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KMPI: measuring knowledge management performance

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Abstract

This paper provides a new metric, knowledge management performance index (KMPI), for assessing the performance of a firm in its knowledge management (KM) at a point in time. Firms are assumed to have always been oriented toward accumulating and applying knowledge to create economic value and competitive advantage. We therefore suggest the need for a KMPI which we have defined as a logistic function having five components that can be used to determine the knowledge circulation process (KCP): knowledge creation, knowledge accumulation, knowledge sharing, knowledge utilization, and knowledge internalization. When KCP efficiency increases, KMPI will also expand, enabling firms to become knowledge-intensive. To prove KMPI's contribution, a questionnaire survey was conducted on 101 firms listed in the KOSDAQ market in Korea. We associated KMPI with three financial measures: stock price, price earnings ratio (PER), and R&D expenditure. Statistical results show that the proposed KMPI can represent KCP efficiency, while the three financial performance measures are also useful.

Keywords: Knowledge management performance; Knowledge circulation process; Logistic function; KMPI; Factor analysis

1. Introduction

A knowledge-based view of a company has emerged as an important topic in strategic management. It provides a theoretical basis on why knowledge-based resources play an important role in increasing the sustainable competitiveness of the firm [10,60,61]. A resource-based view of a company [4,72,81] promotes a knowledge-based perspective, which postulates that competitive advantage builds upon those privately developed resources, tacit and explicit, inside the firm. Similarly, the knowledge-based view of the firm assumes that the knowledge assets existing at any given time provide an opportunity for sustainable competitive advantage [25]. Those assets tend to be created, accumulated, shared, and utilized among individuals more easily by employing information technology (IT) and information system. In this era of IT, a knowledge-based view of the firm can explain convincingly why certain firms are more competitive under the same market conditions. The knowledge assets are dependent upon the quality of organizational knowledge and intangible assets in general [21,22].

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Thus, there is an important research question: why do most firms that initiated KM still struggle to develop appropriate metrics to assess the effectiveness of their initiative? In other words, there is a need for metrics to justify KM initiatives. Also, linking KM initiatives to financial investment may help justify KM to senior management and thus improve the firm's ability to manage knowledge assets effectively.

Given that most KM benefits are intangible, one method of measurement is the balanced scorecard. This includes both financial and other perspectives; e.g., customers, internal business processes, innovation and learning, etc. However, linking KM initiatives to performance is not enough. We need a more rigorous metric to assess KM performance with the ability to explain it and suggest future strategic actions that the firms should take to improve KM performance.

Our research objective was therefore to propose a new metric, which we called the knowledge management performance index (KMPI), to evaluate knowledge management performance. The basic assumption underlying it is that knowledge may be viewed from a unified perspective; it circulates in the organization creating knowledge assets and influencing organization performance. It has multifaceted characteristics, such as: state of mind [54], object [9], having access to information [37], or the potential for influencing future action [78]. Alavi and Leidner [2] summarized the distinction between these perspectives about knowledge. Table 1 is an excerpt from their paper.

Based on a unified perspective of knowledge, we made the following assumptions:

(1) KM activities result in knowledge circulation processes; there are five components: creation, accumulation, sharing, utilization, and internalization of knowledge.
(2) KM is defined tactically by all kinds of management activities that promote the use of KCP.
(3) A firm can increase its flexibility and adaptability in a rapidly changing business environment by focusing on the efficiency of KM activities.
(4) With the firm's adoption of KM, KMPI will gradually increase.

2. KM studies

Previous studies of KM built on multiple disciplines; e.g., management, computer science, and information systems theory. This study reviewed previous KM literature at the start: these are summarized in Table 2.

Some KM studies dealt with the managerial and social issues. These (e.g., [15,84]) stressed the importance of the strategy behind KM and the organizational culture within which it operates. Other studies focused directly on specific processes and activities within KM; knowledge acquisition, generation, storage, distribution, application, and measurement [1,11,26,38,46,62,70,76]. Similarly, the research agenda and general perspective of KM, based on literature review, have been addressed [14,20].

