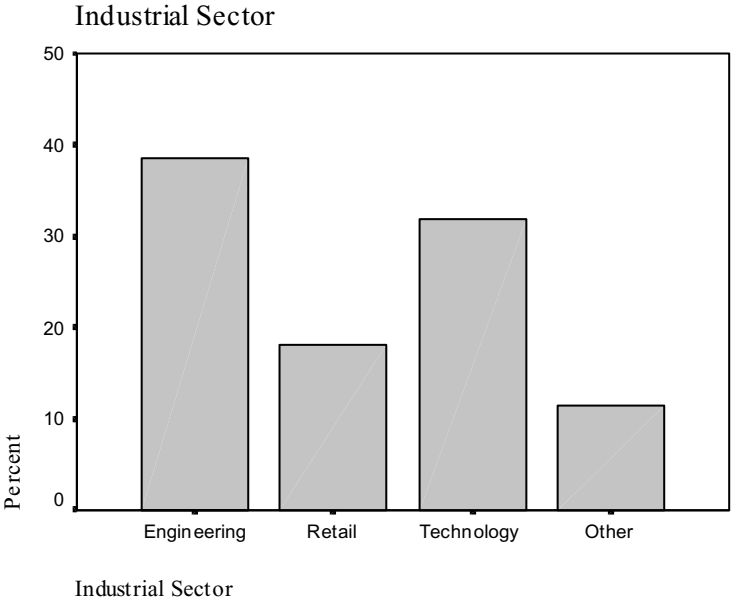


Figure 3 Frequency of employees



effects of socialization, where smaller organizations (especially in the developing bracket of 51-250 employees) need to focus on face-to-face knowledge share, and globalization, when larger organizations are operating across geographical boundaries. Further analysis of organization type indicated that over half of the respondents were limited companies (51 percent), closely followed by public limited companies (43 percent). This corresponds with the above results.

Further insight into the organizations was gained by assessing market stage. A large percentage of the respondents (61 percent) operated within mature markets. Only 1 percent of organizations were in the introductory stage, while 28 percent were in growth. From these figures one can ascertain that the majority of organizations who responded to the survey are

looking to KM as a business improvement initiative and a way to sustain or increase market share. These figures are presented diagrammatically in Figure 4.

As 90 percent of the organizations are in growth or mature stages, it is not surprising that they are profitable. A total of 41 percent of respondents earned profits well in excess of costs, while 40 percent made a small profitable return. Another reason for high profit margins may be the fact that 27 percent of organizations surveyed considered profit to be the most important factor to the organization (refer to Table III). Other very important factors were increase in sales (17 percent) and quality (16 percent). Price and speed to market were also deemed important at 21 percent and 17 percent. Surprisingly, 24 percent of respondents did not value customizable products to be important and 25 percent placed no importance on innovation. These two aspects are contradictory to KM, which emphasizes the need for customer focus and innovation to gain competitive edge.

The final frequency tabulation, shown in Figure 5, refers to the position in the organization that the participant, that is the person who completed the survey, holds. The graph shows that 48 percent per cent of respondents hold chief executive officer (CEO) or managing director (MD) positions. This is closely followed by those in senior management posts (44 percent). One

