Defining a knowledge management conceptual model by using MADM

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Abstract

Purpose – *To survive high-level management needs business intelligent information to efficiently manage corporate operations and support its decision making. Knowledge management (KM) is recognized as one of the most critical factors for obtaining organizational competitive advantage. A variety of factors determines significant success ingredients for successful implementation of KM in any organization. The primary challenge in KM initiation is how to integrate the above factors with organizational and personnel constraints and capabilities. This paper aims to develop a priority framework based on multi-criteria decision making (MCDM) to help organizations build awareness of the critical influential factors affecting successful implementation of KM.*

Design/methodology/approach – *To identify critical influential factors, the authors studied and reviewed relevant literature from numerous fields of study associated with the essential issues of KM projects implementation. These cover the factors that affect a KM implementation based on comprehensive analysis of KM literature from numerous research studies. Research methodology used in this study is based on a combination of other methodologies such as action research, group discussion, documentary study and questionnaire research. For this purpose a group of experienced managers were selected and discussion sessions were held to set objectives and road map the study. Finally group analysis hierarchy process (GAHP) was used to analyse questionnaires and prioritize influential factors.*

Findings – *The conceptual framework presents a roadmap for success of KM programs in the organizations. The paper identifies eight major aspects, 44 influential factors and a conceptual framework to assisting managers to design and implement a KM system in their organizations. The results show top management, executive management and culture have great impact on success of KM implementation among main aspects. The conceptual framework presents guidelines for success of KM implementation in organizations.*

Practical implications – *The result of this study not only validates theory with reality, but it also provides a reference for the academic as well as the business world. It is hoped that the factors proposed in this study help organizations to manage knowledge activities effectively and implement knowledge projects smoothly in order to maximize benefits from KM projects and returns from knowledge assets.*

Originality/value – *This study is the first to provide an integrated perspective of critical success factors in KM implementation in Khorasan Science and Technology Park (KSTP). It gives valuable guidelines for top managers and leaders to accomplish KM projects effectively.*

Keywords *Knowledge management, Modelling, Analytical hierarchy process, Critical success factors*

Paper type *Case study*

1. Introduction

Some authors address the question of defining knowledge by distinguishing among knowledge, information, and data. A commonly held view with sundry minor variants is that data are raw numbers and facts, information is processed data, and knowledge is authenticated information (Alavi and Leidner, 2001). They posit that information is converted to knowledge once it is processed in the mind of individuals and knowledge becomes information once it is articulated and presented in the form of text, graphics, words, or other symbolic forms (Alavi and Leidner, 2001). Davenport and Prusak (1998) point out that

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knowledge is a fluid mix of framed experience, values, contextual information, and expert insights that provides a framework for evaluating and incorporating new experiences and information (Chen and Hsiang, 2007). Knowledge is now considered to be a major driving force for organizational change. (Savvas and Bassiliades, 2009).

The recent interest in organizational knowledge has prompted the issue of managing the knowledge to the organization's benefit. Defining knowledge management (KM) is not easy because it can refer to several different activities in an industrial firm, such as data collection, data analysis, data storage, data dissemination, and data utilization (Lancioni and Chandran, 2009). KM is to discover, develop, utilize, deliver, and absorb knowledge inside and outside the organization through an appropriate management process to meet current and future needs (Quintas *et al.*, 1997). KM is the process through which organizations extract value from their intellectual assets.

To survive in the harsh environment, high-level management needs business intelligent information to efficiently manage corporate operations and support their decision making (Cheng *et al.*, 2009). KM has been recognized as one of the most critical factors for obtaining organizational competitive advantage (Mudambi and Swift, 2009; Yang and Farn, 2009; Chen *et al.*, 2009; Joo and Lee, 2009; Paswan and Wittmann, 2009). The major goal of KM implementation is frequently to accrue maximum benefit and achieve competitiveness (Wang and Chang, 2007). KM has benefited several industries. One of the successful applications of KM is explored by Kamp (1999). He describes four introductory projects of knowledge-based systems (KBS) and also analyzes their critical success factors and pitfalls on the farm. The current theory of successful innovations puts the farmer in a much more central position (initiating, steering, controlling): a mix between top-down and bottom-up in comparison with the traditional knowledge chain (top-down). Kamp concludes that decision support systems (DSS) on an operational level are more successful than those working on the tactical level. Furthermore, those systems bring clear financial benefits which are of course a good potential in agricultural industry (Kamp, 1999).

KM makes enterprises integrate traditional resources and capabilities in a unique innovative way, and provides more customer value than competitors (Chen and Lin, 2009).

A variety of factors determines significant success ingredients for successful implementing KM in organization. There are many pervious researchers to identify critical success factors (CSFs). CSFs are described as ''being in necessary and sufficient for success: each factor is necessary and the set of factors are sufficient'' (Williams and Ramaprasad, 1996). Many researchers have attempted to develop a comprehensive list of CSFs for KM implementation (see Table I). However, the list differs considerably from one research to another one because of the multidisciplinary nature of KM.

Davenport *et al.* (1998) identify that the key success factors of implementing KM in organizations are a knowledge-oriented culture, technical and organizational infrastructure, senior management support, a link to economics or industry value, clarifying of purpose and language, nontrivial motivational aids, knowledge structure and multiple channels for knowledge transfer.

Table I The Saaty nine-point comparison scale

Preferences	*Numerical value*
Extremely preferred	9
Very strong preferred	7
Strongly preferred	5
Moderately preferred	3
Equally important	1
Intermediate importance between two adjacent judgments	2, 4, 6, 8

Chang and Wang (2009), use the fuzzy multi criteria decision-making approach to measure the possibility of successful KM. They consider seven major factors, including employee traits, strategy, superintendent traits, audit and assessment, organizational culture, operation procedure, information technology and 31 influential factors. The empirical results demonstrate that direct participation and trust relationships among all staff, establishing a specific team to take charge of KM implementation, participation and support from senior administrators, motivation to share knowledge, auditing index and system for KM are the five main influential factors of the success of KM project.

The primary challenge in KM initiation is how to integrate the above factors with organizational and personnel constraints and capabilities. The main objectives of KM implementation are frequently to maximize benefit, improve customer service, shorten product-manufacturing cycle and achieve competitiveness; KM thus acts as a stimulus forcing an organization to change its practices (Chang and Wang, 2009).