Some KM studies took a management perspective that asked how learning organization could obtain sustainable competitive advantage. The same knowledge has to be developed because no one knows who

Table 1
Diverse perspectives of knowledge and their implications for KM (excerpt from [2], p. 111)

	Perspectives	Implications for KM
State of mind	Knowledge is the state of knowing and understanding	KM involves enhancing individual's learning and understanding through provision of information
Object	Knowledge is an object to be stored and manipulated	Key KM issue is building and managing knowledge stocks
Process	Knowledge is a process of applying expertise	KM focus is on knowledge flows and the process of creation, sharing, and distributing knowledge
Access to information	Knowledge is a condition of access to information	KM focus is organized access to and retrieval of content
Capability	Knowledge is the potential to influence action	KM is about building core competencies and understanding strategic know-how

Table 2
KM studies

Category	Implications	Sub-categories	Researchers
General	Several managerial and social issues pertaining to KM are dealt with	KM strategy and organizational culture	[15,84]
		Specific processes and activities within KM	[1,11,26,38,46,70,76]
		Review and research agenda	[2,14,20]
Learning organization	Firms maintain organizational knowledge to obtain a sustainable competitive advantage	Organizational knowledge	[34,53,56,64,65,74,77]
		Learning capability and design of leaning organization	[30,47,59,75]
Role of IT	KM should be supported by IT and/or KMS so that KM can contribute to increasing management performance	Knowledge management system (KMS)	[5,13,23,50,57,79]
		Role of IT in KM in general	[45]
		Role of IT for specific KM activities	[33,63,67]
		Knowledge mining and DSS for KM	[27,50,62]
		Strategic use of the Internet	[8,16,17,35,48,55,71]
Success and failure factors	Success factors for KM should be given sufficient consideration before launching KM strategy		[13,29,51]
Evaluation of KM performance	Valuing and measuring intangible assets promotes organizational. learning and generates organizational capabilities	Intellectual capital	[7,18,68]
		Balanced Score Card	[28]
		Strategic organizational learning and organizational capabilities	[31,36,49,52,66,72,73]

in the company has the required knowledge [32]. The notion of how knowledge was acquired and how it was assembled and restructured could provide a competitive advantage for a company. According to Stata [64] and Senge [56], learning was the only sustainable competitive advantage, and a learning situation resulted in organizational knowledge (or memory) [53].

Markus [34] developed a theory of organizational knowledge reuse. The corporate memory has an effect on present decisions and plays an important role in the success of an organization's operations and response to changes and challenges [65]. There have been many attempts to help organizations improve their learning capability and to become learning systems [47]. In addressing how organizations can improve their learning capability, researchers identified a number of problems that were faced [30,59,75].

Some studies have addressed the role of IT in KM. It has been considered in KM in general [45] or in particular [33,63,67]. A knowledge management system (KMS) is a specialized IS for KM using modern technologies (e.g., the Internet, intranets, browsers, data warehouses, and software agents) to systematize, facilitate, and expedite firm-wide KM. KMS research consists primarily of general and conceptual principles and case studies of such systems in a few organizations [5,57,79]. In particular, Gray [23] describes how KMS can enhance the effectiveness of teams that analyze complex, non-recurring problems by improving the way that their team composition evolves. Knowledge mining is similar to data mining. However, Rouse et al. [50] have used mining to extract knowledge from several data sources and apply it to more complicated and value-added problems: DSS could be used to provide the right knowledge in the right form to the right persons at the right time. Several papers have dealt with the strategic use of the Internet for KM activities. Dieng [16] discussed the potential of the Internet and intranets in developing distributed KMS. The XML-based meta language was developed for knowledge retrieval [35].

A KMS prototype named PlanetOnto was proposed to support an academic community in constructing and sharing an archive of news items [17]. Schwartz and Te'eni [55] used the internet and e-mail to

disseminate knowledge. Rabarijaona et al. [48] utilized XML to support corporate users by translating the corporate ontology into an annotation document type definition. A representational infrastructure and a computational DSS framework were proposed for creating design repositories on the internet [71] and also in assisting a distributed team of designers in conceptual design evaluation on the web [8].