Figure 4 Organization market share

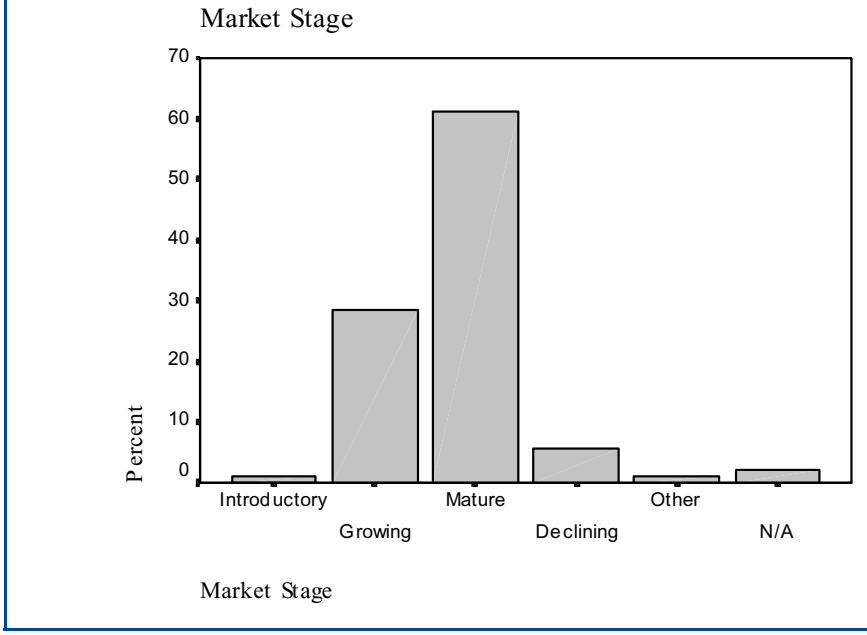
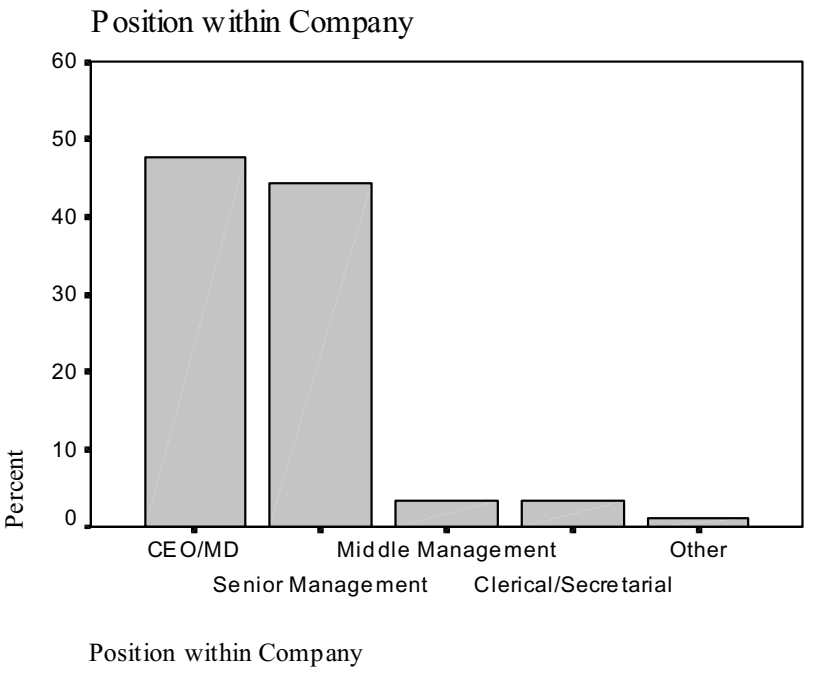


Table III Factors important to business

	Most important %	*Important* %	*Neutral* %	*Less important* %	*None* %
Profit	27	4	1	3	6
Increase in sales	17	11	14	5	13
Market share	7	11	21	20	11
Price	7	21	17	15	7
Quality	10	15	11	6	8
Variety/customizable	7	11	12	18	24
Speed to market	9	17	16	17	6
Innovation	10	10	8	16	25

Figure 5 Position of respondent



reason for these high figures may be that the questionnaire was directed to specific personnel within senior positions. This contact was then requested to either complete the questionnaire or forward it to the person deemed most capable for completion. In many of the cases the CEO/MD may have found themselves to be the most knowledgeable person of the subject in hand.

Factor analysis

Factor analysis is a statistical technique used to identify a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables (Norusis, 1988). Its primary objective is data reduction and summarization with a minimum loss of information (Kim and Mueller, 1978; Hair *et al.*, 1987).