Khorasan Science and Technology Park (KSTP) was established on September 2002 and started its operation, relying on experiences gained over 22 years of research activities on the fields of creation and development of national technology. KSTP has provided the small and medium enterprises with a suitable environment for their professional presence, R&D sectors of industry and research organizations to facilitate interactive and mutual constructive technology-based activities with other academic centers. Currently, two incubators are operative in KSTP, the comprehensive technology incubator and ICT incubator, to support SMEs to proceed towards technology-based lasting job opportunities. At present, there are over 30 technology-based and technology-core firms residing in the KSTP. KSTP is established on an area about 400,000 square meters. First and second phases are utilized on a surface of 13,000 square meters, and the expansion phase has already been completed. Also, KSTP has erected three small pilot plants on food-industry, chemical and mechanical workshops summing up to an area of 1,750 square meters. KSTP also welcomes the presence of Khorasan Research Center for Technology Development (KRCTD), a governmental research center with services of some 25 experienced technologists, members of academic staff, who work on applied research projects towards technology development as well as providing technical and technological consultations to the tenants in the park. KSTP has established KM system and designs, implements to KM projects.

Since KM implementation is extremely costly in terms of money and time, it requires considerable advance planning. The CEO of KSTP has considered about identification, evaluation and prioritizing of the KM factors. The framework of the priority approach thus is introduced to the CEO who is interested in the priority framework. The CEO asked the general manager to help us organize a committee. after some meeting sessions, with general manager, the authors made sure they understood meaning of the model.

The next section discusses the concept of multi criteria decision making (MCDM) or analytic hierarchy process (AHP) and group analytic hierarchy process (GAHP). The research methodology is in section 3. In section 4, identification of critical success factors and discussions are presented. Finally, and conclusions is given in sections 5.

2. Concept of AHP

AHP method is used to face a complex decision making problem which is one of the most widely used technique for multi attributes decision making (MADM). Multiple criteria decision making (MCDM) is concerned with theory and methodology that can treat complex problems which are characterized by incommensurate and conflicting criteria or objectives. The AHP is an effective tool in structuring and modeling multi-criteria problem and has been successfully used in a variety of construction management application (Hasenaman *et al.*, 2004).

Cakir and Canbolat (2008), mention several areas of AHP applications such as supplier selection, performance evaluation, project management, inventory management, resource allocation, financial planning and credit scoring, portfolio management, budgeting

decisions, technology management, distribution channel management, promotion and recruitment decisions, socio-economic planning, energy resources planning, conflict resolution and common vote prediction.

However, the basic steps in using AHP remain the same in all the applications and consist of:

1. Description of complex decision problem as a hierarchy.
2. The use of pair-wise comparisons to estimate the relative weight (importance) of the various elements on each level of the hierarchy.
3. The integration of these weights to develop an overall evaluation of decision alternatives
4. Estimation of the consistency ratio (CR):

$$CR = \frac{CI}{RI}$$

where RI is the random index and CI is the consistency index. The formula for CI is:

$$CI = \frac{\lambda_{\max} - n}{n - 1},$$

$\lambda_{\max}$ is the maximum value of the consistency vector.

The consistency ratio indicates the degree of consistency with answers. A higher number means less consistency, while a lower number means that data collected are consistent. In general, if the consistency ratio is 0.10 or less the decision maker's answers are relatively consistent. For a consistency ratio that is greater than 0.10, the decision maker should seriously consider reevaluating his or her responses during the pairwise comparisons (Render and Stair, 1991).

2.1. GAHP

AHP can be particularly useful with groups. Each member's assessments can, of course, be evaluated for priorities and inconsistency, and then the group rollup (and group segments) may be synthesized and viewed the same way. This is considered a powerful way to build consensus, as each constituent can see where he/she stands and compare it to the group as a whole. If the group has a high inconsistency ratio (more than 0.1, or so) segmenting might reveal where the differences in agreement are and why. That, too, can help lead to better understanding and consensus. We use geometric average of member's assessment (x_{ij}):

$$x'_{ij} = \left(\prod_{l=1}^{k} x_{ijl}\right)^{1/k}, \; i, j = 1, 2, ..., n, \; i \neq j, \; l = 1, 2, 3, ..., k$$

where l = Decision maker number, and k = the number of decision maker.

3. Research methodology and data collection

Research methodology used in this study is based on a combination of other methodologies, including action research, group discussion, documentary study and questionnaire research. For this purpose a group of experienced managers were selected and discussion sessions were held to set up objectives and road map the study.

The group consisted of eight members. Using the GAHP method in analyzing the questionnaires led to the elimination of two of them because their CRs counted above 0.10.

4. Prioritizing critical success factors of KM implementation using GAHP approach

This section deals with the construction of analytical model for prioritizing success factors of a KM project using the multicriteria decisionmaking approach. This section comprises four

subsections: investigating the factors affecting KM success; determining the importance weights of influential factors; obtaining portion percentage of each influential factor; and finally defining the conceptual model of KM.

The notations that the authors used in this paper are as follows:

C_i: The ith main aspect.

C_{ij}: The jth influence factor of ith aspect.

4.1. What factors affecting KM success implementation?

The influential factors are determined via widespread investigations and consultations with a group of top managers. Synthesizing the literature review and the opinions of those managers are employed to obtain the eight main aspects including top management, executive management, culture, organizational infrastructure, human resource management (HRM), continuous improvement (CI), KM process and technical infrastructure. From these main aspects, 44 influential factors for the KM success are maintained. At first the authors assume all aspects and influential factors have equal portion in success of KM implementation. Figure 1 shows a hierarchical structure for solving the prioritizing problem of the success factors of KM.

The classification of those main aspects and their influential factors are shown in Table II and brief explanations of important concepts are as follows.

4.1.1. Top management. Like almost every other type of change program, KM projects benefited from senior management support (Davenport *et al*., 1998). Leaders have to share a vision on KM and provide such a program with ongoing support (Plessis, 2007). Soliman and Spooner (2000) indicate inclusion of top management in KM efforts provides additional motivation for staff to share knowledge and increase the chance of success of KM implementation.