The success and failure factors of KM have also been examined. Davenport et al. [13] looked at successful KM projects to determine eight key factors to help a company create, share, and use knowledge efficiently. Success factors included compensation of the knowledge provider, incentive systems, organization culture, etc. [29].

3. The knowledge circulation process for organizational performance

The first component of KCP is knowledge creation. This deals with a variety of knowledge, whether tacit or explicit and is accelerated by encouraging synergistic interrelations of individuals from diverse backgrounds.

Knowledge accumulation is the second component. All individuals in the firm must have access to the base to obtain the relevant knowledge to aid in their work and decision making. The knowledge accumulated in firms can play an important role in eliminating obstacles and inefficiencies and, at the same time, in improving management performance [77]. However, if knowledge created through management activities for years is not accumulated systematically, it cannot be beneficial for future decision-making needs.

The third component of KCP is knowledge sharing, which promotes diffusion of knowledge and also contributes to making the work process astute and knowledge-intensive: workers consider themselves to be knowledge workers. If they can find the knowledge from the knowledge source administered by the firms, they are able to apply it to complete their works successfully. This requires integration of knowledge from multiple sources to obtain improved performance.

Knowledge utilization, the fourth component of KCP, can occur at all levels of management activities in firms: one of the popular forms of knowledge utilization is to adopt the best practice from other leading organizations, uncover relevant knowledge, and apply it [40].

The fifth component is knowledge internalization, which may occur when individual workers discover relevant knowledge, obtain it and then apply it. Therefore, internalization may give rise to new knowledge. In this way, it provides a basis for active knowledge creation.

Organizations need to support the combination of various components of the KMS, such as developing its infrastructure, securing new and existing knowledge, distributing it, and combining it [82]. Nonaka and Takeuchi [39] proposed that knowledge conversion, from tacit to explicit knowledge and vice-versa, occurs through a life 'knowledge flow' cycle: socialization, internalization, externalization, and combination. Knowledge management can be described as the management of the environment, making knowledge flow through the different phases of its life cycle.

Thus, knowledge developed at one place in an organization can be made available to other units through an organizational knowledge repository. Companies survive with the continuous development of new knowledge based on creative ideas, daily experiences, and work in R&D departments. A company can only perform at its best if all available knowledge areas are combined.

The effectiveness of KCP is influenced by the organizational culture: human relationships, harmony between decision-making entities, quality of the work process, strategic alliances with vendors, customer trust, effectiveness of strategic management, and the CEO's character and vision, etc. Therefore, KCP has always been present in firms, and organizational knowledge increases as KCP supports management activities.

Tuomi [74] suggested a reverse hierarchy of knowledge in which organizational knowledge was created when information was given meaning from data that emerged as a by-product of cognitive artifacts. Thus KMPI increased only if the KCP efficiency was improved, and the existence of knowledge can create competence and enhance management performance.

Knowledge accumulated in firms is a by-product of KCP. Therefore, it has flow and speed. If the flow is

fast, then knowledge is accumulated, shared, utilized, and internalized quickly, and thus management performance increases and the proposed KMPI improves.

4. Theoretical framework

4.1. Rationale for the metrics of KM performance

KMPI resulted from studies in marketing and KM. In marketing, the customer satisfaction index (CSI) was developed to assess the firm's past, current, and future performance [3,19]. The CSI measures the quality of the goods and services, as experienced by the customers that consume them. The American CSI (ACSI) uses a multiple indicator approach is general enough to be comparable across firms, industries, sectors, and nations. ACSI is embedded in the cause and effect relationships, making it the centerpiece in a chain of relationships running from the antecedents of overall customer satisfaction: expectations, perceived quality, and value—to its consequences—decreased complaints and increased customer loyalty. When the relationship between the antecedents and the consequences is properly managed, the firm is successful in turning complaining customers into loyal customers.