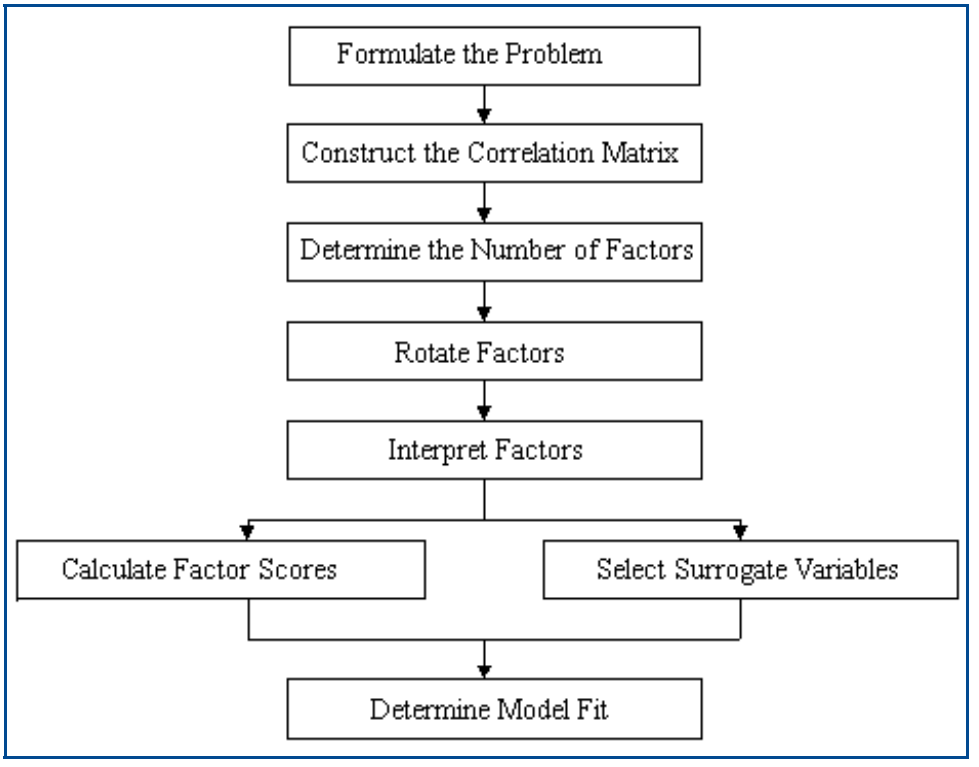
The steps involved in conducting factor analysis are outlined in Figure 6. The first step is to define the factor analysis problem and identify variables to be analyzed. A correlation matrix of these variables is then constructed and a method of factor analysis is selected. Next, the relevant number of factors are extracted, rotated and interpreted.

Depending on the objectives of use, factor scores can be calculated, or surrogate variables selected to represent factors in subsequent multivariate analysis. Finally, the fit of the factor analysis model is determined.

To analyze and interpret data derived from the empirical survey, factor analysis was conducted on five main areas of data, namely, organizational climate, technical climate, information, technology and people factors. Variables contained in each of these sections were selected from an initial factor analysis. In this case all variables were ''put into the pot''; factor analysis then determined the five aspects as key areas for further analysis. These five elements accounted for 60.532 percent of the survey variables.

Before conducting factor analysis on each of the five categories of data, the variables contained within each were subjected to reliability and appropriateness testing; this ensured quality of measurement (Rose and Sullivan, 1993). Having determined that the data scales were suitable for factor analysis, extraction of key variables was then possible. Factor loadings were calculated to depict the significance of each variable within the factor category. Factor

Figure 6 Conducting factor analysis (adapted from Becker and Narnett, 1987)



descriptions were awarded to the variables to capture the underlying nature of the factor. Both these descriptors enabled easy interpretation of the factors.

Having identified key factors for each data element it was possible to conduct further data analysis through the calculation of factor scores; this enabled comparison between various elements. In the first instance three elements were evaluated; these were technology, information and people. These three elements were considered to be the main contributory areas to successful KM implementation.

Computation of factor scores

Factor scores were calculated using two different methods. The first technique involved awarding a factor score to each of the three components classified as key to KM (technology, information and people). Using survey responses it was possible to compute a value for each of these, employing SPSS procedures. A value for KM was calculated by adding together the total factor scores for the three elements. Frequency analysis conducted on the factor scores permitted a ranking for each organization; the overall score for KM in relation to each respondent organization is also recorded. Frequency results of this analysis are presented in the Appendix.

To ensure that the process for calculating a value awarded to KM (as outlined in previous paragraph) is accurate, an alternative technique was employed. This procedure involved a complete factor analysis on all reliable variables relevant to the technology, information and people factors. A total of 85 variables were included. The initial outcome indicated that 23 factors could be derived from this data, however many of these showed low association values. When analysis was performed selecting the highest-ranking factors, a total of three were produced. These three factors accounted for 33.094 percent of the total variables. The variables within these three factors could easily be categorized into technology, information and people factors.