Figure 1 Primary conceptual framework of hierarchical structure

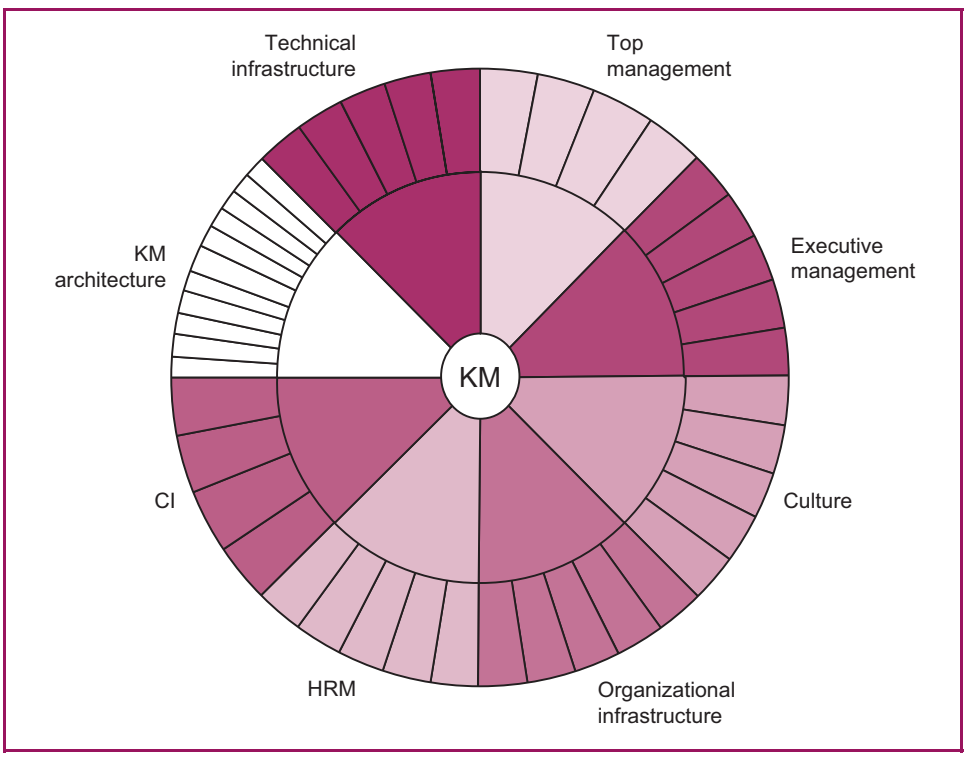


Table II Proposed main aspects and influential factors and related research studies of them

Main aspect	*Influential factors*	*Related research studies*
Top management (C_1)	Support and commitment (C_{11}); the link between business vision, mission and task, and KM strategy (C_{12}); clarifying what types of knowledge are most important to the company; (C_{13}); providing necessary resources and budget (C_{14})	Davenport *et al.* (1998); Leibowitz (1999); Skyrme and Amidon (2000); Soliman and Spooner (2000); Ryan and Prybutok (2001); Bixler (2002); Chourides *et al.* (2003); Moffett *et al.* (2003); Ebgu (2004); Hung *et al.* (2005); Wong and Aspinwall (2005); Yeh *et al.* (2006); Plessis (2007); Chang and Wang (2009)
Executive management (C_2)	KM champions and leaders (C_{21}); defining KM strategy and vision (C_{22}); network of experts (C_{23}); the pilot of formal KM program (C_{24}); formal and informal communication by other levels of organization (C_{25})	Davenport *et al.* (1998); Leibowitz (1999); Skyrme and Amidon (2000); Soliman and Spooner (2000); Ebgu (2004); Wong and Aspinwall (2005); Akhavan *et al.* (2006); Plessis (2007); Chang and Wang (2009)
Culture (C_3)	Obtaining the value and advantages of knowledge (C_{31}); members' recognition of the importance of intellectual capital and KM (C_{32}); providing proper space and time for learning, creating knowledge, innovation and brainstorming (C_{33}); mutual trust, openness, collaboration, cooperation between employees (C_{34}); acceptance of knowledge sharing with the positive attitude (C_{35})	Davenport *et al.* (1998); Leibowitz (1999); Skyrme and Amidon (2000); Soliman and Spooner (2000); Ryan and Prybutok (2001); Bixler (2002); Moffett *et al.* (2003); Ebgu (2004); Hung *et al.* (2005); Wong and Aspinwall (2005); Akhavan *et al.* (2006); Yeh *et al.* (2006); Plessis (2007); Chang and Wang (2009)
Organizational infrastructure (C_4)	Establishing KM roles and teams (C_{41}); having a flat or network structure (C_{42}); communities of practice (CoPs) (C_{43}); the unit (committee or team) to plan and promote KM (C_{44}); the KM implement unit (department) (C_{45})	Leibowitz (1999); Soliman and Spooner (2000); Ryan and Prybutok (2001); Bixler (2002); Ebgu (2004); Wong and Aspinwall (2005); Akhavan *et al.* (2006)
Human resource management (HRM) (C_5)	Employee empowerment (C_{51}); employee involvement (C_{52}); employee learning and development (C_{53}); employee recruitment and selection (C_{54}); reward system (C_{55})	Davenport *et al.* (1998); Skyrme and Amidon (2000); Ryan and Prybutok (2001); Chourides *et al.* (2003); Moffett *et al.* (2003); Hung *et al.* (2005); Wong and Aspinwall (2005); Akhavan *et al.* (2006); Yeh *et al.* (2006); Plessis (2007); Chang and Wang (2009)
Continuous improvement (CI) (C_6)	Measurement (C_{61}); benchmarking (C_{62}); reduce coping and duplication (C_{63}); TQM (C_{64})	Chourides *et al.* (2003); Moffett *et al.* (2003); Hung *et al.* (2005); Wong and Aspinwall (2005); Akhavan *et al.* (2006); Plessis (2007); Chang and Wang (2009)
KM architecture (C_7)	Process-based view to KM (C_{71}); the process and regulations to continually improve knowledge and KM strategies (C_{72}); linking KM activities to business process (C_{73}); the process and regulations to create and protect knowledge structure and map (C_{74}); the regulations or processes to share knowledge with external organizations (C_{75}); the process and regulations to protect knowledge (C_{76}); the process and regulations to facilitate knowledge sharing (C_{77}); the process and regulations to encourage employee to participate projects and share project results (C_{78}); the process and regulations to assist members to obtain, to get and to create internal and external knowledge (C_{79}); the process and regulations to store knowledge (C_{710}); the process and regulations to assist members to apply internal and external knowledge (C_{711})	Davenport *et al.* (1998); Leibowitz (1999); Skyrme and Amidon (2000); Soliman and Spooner (2000); Moffett *et al.* (2003); Ebgu (2004); Wong and Aspinwall (2005); Akhavan *et al.* (2006); Plessis (2007); Chang and Wang (2009)
Technical infrastructure (C_8)	Building IT infrastructure (C_{81}); integrating with current systems (C_{82}); effective use of software tools (C_{83}); the database is updated periodically (C_{84}); security of data on internet (C_{85})	Davenport *et al.* (1998); Skyrme and Amidon (2000); Soliman and Spooner (2000); Ryan and Prybutok (2001); Bixler (2002); Chourides *et al.* (2003); Moffett *et al.* (2003); Ebgu (2004); Hung *et al.* (2005); Wong and Aspinwall (2005); Yeh *et al.* (2006); Plessis (2007); Chang and Wang (2009)

Davenport *et al.* (1998) notice types of support which play important role in KM, including:

- sending messages to the organization that KM and organizational learning are critical to the organization's success;
- providing funding and other resources for infrastructure; and
- clarifying what types of knowledge are most important to the company.