Practicing KM for years can produce various forms of knowledge asset (intangible assets or intellectual capital) in firms. Edvinsson [18] showed that the intellectual capital of a firm can be measured, documented, and monitored. Brooking [7] analyzed the multiple components of intellectual capital and provided lists of high-level questions useful for auditing an organization's intellectual capital. In addition, Sveiby [68] detailed how to use and measure intangible assets and how to monitor them for financial success. Kaplan and Norton [28] developed a Balanced Score Card (BSC) using a combination of measures in four categories (financial performance, customer knowledge, internal business processes, and learning and growth) to align individual, organizational, and cross-departmental initiatives. They expected that BSC would help companies test and update their strategy and meet their customer's needs and shareholder's objectives.

The evaluation of KM performance has become increasingly important since it promotes strategic organizational learning [36,49,52,66,73] and generates the capabilities required to meet customer expectations. The objective of our study was to introduce KMPI, a new metric measurement in assessing KM performance.

4.2. Concepts of KMPI

Peffers and Dos Santos [44] suggested a measurement mechanism for IT impacts; in it a metric of performance effects of IT applications was developed. They measured the impact of automatic teller machines on market share and overall bank performance using an S-shaped logistic model:

$$y = \frac{m}{1 + e^{a+bt}}$$

where y is the benefit of the IT application at time t, m is the upper bound on the benefits of the application, and a and b are constants that determine the shape of the curve.

The rate at which the system benefits increase will be small while users learn a new application and integrate it into the existing operations. The rate then increases, as users become familiar with it. The rate, however, slows as the benefits approach the limit that can be gained from the application, or when competitors invest in similar applications in response to the benefits obtained by innovators. A similar rational can be applied in the context of KMS, because knowledge asset will be limited. Rather, the increase rate will naturally saturate. In this sense, we followed the logic of [44] in developing KMPI.

If KCP efficiency increases, then KMPI will improve, turning firms into knowledge-intensive businesses. The expansion of KMPI per unit time is thus also modest at first, then increases rapidly, and finally slows down. KCP has a dynamic nature because it represents a knowledge flow concept where five components of knowledge circulation are interlinked.

4.3. Constructs of KMPI

The impact of KCP application at time t is proportional to the KMPI gained at time $t-1$ (i.e., KMPI_{t-1}) relative to the maximum possible KMPI gains from the KCP application (i.e., 1) and the remaining KMPI

yet to be gained (i.e., $1 - \mathrm{KMPI}_{t-1}$). This description of KMPI over time t can be expressed as:

$$\frac{\mathrm{dKMPI}}{\mathrm{d}t} = -\mathrm{KCP}\,(1 - \mathrm{KMPI}_{t-1}) \tag{1}$$

where KCP is a term denoting efficiency of KM in the organization. Solving (Eq. (1)) for KMPI yields:

$$\mathrm{KMPI}_t = \frac{1}{1 + \mathrm{e}^{a+\mathrm{KCP}t}} \tag{2}$$

Eq. (2) is the S-shaped logistic model, where 1 is the upper bound on the KMPI from the KCP application. We assume that constant a is zero because each organization is supposed to start with very small KMPI. The next step is to compute KCP. Therefore, the final expression for KMPI is:

$$\mathrm{KMPI}_t = \frac{1}{1 + \mathrm{e}^{\mathrm{KCP}t}} \tag{3}$$

The KCP term in (Eq. (3)) is a function of the relative weight of the eigenvalue (RWE) of each knowledge circulation component multiplied by the average factor value (AFV) of the corresponding knowledge circulation component.

$$\begin{aligned}\mathrm{KCP} = {} & \mathrm{RWE}_{\mathrm{KC}}\,\mathrm{AFV}_{\mathrm{KC}} + \mathrm{RWE}_{\mathrm{KA}}\,\mathrm{AFV}_{\mathrm{KA}} \\ & + \mathrm{RWE}_{\mathrm{KS}}\,\mathrm{AFV}_{\mathrm{KS}} + \mathrm{RWE}_{\mathrm{KU}}\,\mathrm{AFV}_{\mathrm{KU}} \\ & + \mathrm{RWE}_{\mathrm{KI}}\,\mathrm{AFV}_{\mathrm{KI}}\end{aligned} \tag{4}$$

where KC is knowledge creation, KA knowledge accumulation, KS knowledge sharing, KU knowledge utilization, and KI knowledge internalization.