Reliability of the two methods employed to calculate a value for KM was further ascertained by comparing the results from each technique. The two values obtained for Knowledge

Management were compared using both graphical and statistical applications. Figure 7 shows the output of the comparison via a scatter graph.

The scatter graph indicates that the values attributed to the variable KM are closely related, independent of which technique is employed. Statistical procedures in the form of regression analysis (refer to next section) further outline the extent of this relationship. Figure 8 presents the results of regression analysis performed to compare the relationship between the two values derived for KM.

The results of the KM totals regression coefficient tested under the ''*t*-test'', compared with the probability of making a type I error (equal to 0.05), indicate that there is strong rejection of the null hypothesis, significant at the 0 percent level. This significance level of zero denotes a highly significant relationship between both the dependent and independent variables, that are the two total values for knowledge management. This relationship is further supported by the high *F* value at 182.828. Overall model fit indicates that over 70 percent of the variability in the dependent value (total 1) is explained by the independent variable (total 2). Thus, it can be concluded that the value awarded to KM is accurate, irrelevant of the technique used for its calculation.

For the purpose of this paper the values of KM calculated using the first technique (adding together the total factor scores for the technology, information and people variables) will be used in further analysis. The outcomes from the first technique are selected as the variables contained in this approach have been subjected to more rigorous application; each element has been considered individually in detail. Again, the total values of KM for each organization can be referred to in the Appendix.

Interpretation of factor scores

The factor scores for KM were interpreted in two ways. In the first instance, the respondent organizations were classified into poor, average and good categories. The value range within each category was calculated. The minimum and maximum factor scores possible were added to find the end values of each range. The lowest possible scores are technology -3.12, information –10.82 and people –8.06 providing a total of –22.00. The highest possible scores are technology 7.49, information 8.22 and people 4.75 providing a total of 20.46). This initial observation facilitated understanding of organizational position regarding KM implementation.

Figure 7 Comparison of methods to calculate value for knowledge management

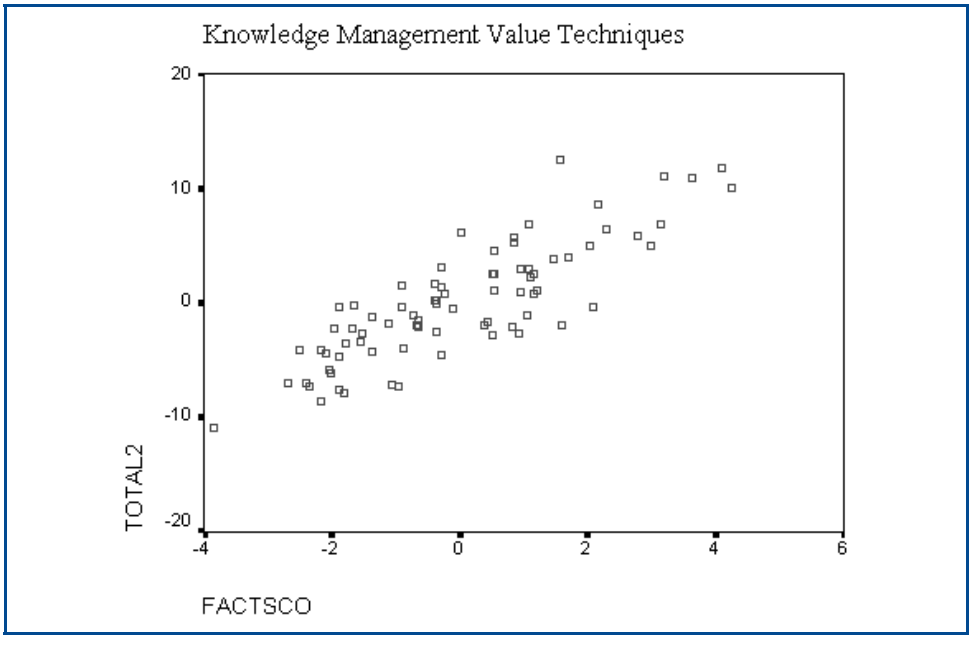


Figure 8 Regression analysis for KM totals

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.839[a]	.704	.700	2.7828

a. Predictors: (Constant), FACTSCO

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1415.766	1	1415.766	182.828	.000[a]
	Residual	596.267	77	7.744		
	Total	2012.033	78			