Making investments in technical infrastructure, coordinating employee, managing implementation process, encouraging human resource taking up KM roles, reward systems, etc. requires financial support. Proper budgeting of resources is crucial for KM (Bixler, 2002).

Top managers should define clear objectives and rules to support KM activities. KM strategy should be developed based on business strategy to confirm that KM goals are congruent with the strategic goals of the firm.

4.1.2. Executive management. O'Dell and Grayson (1999) believe that in addition to top management support, KM champions or sponsors have to be identified throughout the organization to be evangelists and role models within the program (Plessis, 2007).

Success of every program and planning in the organization depends directly on CEO support and commitment. Undoubtedly a KM program also needs CEO support for being successful in design and implementing phases (Akhavan *et al.*, 2006). KM leaders, including chief knowledge officer (CKO), chief learning officer (CLO), chief information officer (CIO, chief operation officer (COO), etc., at executive level have responsibilities to manage and implement KM strategies and programs within the organization. Leadership is responsible for setting up clear objectives, prioritizing knowledge projects, formulating knowledge strategies, building knowledge-oriented culture and supporting changes in performance measurement (Davenport *et al.*, 1998).

In an ideal situation, instead of implementing the project immediately across the whole organization, a pilot implementation should be carried out, during which it should be possible to learn from the process and to avoid the pitfalls encountered when extending the implementation process across the whole organization (Akhavan *et al.*, 2006).

It has been recognized by organizations that communication would play a vital role in entrenching KM as a strategic focus area in the organization (Plessis, 2007). Employees should be informed about benefits and advantages of sharing knowledge and results of KM projects. Some communication channels used in an organization to convey achievements of KM projects are internal magazines, journals, meetings, etc.

4.1.3. Culture. Many researchers have insisted that a knowledge-friendly culture must be presented or nurtured in order to achieve KM implementation success. Culture is perhaps the most difficult constraint that knowledge managers must deal with (Davenport *et al.*, 1998). Effective KM requires creating a supportive, collaborative culture and eliminating traditional rivalries. Elements of such a culture include believing people who want to share knowledge, preparing to lead by doing, relying on the forces of democracy and capitalism, developing collaborative relationships, instilling personal responsibilities for knowledge creation and sharing, and creating a collective sense of purpose (Plessis, 2007).

A culture of confidence and trust is required to encourage the application and development of knowledge within an organization. Soliman and Spooner (2000) indicate that supportive culture (openness) is another important factor that means mistakes and failures should be openly shared and discussed without fear of punishment. Yang and Wang (2004) believe making mistakes is a key source of the creation of the learning organization. Although explicit knowledge sharing is seen as important, it has been recognized that great value in respect of KM would also be achieved by creating tacit knowledge sharing communities (Plessis, 2007). Tacit knowledge is in an individual's brain. Sharing and expressing tacit knowledge needs people come to gather to interact and exchange ideas.

It is important to allocate time for employee learning, knowledge creation, initiatives. It is also important to invest heavily in employee training and development as well as R&D to develop a knowledge-oriented culture (Leibowitz, 1999).

4.1.4. Organizational infrastructure. Building an organizational infrastructure for KM implies establishing a set of roles and organizational groups whose members have the skills to serve as resources for individual projects (Davenport *et al.*, 1998). According to Nonaka (1994) one of the most important tasks of organizations is to organize self-organizing and cross-functional teams so that knowledge-workers can come together to create new knowledge and present it in an easily accessible format.

Organizational structure hierarchical bureaucracy leads to insufficient, ineffectiveness, powerlessness and prohibiting sharing knowledge and expertise among employees and managers (Leibowitz, 1999). Hierarchical bureaucracy also limits communications between employees and between employees and supervisors. But organic organization with flat and network structure has low functional barriers, fosters cross communication, allows the sharing of organizational knowledge, building new knowledge and seems that it can facilitate KM more effectively.

Community of practice (CoPs) is an activity system that includes individuals who are united in action and in the meaning of action has for them and for a larger collective (Lave and Wenger, 1991). CoPs enable knowledge team members to interact with the member of other knowledge teams in other organizations with similar interests and competencies and further promote inter-team knowledge sharing which leads to organizational performance improvement (Walczak, 2005).

4.1.5. HRM. People are the main driver of KM projects. Empowered employees are given autonomy – the freedom, independence and discretion – over their work activities (Moffett *et al.*, 2003), which have high levels of task significance – important to themselves and others. When employees are empowered, they would have a sense of ownership in the overall aim of the organization's KM efforts and this allows effective creation and sharing of knowledge.

Employee involvement means allowing employees to involve in their own jobs design and evaluation of their own jobs. If employees are not involved and consulted in the KM project design and planning stages, this will lead to their knowledge requirements to be poorly understood and satisfied (Lam and Chua, 2005).

Plessis (2007) is of the opinion that it is very important that staff understand the philosophy behind the development of a KM program. They have to have an in-depth understanding of how the program works, as well as in-depth training on the technology based system, to enable successful participation in the program. The skills and competences of employees and especially knowledge workers need to be continuously developed (Wong and Aspinwall, 2005). In order to implement KM effectively skills development should occur in the following areas: communication, soft networking, peer learning, team building, collaboration and creative thinking. Bixler (2002) describes learning as acquisition of knowledge or skill through study, experience or instruction. Internal communications, promoting cross-functional teams and establishing a learning community are ways that organizations can use and train their employees.

People bring knowledge and competencies by themselves, thus effective recruitment plan of employees is essential. Employees' selection should be based on their willingness and ability to share knowledge and skills with others.

Rewards and incentives are crucial to the success of KM. The reward and incentive system for KM should consist of push and pull rewards, e.g. rewarding people as part of their performance appraisals according to participation in the program (push) and incentivizing people to use the knowledge base to provide a platform for their innovative ideas, i.e. providing them and their ideas with visibility in the organization (pull) (Plessis, 2007).

4.1.6. Continuous improvement. The benefits, performance and impacts of KM projects need to be evaluated, outcomes must be measured against desired output, and improvement action should be taken when necessary. Measurement acts like a data collection system that

gives useful information about a particular situation or activity (Wong and Aspinwall, 2005). It enables the organization to track the progress of KM, to determine its benefits and effectiveness and to assess the extent to which KM project was achieving its objectives.