4.3.1. Knowledge creation

To measure knowledge creation, two constructs were needed: tasks understandings and information understandings. The first was measured by assessing the responses to three questions: (1) I often use an electronic bulletin board to analyze tasks, and (2) My predecessor adequately introduced me to my tasks, (3) I fully understand the core knowledge necessary for my tasks. Information understandings was measured by answers to four items [31]: (4) I obtain useful information and suggestions from brainstorming meetings without spending too much time, (5) I am ready to accept new knowledge and apply it to my tasks when necessary, (6) I understand computer programs needed to perform the tasks and use them well, and (7) I search information for tasks from various knowledge sources administered by organization.

4.3.2. Knowledge accumulation

An instrument to assess knowledge accumulation used three constructs: database utilization, systematic management of task knowledge, and individual capacity for accumulation. Database utilization was operationalized by two items [41–43]: (1) We refer to corporate database before processing tasks, and (2) We extensively search through customer and task-related databases to obtain knowledge necessary for the tasks. Systematic management of task knowledge is operationalized by three items: (3) We try to store expertise on new tasks design and development, (4) We try to store legal guidelines and policies related to tasks, and (5) We are able to systematically administer knowledge necessary for the tasks and store it for further usage. Individual capacity for accumulation was operationalized by two items, and (6) We document such knowledge needed for the tasks, (7) We summarize education results and store them.

4.3.3. Knowledge sharing

Degree of sharing knowledge depends on constructs such as core knowledge sharing and knowledge sharing. Core knowledge sharing was measured by two items [69]: (1) We share information and knowledge necessary for the tasks, and (2) We improve task efficiency by sharing information and knowledge. Knowledge sharing in organization was operationalized by two items [51]: (3) We promote sharing of information and knowledge with other teams, and (4) We developed information systems like intranet and electronic bulletin boards to share information and knowledge.

4.3.4. Knowledge utilization

Knowledge utilization depends on two constructs: degree of knowledge utilization in organization, and knowledge utilization culture. The former was operationalized by three items [6,80]: (1) Team work is promoted by utilizing organization-wide information and knowledge, (2) EDI is extensively used to facilitate processing tasks, and (3) Work flow diagrams are required and used in performing tasks. The latter was operationalized by three items [83]: (4) There exists a

culture encouraging knowledge sharing, (5) There exist incentive and benefit policies for new idea suggestions through utilizing existing knowledge, and (6) There exist research and education programs.

4.3.5. Knowledge internalization

Knowledge internalization is measured by three constructs: capability to internalize task-related knowledge, education opportunity, and level of organization learning. Capability to internalize task-related knowledge was operationalized by four items: (1) I have a unique mastery of the tasks, (2) I can learn what is necessary for new tasks, (3) I can use the Internet to obtain knowledge for the tasks, and (4) I can refer to best practices and apply them to my tasks. Education opportunity was operationalized by two items: (5) Employees are given educational opportunities to improve adaptability to new tasks, and (6) University-administered education is offered to enhance employees' ability to perform the tasks. Level of organization learning was operationalized by three items: (7) Professional knowledge such as customer knowledge and demand forecasting is managed systematically, (8) Organization-wide standards for information resources are built, and (9) Organization-wide knowledge and information are updated regularly and maintained well.

4.4. Test of KMPI

KCP has an influence on the efficiency of work processes and management performance. We claim that KMPI can measure the quality of organizational knowledge, and that it is related directly and/or indirectly with the firms' management performance. Therefore, we hypothesize that firms with good quality organizational knowledge will increase their KMPI, and that those with a larger KMPI will improve management performance. We adopted three specific measures (stock price, PER, and R&D expenditure) to translate management performance into tangible statistics. Thus, our research hypotheses were:

Hypothesis 1. If KMPI is greater, then the stock price is significantly better.

Hypothesis 2. If KMPI is greater, then the PER is significantly better.