a. Predictors: (Constant), FACTSCO

b. Dependent Variable: TOTAL2

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.544E-02	.313		.081	.935
	FACTSCO	2.460	.182	.839	13.521	.000

a. Dependent Variable: TOTAL2

Group 1, were organizations that fell within the range –22 through to –8; these were considered poor at KM. This range accounted for 2.3 percent of the total population. The second group were those organizations within the range –7.99 through to 6.30; these were classified as having potential for KM. Of respondents 86.4 percent were within this arena. The third group were those within the range 6.31-21; these organizations showed most development within Knowledge Management. A total of 11.4 percent of respondents were categorized under this umbrella.

To gain further comprehension of organizational interest in KM, the same information was used to classify the organizations according to component structure. Each organization is classified depending on their factor scores for each individual element. If an organization scores highly on all three factors it is regarded as an ''achiever'', if the organization scores highly on two factors it is regarded as a ''progresser'', if the organization scores highly on one factor it is regarded as a ''laggard'', and if the organization scores low on each element it is regarded as a ''beginner''. An organization that scores zero on each account is considered to be a ''non-starter''. This approach is similar to one adopted by Parkinson *et al.* (1997) in a study conducted for the Chartered Institute of Marketing. Table IV shows the various combinations that contribute to each category.

From the total population 13 percent are non-starters; these organizations have no KM activity at present. A total of 24 percent of the respondents were beginning to undertake some KM activity, though this is limited at present. The majority of respondents (39 percent) had some KM practices in motion, with high performance in one particular area, and 18 percent of respondents were progressing towards achieving KM within their organizations, while only 7 percent could be classified as having gained KM success.

Table IV Knowledge management category combinations

Technology	*Information*	*People*	*Category*
High	High	High	Achiever
High	High	Low	Progresser
High	Low	High	Progresser
Low	High	High	Progresser
High	Low	Low	Laggard
Low	Low	High	Laggard
Low	High	Low	Laggard
Low	Low	Low	Beginner
Zero	Zero	Zero	Non-starter

Having analyzed and interpreted key contributors to KM, namely, information, technology and people, it was possible to conduct further discriminant analysis. The cause of this analysis was to discover relationships between these three elements and any other contributory independent variables. This analysis was conducted using regression analysis.

Regression analysis

Regression analysis is a technique aimed at proportionate reduction in error (PRE). As with all statistical applications, it is designed to simplify and summarize complex information, through the deduction of errors, to ascertain underlying patterns in the data. Regression analysis informs how strongly related a pair of variables is, via a measure of correlation. It also measures the extent of the effect that a change in the independent variable has on the dependent variable (Rose and Sullivan, 1983). This technique is known as ''explaining variance'' (Lewis-Beck, 1993).

Regression analysis is used in this research to establish statistical model fit of the MeCTIP model. To achieve this, the variable obtained for KM (combination of technology, information, and people) was subjected to further variable relationship analysis. First, regression analysis was performed to ascertain if any relationships exist between KM and internal organizational factors, namely organization climate and technical infrastructure. Second, regression analysis was employed to ascertain if an indirect contribution is made to KM by external factors; all elements external to KM were evaluated. In this instance the dependent variable, KM, is assessed against the independent variables, organizational climate, internal technical climate, organization size, market stage and type of respondent.

Figure 9 presents the findings of statistical investigation to establish a relationship between KM and internal organizational factors.

The result of this multiple regression analysis indicates a highly significant relationship (0 percent level) between the dependent variable (KM) and independent variables (organizational climate and internal technical climate). Overall model fit indicates that almost 48 percent of variablility in the dependent variable is explained by the independent variables. Model fit supports the hypothesis that changes in organizational climate and/or changes in the internal technical climate will have a direct effect on KM.

The results from the second multiple regression analysis performed, conducted using the five elements external to KM, are shown below in Figure 10.

This regression analysis reports that a highly significant relationship exists between the dependent and the independent variables. Overall model fit testifies that the independent variables contribute to just over half the variability of the dependent variable.

However, from the multiple regression coefficient table only internal organizational factors, namely organizational climate and internal technical climate, have a direct effect on KM. While other macro-environmental factors tend to influence KM in an indirect manner, this relationship is not strong.