In order to survive and grow in global competition, an organization should develop any business unit continuously. Benchmarking is a very well-known management tool. Benchmarking, as defined by Camp (1989), is the systematic or ongoing process of searching for industry wide best practices that lead to superior performance. It has been identified to play a critical role in successful KM implementation. It helps organization to gain competitive advantages.

4.1.7. KM architecture. Knowledge architecture can also be defined as a logically set of principles and standards which guides the engineering (high level design, detailed design, selection, construction, implementation, support, and management) of an organization's KM system infrastructure (Akhavan *et al.*, 2006). Knowledge structures lead to easier navigation, organization and retrieval of knowledge. As Plessis (2007) points out these structures should be very flexible and must be able to adapt as the business environment changes.

KM is regarded as process involving various activities. According to Rumizen (2002), ''KM is the systematic processes by which an organization identifies, creates, captures, acquires, shares and leverages knowledge'', KM process has six major activities. These KM activities may vary depending on organization and the industry sector. These major activities can be subdivided, for example, captures knowledge is divided into: the process and regulations to assist members to obtain and get internal knowledge and the process and regulations to assist members to obtain and get external knowledge.

Bixler (2002) indicates that KM processes should be incorporated into employee's daily work activities and integrated into business processes so that they become common practices in an organization and allow seamless flow of knowledge in the business life.

According to Gupta *et al.* (2000) knowledge maps are actually classification that identify where knowledge resides and which knowledge needs to be shared with whom, how and why within and outside the organization's boundaries. Organizations need to have these knowledge maps and ontology defined to ensure standardization and integrity of the development of the repositories as well as to facilitate maintenance and controlled growth of these repositories (Leibowitz, 1999).

4.1.8. Technical infrastructure. Technical infrastructure enables rapid search, access and retrieval of information and can support collaboration and communication among organization's employees (Wong, 2005). Davenport *et al.* (1998) point out two critical factors for the successful KM project, one is the establishment a broad information systems infrastructure based on desktop computing and communication, and the second is the utilization of the network technology infrastructure such as the internet, Lotus Notes and global communication systems for effective transfer of knowledge.

A justification for the technology should be given to ensure that it is aligned to the goals of the KM project at large (Soliman and Spooner, 2000). Any technical solution must add value to the KM processes and achieve measurable improvement (Davenport *et al.*, 1998). Bixler (2002) points out that, it is necessary to review exiting architecture, infrastructures and IT systems for KM applicability to avoid unnecessary costs.

KM technologies and a software application provide the right information to the right people at the right time. Thus organizations can be able to design dynamic operational processes, make right decisions on time, enhance communications and participation among staff, solve problems efficiently, and improve financial performance.

4.2. Weighting calculation of the influential factors

Eight major aspects, comprising 44 influential factors are considered in this prioritizing problem. Exert Choice software has been applied to analyze preceding questionnaires. Tables III-XI indicate the results of the surveys.

Figures 2-10 show the weights of the main aspects and influential factors.

Table III Combination pair-wise comparison and consistency ratio for main aspects

Main aspects	*Top management*	*Executive management*	*Culture*	*Main aspects Organizational infrastructure*	*HRM*	*CI*	*KM architecture*	*Technical infrastructure*
Top management	1	4.472	4.966	6.037	6.776	6.172	5.044	5.582
Executive management	0.224	1	1.051	4.063	5.345	3.915	3.87	3.689
Culture	0.201	0.905	1	4.509	4.973	4.824	3.448	4.309
Organizational infrastructure	0.166	0.246	0.222	1	3.26	2.884	1.587	1.944
HRM	0.148	0.187	0.201	0.307	1	2.182	3.175	2.798
CI	0.162	0.295	0.207	0.347	0.458	1	1.817	2.289
KM architecture	0.198	0.258	0.209	0.63	0.315	0.55	1	2.04
Technical infrastructure	0.179	0.271	0.232	0.514	0.357	0.437	0.49	1
CR	0.06							

Table IV Combination pair-wise comparison and consistency ratio for top management

C_1: top management	*C_{11}*	*C_{12}*	*C_{13}*	*C_{14}*
C_{11}	1	2.952	3.026	2.621
C_{12}	0.339	1	1.944	1.414
C_{13}	0.33	0.514	1	1.049
C_{14}	0.382	0.0707	0.953	1
CR	0.02			

Table V Combination pair-wise comparison and consistency ratio for executive improvement

Executive management	*C_{21}*	*C_{22}*	*C_{23}*	*C_{24}*	*C_{25}*
C_{21}	1	1.406	2.303	2.144	1.285
C_{22}	0.711	1	2.791	3.072	2.335
C_{23}	0.434	0.358	1	1.02	2
C_{24}	0.466	0.325	0.981	1	2.376
C_{25}	0.778	0.428	0.5	0.421	1
CR	0.02				

Table VI Combination pair-wise comparison and consistency ratio for culture

C_3: culture	*C_{31}*	*C_{32}*	*C_{33}*	*C_{34}*	*C_{35}*
C_{31}	1	1.081	1.282	1.372	1.513
C_{32}	0.925	1	1.122	1.232	1.383
C_{33}	0.78	0.891	1	1.647	3.427
C_{34}	0.729	0.812	0.607	1	2.265
C_{35}	0.661	0.723	0.292	0.441	1
CR	0.03				

Table VII Combination pair-wise comparison and consistency ratio for organizational infrastructure

C_4: organizational infrastructure	*C_{41}*	*C_{42}*	*C_{43}*	*C_{44}*	*C_{45}*
C_{41}	1	4.067	1.424	1.285	1.348
C_{42}	0.246	1	2.854	2.093	2.239
C_{43}	0.702	0.35	1	2.96	3.322
C_{44}	0.778	0.475	0.338	1	1.782
C_{45}	0.742	0.447	0.301	0.561	1
CR	0.05				

Table VIII Combination pair-wise comparison and consistency ratio for HRM

C_5: HRM	C_{51}	C_{52}	C_{53}	C_{54}	C_{55}
C_{51}	1	1.201	2.493	2.871	4.966
C_{52}	0.833	1	3.488	3.177	5.744
C_{53}	0.401	0.287	1	1.175	2.376
C_{54}	0.348	0.315	0.854	1	1.798
C_{55}	0.201	0.174	0.421	0.848	1
CR	0.002				

Table IX Combination pair-wise comparison and consistency ratio for continuous improvement