Hypothesis 3. If KMPI is greater, then the R&D expenditure is significantly better.

5. Methodology

5.1. Survey instrument development

Design of the survey was influenced by Churchill's [12] recommendations for developing reliable and valid measures. Initially, a questionnaire with 40 questions was prepared. Open-ended interviews were used. Two professors, four doctoral candidates, and two practitioners, all of whom had been studying or practicing KM for years, were interviewed to determine the validity of questionnaire items. Discussions with the two professors helped in developing operational measures. Upon completion of these interviews, a pre-test was conducted where 18 executives from different companies were asked individually to evaluate the instrument and comment on its clarity and understandability. All responded and, based on the feedback received, seven items were deleted from the original 40. After evaluation, we concluded that the questionnaire should use a seven-point Likert scale, ranging from 1 (strongly disagree) to 4 (neutral) to 7 (strongly agree), for measuring KMPI.

Table 3
Distribution of respondents

Sales volume (unit: $ 1000)	No. of respondents	Percentage
(a) Distribution by sales volume		
$ 1000≤	16	15.9
$ 1000–10,000	28	27.7
$ 10,000–100,000	42	41.5
≥$ 100,000	15	14.9
Total	101	100
No. of full-time employees	**No. of respondents**	**Percentage**
(b) Distribution by full-time employees size		
20≤	18	17.8
20–50	37	36.6
50–100	35	34.7
≥100	11	10.9
Total	101	100

Table 4
Factor structure of variables ($N = 101$)

Factor	Eigenvalue	Cronbach's alpha	Items	Factor loadings	Convergent validity
Knowledge utilization	4.13	0.86	There are research and educational programs	0.80	0.86
			Team work is promoted by utilizing organization-wide information and knowledge	0.64	0.68
			EDI is extensively used to facilitate processing tasks	0.62	0.72
			There exist incentive and benefit policies for new idea suggestions in utilizing existing knowledge	0.53	0.67
			There exists a culture encouraging knowledge sharing	0.52	0.71
			Work flow diagrams are required and used in performing tasks	0.51	0.68
Knowledge accumulation	4.11	0.83	We refer to corporate database before processing tasks	0.72	0.62
			We try to store expertise on new tasks design and development	0.68	0.65
			We try to store legal guidelines and policies related to tasks	0.67	0.69
			We extensively search through customer and task-related databases to obtain knowledge necessary for the tasks	0.57	0.66
			We document such knowledge needed for the tasks	0.55	0.81
			We summarize education results and store them	0.54	0.65
			We are able to systematically administer knowledge necessary for the tasks and store it for further usage	0.51	0.85
Knowledge internalization by education opportunity and organizational learning	3.24	0.77	I have a unique mastery of the tasks	0.71	0.72
			Professional knowledge such as customer knowledge and demand forecasting is managed systematically	0.64	0.60
			Organization-wide standards for information resources are built	0.62	0.71
			Employees are given educational opportunities to improve adaptability to new tasks	0.60	0.66
			University-administered education is offered to enhance employees' ability to perform tasks	0.57	0.75
			Organization-wide knowledge and information are updated regularly and maintained well	0.50	0.70
Knowledge internalization by task-related knowledge	2.48	0.78	I can learn what is necessary for new tasks	0.70	0.63
			I can refer to best practices and apply them to my tasks	0.65	0.62
			I can use the Internet to obtain knowledge for the tasks	0.56	0.69
Knowledge sharing	2.35	0.75	We share information and knowledge necessary for the tasks	0.88	0.64
			We improve task efficiency by sharing information and knowledge	0.78	0.73
			We developed information systems, like intranet and electronic bulletin boards, to share information and knowledge	0.72	0.71
			We promote sharing of information and knowledge with other teams	0.54	0.61
Knowledge creation by task understandings	2.34	0.72	I often use an electronic bulletin board to analyze tasks	0.64	0.62
			My predecessor adequately introduced me to my tasks	0.63	0.64
			I fully understand the core knowledge necessary for my tasks	0.55	0.66
Knowledge creation by information understandings	2.01	0.70	I obtain useful information and suggestions from brainstorming meetings without spending too much time	0.75	0.63
			I search information for tasks from various knowledge sources administered by the organization	0.56	0.67
			I understand computer programs needed to perform the tasks and use them well	0.55	0.64
			I am ready to accept new knowledge and apply it to my tasks when necessary	0.53	0.71