Figure 9 Regression analysis for organizational and technical climate

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.691[a]	.477	.465	3.6722

a. Predictors: (Constant), TECHCISC, CULTSCOR

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1047.491	2	523.745	38.838	.000[a]
	Residual	1146.250	85	13.485		
	Total	2193.740	87			

a. Predictors: (Constant), TECHCISC, CULTSCOR

b. Dependent Variable: TOTAL2

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.503E-16	.391		.000	1.000
	CULTSCOR	.621	.175	.350	3.553	.001
	TECHCISC	.705	.165	.421	4.281	.000

a. Dependent Variable: TOTAL2

Overall, conclusions can be drawn to support the fact that KM is influenced by organizational factors. Evidence is also provided to show that organizations are receptive to influences beyond their boundaries. Changes in the macro-environment tend to affect both organizational climate and the internal technical climate of an organization. This in turn has a knock on effect to KM. While no direct relationship exists between the macro-environment and KM, statistical results have shown that KM is still affected by macro-environmental factors within an organizational context.

Interpretation of statistical data

Having obtained a complete set of statistical results in relation to the MeCTIP model, it is possible to draw some conclusions on the respondent organizations. Through the interpretation of various factor scores, the respondent organizations were classified according to their current KM position. Further insight to these organizations can be obtained through the analysis of organizational approaches to KM. This is achieved by analyzing internal organizational factors.

A total of five categories of organizations exist. The first category contains organizations that pay attention to both organizational climate and internal technical climate for KM success – these are classified as ''all-rounders''. The second category is those who seek KM through organizational climate influences only – these are classified as ''cultchies''. The third category is those who seek KM through the internal technical climate – these are classified as ''techies''. The fourth category contains organizations that do not focus on any particular approach for KM attainment – these are classified as ''non-viewers''. The final category consists of organizations that have no current activity for KM implementation – these are classified ''non-starters''. Table V shows the five categories.

Figure 11 presents the results of analysis for respondent organizations.

Figure 10 Regression analysis of element external to KM

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.710[a]	.505	.474	3.5268

a. Predictors: (Constant), TECHCISC, Organisation Size, Type of Respondent, Market Stage, CULTURE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1027.051	5	205.410	16.515	.000[a]
	Residual	1007.487	81	12.438		
	Total	2034.538	86			

a. Predictors: (Constant), TECHCISC, Organisation Size, Type of Respondent, Market Stage, CULTURE

b. Dependent Variable: TOTAL2

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.059	1.860		-.569	.571
	Organisation Size	.439	.435	.081	1.010	.315
	Market Stage	-.182	.396	-.037	-.459	.648
	Type of Respondent	.573	.967	.048	.593	.555
	CULTURE	.590	.170	.345	3.471	.001
	TECHCISC	.696	.162	.431	4.289	.000

a. Dependent Variable: TOTAL2

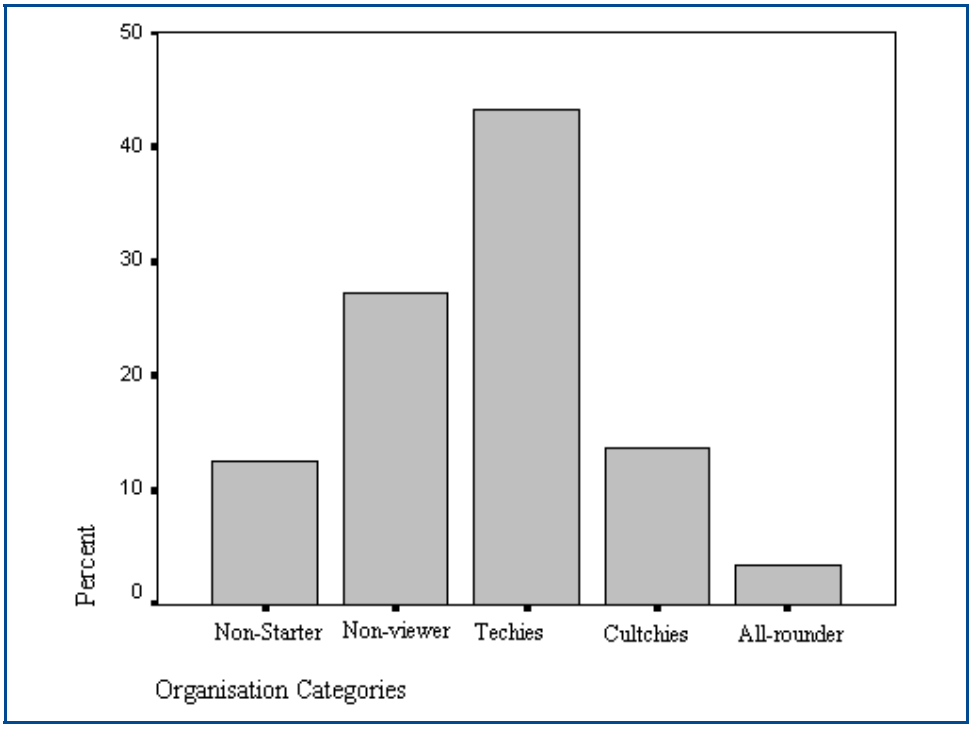
Table V Organization category combinations