C_6: CI	C_{61}	C_{62}	C_{63}	C_{64}
C_{61}	1	1.414	3.107	1.348
C_{62}	0.707	1	2.182	2.04
C_{63}	0.322	0.458	1	2.159
C_{64}	0.742	0.49	0.463	1
CR	0.03			

Table X Combination pair-wise comparison and consistency ratio for KM architecture

C_7: KM architecture	C_{71}	C_{72}	C_{73}	C_{74}	C_{75}	C_{76}	C_{77}	C_{78}	C_{79}	$C_{711}0$	C_{711}
C_{71}	1	1.48	2.493	2.587	2.884	2.658	2.749	2.789	2.667	3.476	2.608
C_{72}	0.676	1	1.94	1.979	3.62	2.587	2.633	2.376	2.289	2.305	2.493
C_{73}	0.401	0.838	1	1.225	1.414	1.698	2.714	2.376	2.098	1.944	3.485
C_{74}	0.386	0.505	0.816	1	1.732	1.07	2.289	2.493	2.804	2.289	3.203
C_{75}	0.347	0.276	0.707	0.852	1	2	3.813	3.984	3.915	3.328	4.063
C_{76}	0.376	0.386	0.589	0.935	0.5	1	3.383	3.26	3.086	2.04	3.26
C_{77}	0.364	0.38	0.368	0.437	0.262	0.295	1	1.484	1.651	2.854	1.543
C_{78}	0.359	0.421	0.421	0.401	0.251	0.307	0.674	1	1.732	1.442	1.619
C_{79}	0.375	0.437	0.477	0.357	0.255	0.324	0.608	0.577	1	2.182	1.049
C_{710}	0.288	0.434	0.514	0.437	0.309	0.49	0.35	0.693	0.458	1	1.619
C_{711}	0.383	0.401	0.299	0.312	0.246	0.307	0.648	0.618	0.953	0.918	1
CR	0.04										

Table XI Combination pair-wise comparison and consistency ratio for technical infrastructure

C_8: Technical infrastructure	C_{81}	C_{82}	C_{83}	C_{84}	C_{85}
C_{81}	1	4.189	4.263	3.302	2.445
C_{82}	0.239	1	1.944	2.696	3.203
C_{83}	0.23	0.514	1	1.201	3.203
C_{84}	0.303	0.371	0.893	1	2.57
C_{85}	0.408	0.312	0.312	0.389	1
CR	0.03				

4.3. Calculation of portion percentage of influential factors

Once the importance weights of main aspects and influential factors are determined, according to AHP method, multiplying the importance weights of main aspects by influential factors can obtain global priority:

$$G_{ij} = W_i \times L_{ij},\ i = 1, 2, ..., 8$$

j is based on the number of subdivision of its main aspects.