5.2. Data collection

A cross-sectional field survey was conducted of companies in the KOSDAQ market in Korea. A directory of firms compiled by a securities brokerage company was used as the sampling frame. This consisted of firms with at least one of the following three criteria:

(1) They were members of the KOSDAQ market.
(2) Their operating years were similar to one another because our definition of KM, with KCP application starting with the founding of firm and then KMPI thus increasing from its inauguration date, requires the same number of years in operation to avoid biases in measuring KMPI. As the KOSDAQ market opened in 1996, the companies surveyed had about the same number of years of operation.
(3) They report annual financial performance using formal accounting standards imposed by the KOSDAQ.

A senior executive of each firm surveyed was asked to respond to the questionnaire. Since using a single source had some limitations, we chose the senior executive most 'informed' about KM and KCP and its associated variables. A similar use of the 'key informant' approach had been suggested for such survey research and adopted by others [58]. Questionnaires were sent to senior executives in 250 randomly selected firms. 101 usable responses were received, providing a response rate of 40.4%.

5.3. Sample description

Table 3 provides a profile of the respondents: the number of full-time employees and their sales volume. All sizes were well represented in our sample.

6. Test results

A preliminary factor analysis validated the measures used in the KMPI calculation model. Exploratory factor analysis was adopted using the orthogonal rotation method. Seven factors had Cronbach's alpha value greater than 0.7, indicating that internal consistency is guaranteed for each. Table 4 shows the factor structure of variables, where reliability and convergent validity were significant because Cronbach's alpha was greater than or equal to 0.70, and all convergent validity was greater than 0.60 [24]. Tables 5 and 6 summarize RWE and AFV, all of which were required to calculate KMPI as shown in Table 7. Table 8 shows the correlation between KMPI and the

Table 5
Relative weight of eigenvalue (RWE)

Factor	Eigenvalue	RWE
Knowledge creation	4.35	0.21
Knowledge accumulation	4.11	0.20
Knowledge sharing	2.35	0.11
Knowledge utilization	4.13	0.20
Knowledge internalization	5.72	0.28
Total	20.66	1

Table 6
Average factor value

Organization	KC	KA	KS	KU	KI
com1	0.39	−0.68	−0.30	−0.31	0.35
com2	−0.78	0.20	0.55	0.48	1.06
com3	0.03	0.10	1.32	−1.71	−1.70
com4	2.38	1.50	0.47	1.85	0.59
com5	0.97	−0.62	−0.60	−1.11	0.38
com6	−0.28	−0.77	0.68	−0.65	−0.27
com7	0.78	−0.09	−0.35	−0.68	−0.71
com8	0.19	−1.39	0.28	0.26	0.01
com9	0.31	0.42	−1.26	−1.04	−1.15
com10	−0.85	0.44	0.38	1.07	−0.31
com11	0.50	−1.56	−1.43	−0.89	−0.42
com12	0.71	0.49	0.93	1.26	−1.66
com13	−1.06	−0.21	0.06	0.59	0.61
com14	0.63	−0.71	0.38	−0.33	0.34
com15	1.78	−2.51	−0.52	1.41	−1.23
com16	−0.18	−0.19	0.050	−1.55	0.01
com17	−1.98	−0.44	−0.55	2.19	1.45
com18	1.21	0.78	−0.03	−0.57	−0.94
com19	0.38	0.64	−0.56	0.17	−0.09
com20	1.88	−0.75	0.11	0.01	0.07
com21	0.19	0.52	0.20	−1.79	−0.27
com22	1.36	0.18	−0.26	−0.04	−0.24
com23	0.44	0.22	−0.14	−0.00	1.09
com24	−0.76	1.30	−0.48	−0.66	−0.54
com25	2.79	1.02	1.03	1.56	0.55
com26	−0.24	−0.16	−0.00	−0.57	0.19
com27	0.94	−0.33	−0.16	0.77	−0.12
com28	0.58	0.14	1.03	0.70	−0.97
com29	−0.22	1.52	−0.18	1.40	0.57
com30	0.42	−0.24	0.27	−1.68	−0.67
com31	−0.23	0.34	−0.10	−0.97	0.61