Organizational climate	*Internal technical climate*	*Category*
High	High	All-rounder
High	Low	Cultchies
Low	High	Techies
Low	Low	Non-viewer
Zero	Zero	Non-starter

From the total population 13 percent are non-starters; these organizations have no KM activity at present. While 27 percent of respondent organizations had some KM activity within their organizations, the approach to this implementation is *ad hoc*. No particular focus exists for KM; they simply exist through a ''trial and error'' manner. The majority of respondents (43 percent) had adopted a ''techie'' approach to KM. This result supports current literature which states organizations are becoming more technology orientated (Borghoff and Pareschi, 1999).

Only 14 percent of respondents opted for a ''cultchie'' approach changing the organizational climate to incorporate KM. Again, this result supports current literary views – changing an organization's culture is the most difficult aspect of any change program (Crosby, 1986). A very low percentage of respondent organizations (3 percent) had adopted an ''all-rounder'' approach to organizational change for KM. This result is disappointing from an organizational

Figure 11 Organization combination groups



perspective. Current literature suggests that organizations that achieve the best results from KM are those who adopt a combined culture/technology approach (Lank, 1997; Davenport and Prusak, 1998).

Overall, the current state of practice for KM within organizations is quite poor. For those organizations that have attempted to implement KM, many of unsure of the best approach to adopt. This is evident through the number of cases that have opted for the ''techie'' route as a KM driver. While the technological arena is important for KM, the ''cultchie'' route cannot be ignored. Organizations will receive maximum benefit from KM if an ''all-rounder'' approach to its implementation and development is achieved. Statistical results presented in this section clearly indicate that this is not the case at present; much scope still exists for KM development within organizations.

Conclusion

The MeCTIP model characterizes the key elements of KM. It is concerned with the impact that external and internal factors have on organizational KM implementation, development and maintenance. In the first instance, emphasize is place on elements external to the organization. These are labelled macro-environmental issues. Although these elements are beyond organizational control, they still impact on the organizations' business environment. Internal to the organization, two main categories exist which influence KM. These are organizational climate and internal technical climate. The model signifies that KM within an organization is characterized by technical, informational and personal elements.

A considerable number of survey respondents have yet to initiate organizational change using a knowledge-orientated approach. This indicates that these organizations are not yet aware of the benefits KM can offer for business improvement and sustainability. A number of those who have attempted to undertake KM have done so in an ''*ad hoc*, trial and error'' manner. Although these organizations realize the importance of KM, they do not understand how to establish a successful KM environment. Those who show most commitment to KM have used technology as the key driver for KM implementation and development. While this approach is fine for short-

> **“ Organizations that fail to shift cultural attitudes will not remain knowledge focused. ”**

time rewards, the technological stance on its own will not offer long-term benefit to the organization.

Implications for management

Very few of the respondent organizations have adopted a culturally led change program for KM. Although changing the organization climate has been outlined as the most difficult aspect of KM (Davenport and Prusak, 1998), it is one that must be embraced for KM success. Thus, managers must avoid the perception of KM as overriding cultural barriers which have been encountered on previous change programmes. Organizations that fail to shift cultural attitudes will not remain knowledge focused; again efforts will be short lived. Rather, the contingent approach for KM adoption by managers within organizations is that of climate and technology combined. Only a handful of respondent organizations claim to have achieved this. Therefore the conclusion exists that the journey yet to be travelled by many organizations to achieve successful KM is not one to be embarked upon lightly.