Figure 2 The weights of main aspects

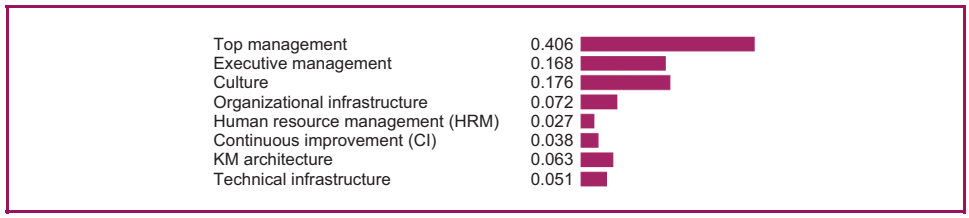


Figure 3 The weights of top management factors

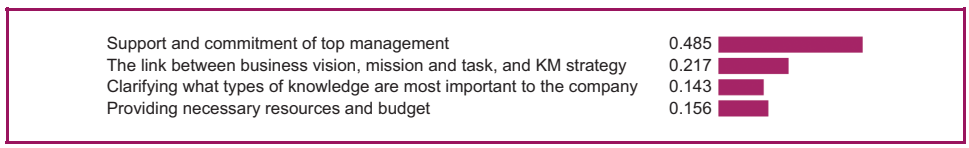


Figure 4 The weights of executive management factors

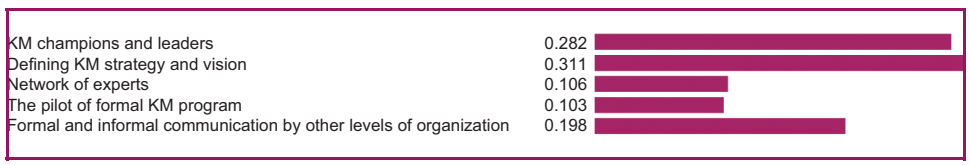


Figure 5 The weights of culture factors

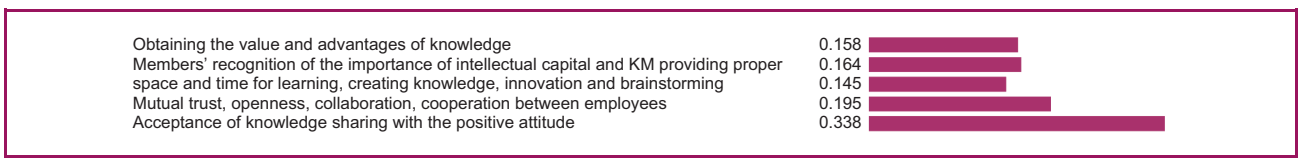


Figure 6 The weights of organization infrastructure factor

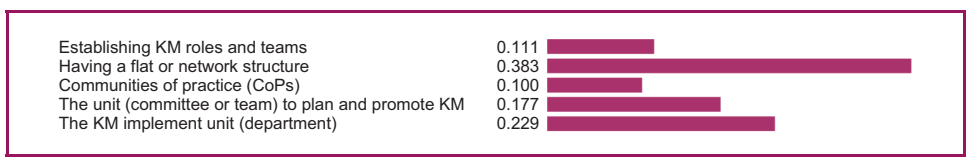


Figure 7 The weights of human resource management factors

Figure 8 The weights of continuous improvement factors

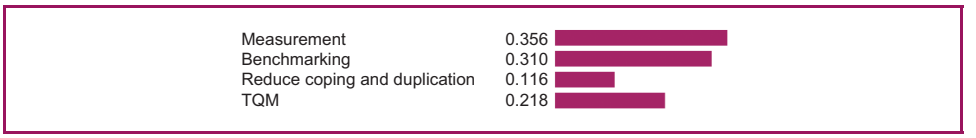


Figure 9 The weights of KM architecture factors

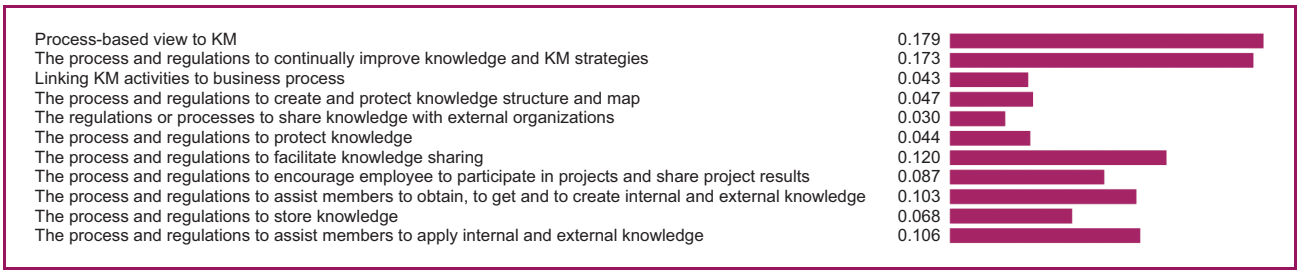


Figure 10 The weights of technical infrastructure factors

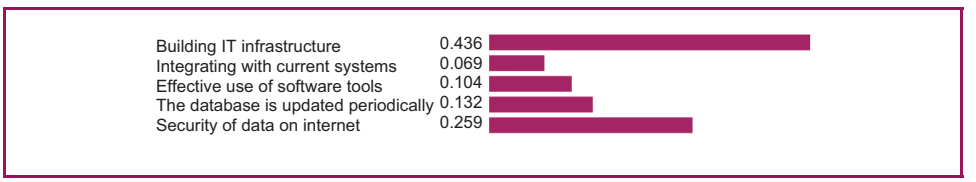


Table III shows the importance weights of influential factors and percentage values of influential factors affecting success of KM implementation. Figure 11 also shows the modified conceptual model.

4.4. Discussion

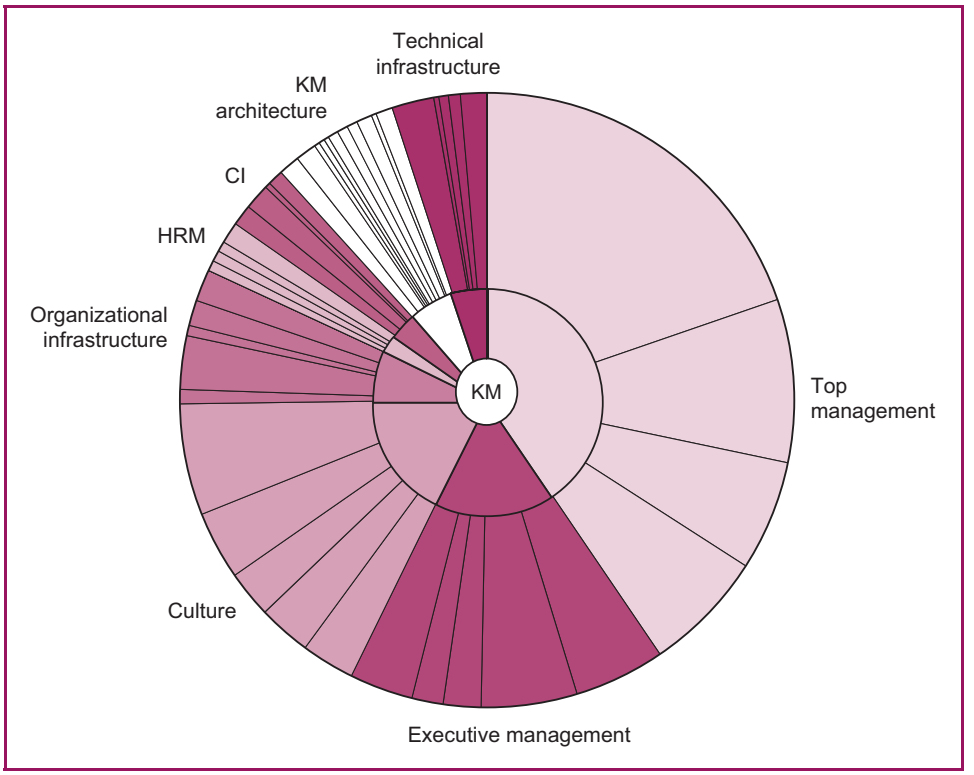
The percentage values for critical factors of KM in relation to eight major aspects and 44 influential factors are summarized in Table XII. These analytical results indicate that top management, executive management and culture have more portions 40.6, 16.8 and 17.6 respectively. Furthermore, top management support and commitment has the greatest priority (19.7).

In addition, the link between business vision, mission and task, and KM strategy; clarifying what types of knowledge are most important to the company; providing necessary resources and budget; defining KM strategy and vision; KM champions and leaders; mutual trust, openness, collaboration, cooperation between employees; formal and informal communication by other levels of organization; members' recognition of the importance of intellectual capital and KM; having a flat or network structure; obtaining the value and advantages of knowledge; providing proper space and time for learning, creating knowledge, innovation and brainstorming; and building IT infrastructure and the KM implement unit (department) have bigger percentages in comparison to other factors.

Chang and Wang (2009) in their research article titled ''Using the fuzzy multi-criteria decision making approach for measuring the possibility of successful KM'' conclude that the performance of mutual communication, cooperation and negotiation among employees, invigorates:

- employees to share knowledge with others;
- participation and support from senior administrators;

Figure 11 Final conceptual prioritized influential factors based on calculated weights



- a learning atmosphere of an organization;
- direct participation; and
- trust relationships among staff.

In addition this research also support some influential factors of their study such as cooperation between employees, and providing proper space and time for learning. Different results caused by environmental situations and conditions between two countries.

In addition, Kimble and Bourdon (2008) explore the contribution of communal structures such as CoPs on intraorganizational KM. Their results of an exploratory qualitative survey, involving CKOs of 12 large French businesses were presented which have examined the contribution that communal structures such as CoPs can make to intraorganizational KM. Those results highlight some of ''success factors'' for the communal management of knowledge. Two types of factors in particular appear to encourage the sharing of knowledge: those related to the characteristics of a CoP, and the organizational context (the support of management, the provision of resources for the community, an organizational structure that facilitates collaboration, an organizational culture of sharing training in the use of supporting technologies, appropriate systems of evaluation and incentives, the support of HRM) (Kimble and Bourdon, 2008). As shown in Table II, this research is in line with their findings.