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Appendix Frequency of factor scores

Technology	*Information*	*People*	*Total*	*Technology*	*Information*	*People*	*Total*
–3.18	–4.8	–2.86	–10.84	–1.57	2.46	–1.27	–0.38
–2.2	–2.6	–3.75	–8.55	–2.83	2.13	0.35	–0.35
0.2	–3.47	–4.55	–7.82	0.58	–0.84	–0.06	–0.32
0	–3.89	–3.84	–7.73	0.3	–0.21	–0.25	–0.16
–1.25	–3.53	–2.78	–7.56	–0.13	–1.36	1.48	–0.01
0.53	–4.33	–3.51	–7.31	–0.36	1.21	–0.61	0.24
–0.77	–2.72	–3.78	–7.27	–2.52	3.33	–0.55	0.26
–0.62	–2.78	–3.75	–7.15	1.46	0.92	–1.56	0.82
–2.41	–2.55	–2.11	–7.07	1.5	0.08	–0.74	0.84
–1.94	–3.82	–1.27	–7.03	0.44	0.56	–0.01	0.99
2.81	–4.12	–4.86	–6.17	–0.4	–0.29	1.73	1.04
–2.56	0.38	–3.8	–5.98	2.74	–0.71	–0.88	1.15
–2.01	–4.34	0.47	–5.88	4.11	0.16	–2.84	1.43
–0.58	–3.5	–0.66	–4.74	0.52	0.94	0.11	1.57
–1.27	–4.18	0.87	–4.58	1.94	–1.77	1.43	1.6
–3.77	–0.31	–0.3	–4.38	–1.96	0.53	3.64	2.21
–0.87	–2.96	–0.38	–4.21	–0.44	1.1	1.81	2.47
–0.73	–0.07	–3.27	–4.07	1.33	1.73	–0.52	2.54
–2.7	–1.26	–0.08	–4.04	0.29	1.86	0.43	2.58
–3.06	–0.92	0.01	–3.97	0	1.54	1.26	2.8
–2.76	–0.99	0.18	–3.57	0	1.12	1.69	2.81
0	0.31	–3.77	–3.46	0	1.43	1.5	2.93
–0.95	–0.76	–1.67	–3.38	0.17	1.2	1.65	3.02
–1.96	–1.97	1.05	–2.88	1.81	0.82	0.51	3.14
–3.49	0.28	0.49	–2.72	0	2	1.56	3.56
–0.36	–1.83	–0.5	–2.69	–1.17	2.89	2.08	3.8
–1.76	–1.64	0.85	–2.55	–2.01	4.26	1.67	3.92
0.56	–1.62	–1.2	–2.26	4.07	–0.82	1.37	4.62
–0.24	–1.1	–0.9	–2.24	1.79	1.71	1.43	4.93
–2.77	0.93	–0.28	–2.12	3.5	0.08	1.38	4.96
–2.77	0.93	–0.28	–2.12	0.23	4.29	0.68	5.2
–2.44	–0.71	1.04	–2.11	6.91	2.18	–3.44	5.65
–1.64	–1.73	1.44	–1.93	4.09	2.18	–0.37	5.9
–0.25	–1.64	–0.04	–1.93	1.11	2.04	3.05	6.2
–0.08	–0.86	–0.94	–1.88	2.45	2.86	1.06	6.37
3.65	–4.95	–0.55	–1.85	0	3.6	3.16	6.76
–4.4	1.37	1.34	–1.69	–2.36	–0.62	9.91	6.93
–1.97	0.71	–0.2	–1.46	3.45	1.61	1.87	6.93
–0.46	0.35	–1.07	–1.18	3.94	3.72	0.88	8.54
–0.21	–0.95	0.01	–1.15	2.53	5.6	1.88	10.01
–1.79	1.14	–0.39	–1.04	2.51	4.3	4.13	10.94
–0.38	0.38	–0.44	–0.44	2.93	4.46	3.7	11.09
0	–1.64	1.23	–0.41	5.1	4.07	2.57	11.74
0	–1.51	1.13	–0.38	6.81	4.93	0.81	12.55