Moreover, Kruger and Johnson (2010) in their research article titled ''Information management as an enabler of KM maturity: a South African perspective'' explore the relationship between information and communications technology (ICT), which is one of our influential factors, information management (IM) and KM. In spite of prior studies which suggest that KM is strongly entrenched and rests on the foundation of ICT and IM, they investigate the maturity of ICT and IM as enablers to KM by using questionnaire as well as interviewing 434 employees from 86 South African-based organizations within the nine industry groupings. Their findings indicate most organizations surveyed agree that ICT

Table XII Importance weights of influential factors, percentage values influential factors affecting success of successful knowledge management implantation

Main factor (C_i)	Weights of main aspects (W_i)	Influential factor (C_{ij})	Local priority (L_{ij}) n	Local priority (L_{ij}) Ranking order	Global priority (G_{ij})	Percentage of global priority n	Percentage of global priority Ranking order
C_1	0.406	C_{11}	0.485	1	0.197	19.7	1
		C_{12}	0.217	2	0.088	8.8	2
		C_{13}	0.143	4	0.058	5.8	4
		C_{14}	0.156	3	0.063	6.3	3
C_2	0.168	C_{21}	0.282	2	0.047	4.7	7
		C_{22}	0.311	1	0.052	5.2	6
		C_{23}	0.106	4	0.018	1.8	15
		C_{24}	0.103	5	0.017	1.7	16
		C_{25}	0.198	3	0.033	3.3	9
C_3	0.176	C_{31}	0.158	4	0.028	2.8	11
		C_{32}	0.164	3	0.029	2.9	10
		C_{33}	0.145	5	0.026	2.6	13
		C_{34}	0.195	2	0.034	3.4	8
		C_{35}	0.338	1	0.06	0.06	22
C_4	0.072	C_{41}	0.111	4	0.008	0.8	20
		C_{42}	0.383	1	0.027	2.7	12
		C_{43}	0.1	5	0.007	0.7	21
		C_{44}	0.177	3	0.013	1.3	18
		C_{45}	0.229	2	0.016	1.6	17
C_5	0.027	C_{51}	0.081	4	0.002	0.2	26
		C_{52}	0.068	5	0.002	0.2	26
		C_{53}	0.202	3	0.005	0.5	23
		C_{54}	0.229	2	0.006	0.6	22
		C_{55}	0.42	1	0.011	1.1	20
C_6	0.038	C_{61}	0.356	1	0.013	1.3	18
		C_{62}	0.31	2	0.012	1.2	19
		C_{63}	0.116	4	0.004	0.4	24
		C_{64}	0.218	3	0.008	0.8	20
C_7	0.063	C_{71}	0.179	1	0.011	0.1	27
		C_{72}	0.173	2	0.011	0.1	27
		C_{73}	0.043	10	0.003	0.3	25
		C_{74}	0.047	8	0.003	0.3	25
		C_{75}	0.03	11	0.002	0.2	26
		C_{76}	0.044	9	0.003	0.2	26
		C_{77}	0.12	3	0.008	0.8	20
		C_{78}	0.087	6	0.005	0.5	23
		C_{79}	0.103	5	0.007	0.7	21
		C_{710}	0.068	7	0.004	0.4	24
		C_{711}	0.106	4	0.007	0.7	21
C_8	0.051	C_{81}	0.436	1	0.022	2.2	14
		C_{82}	0.069	5	0.004	0.4	24
		C_{83}	0.104	4	0.005	0.5	23
		C_{84}	0.132	3	0.007	0.7	21
		C_{85}	0.259	2	0.013	1.3	18
Total	1					1	100

(78.69 percent) and IM (69.65 percent) are enablers to KM, supporting the position that IM, and ICT are prerequisite to KM (Kruger and Johnson, 2010).

The effectiveness of the knowledge map, which is the fourth influential factor of the KM architecture aspect, is confirmed by Lai *et al.* (2009). According to their research from a sample of 133 employees, mostly from four international high-tech companies in the Hsin-Chu Science-based Industrial Park in Taiwan titled ''How knowledge map fit and personalization affect success of KMS in high-tech firms '' conclude that KMS with a higher level of knowledge map fit and personalization which is defined as the extent to which functionality, interface, content, or distinctiveness of KMS can be capable of being tailored to meet idiosyncratic needs of the user will satisfy employees directly or indirectly through the

mediation effects of increased perceptions of ease of use and usefulness of KMS. Moreover, a good knowledge map fit not only enables knowledge workers to acquire knowledge and understand domain concepts better but also facilitate knowledge diffusion, sharing, and creation as well. In addition, decision making, problem-solving processes, and response time for knowledge workers could be improved through providing a fitted knowledge map (Lai *et al.*, 2009).

In this article, the authors define a conceptual model of KM as well as new classification of critical factors of KM implementation. Furthermore, in most of the pervious research works, authors refer to some critical factors but this paper keeps a holistic approach toward KM and also introduces some other factors that appear to be absent in previous studies.

5. Conclusion

Knowledge is now a major driving force for organizational changes and wealth creation, and effective KM is an increasingly important source of competitive advantage and a key to the success of modern organizations (Savvas and Bassiliades, 2009). Implementing KM effectively requires challenging recognition, which holds back KM from performing well as well as criteria exploration, which affects KM implementation, then keeping approaches and defining strategies based on them.

Berends *et al.* (2007) express KM that is profitable in technology-based new business development (NBD) if different approach is adopted which is exploration instead of the exploitation of knowledge by externalization, collecting, and disseminating knowledge. In simpler term, an exploration approach to KM in order to support NBD should focus on experimenting (by providing time and resources for experimenting with new technologies, creating loose structures, tolerating uncertainty and ambiguity and actively probing markets), monitoring (keeping others up-to-date on internal developments) and integrating (by enhancing loose connections and boundary spanning activities). However, there is also a supportive role for exploitation in radical innovation. Without knowledgeable researchers, engineers, project managers and marketeers radical innovation is impossible.

According to O'Leary (1999), the principle functions of a KM system are to facilitate: conversion of data and text into knowledge; conversion of individual and group's knowledge into accessible knowledge; connection of people and knowledge to other people and other knowledge; communication of information between different groups; creation of new knowledge that would be useful to the organization (Fernández-Breis and Martínez-Béjar, 2000). Since KM implementation is a long-term continuum with an impact that is not immediate, defining main aspects and influential factors and prioritizing them in KM implementation is required to establish KM system and implement KM projects successfully. This study proposes a framework based on the multi-criteria decision making approach for prioritizing critical factors affecting KM implementation. Furthermore, the authors utilized opinion of KSTP's experts to prioritize CSFs.

Consequently, organizations or enterprises can apply the proposed prioritizing model to improve their decision making and implement appropriate actions to avoid pitfalls (waste of time and resource) before initiating KM project.

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