Table 6 (*Continued*)

Organization	KC	KA	KS	KU	KI
com32	0.28	0.39	−0.87	0.07	0.42
com33	−0.54	−0.03	1.40	0.24	−0.60
com34	−1.23	0.29	−1.05	0.01	−0.16
com35	−0.60	0.41	−1.48	0.48	1.01
com36	0.47	−0.45	−0.22	−1.95	−0.05
com37	−0.24	0.45	1.37	0.93	0.66
com38	−0.02	−1.05	0.70	0.31	−1.13
com39	−1.02	−0.07	−0.51	0.73	0.94
com40	−0.28	−0.15	0.57	−0.44	0.02
com41	−0.91	−0.91	0.52	0.28	0.37
com42	−0.04	−0.15	−0.81	−0.02	−0.38
com43	1.93	−0.06	0.49	1.54	0.54
com44	0.23	0.76	−1.81	−0.17	−0.24
com45	−0.22	−0.65	−0.12	−0.20	0.14
com46	−0.04	0.14	−0.37	−0.84	0.25
com47	−0.36	0.91	0.38	0.66	−0.08
com48	1.23	−0.44	1.32	−1.89	−1.02
com49	0.64	0.64	−0.01	0.28	0.02
com50	−0.76	0.09	0.43	0.24	−0.88
com51	0.20	−1.64	−0.34	0.16	−0.42
com52	0.94	0.26	0.32	1.16	0.24
com53	−1.15	−0.49	−0.86	0.03	−0.05
com54	0.10	0.85	0.20	0.32	−0.38
com55	0.24	0.86	−0.58	1.05	0.27
com56	0.60	0.77	0.40	0.68	0.43
com57	−0.86	0.78	1.28	−0.61	0.22
com58	−0.60	0.49	−0.18	0.22	−0.16
com59	0.72	−0.58	−0.48	0.68	−0.56
com60	−0.53	−1.55	0.15	−0.39	−0.58
com61	−0.77	−0.34	0.15	−0.53	0.88
com62	−1.15	−0.06	0.48	0.33	0.02
com63	1.00	1.00	0.50	1.11	−0.32
com64	2.27	0.37	−0.26	3.55	−0.48
com65	−1.41	0.65	0.33	0.51	−0.93
com66	0.97	0.81	−0.97	0.80	0.52
com67	−0.94	−0.01	0.10	−0.79	0.30
com68	−1.16	−0.44	0.82	−0.17	−0.16
com69	−0.93	−0.32	1.31	−1.42	1.03
com70	0.81	−0.24	1.20	−0.86	0.08
com71	0.63	0.44	0.06	1.07	0.99
com72	−0.52	0.07	−0.05	0.19	−1.06
com73	0.72	0.71	0.22	0.08	0.19
com74	1.60	−0.64	−0.47	−0.64	−0.59
com75	−2.97	0.37	0.81	−1.29	−1.20
com76	0.08	0.40	0.25	0.05	−0.22
com77	0.75	−0.72	0.91	1.05	0.91
com78	0.74	0.57	0.30	0.45	0.57
com79	0.59	0.26	−0.68	0.15	0.99
com80	0.64	0.73	0.07	−0.58	1.07
com81	−1.74	−0.11	−0.88	−1.39	−0.76
com82	0.63	0.44	0.06	1.07	0.99
com83	−2.97	0.38	0.81	−1.29	−1.20
com84	0.08	0.40	0.25	0.05	−0.22
com85	0.59	0.26	−0.68	0.15	0.99

Table 6 (*Continued*)

Organization	KC	KA	KS	KU	KI
com86	0.64	0.73	0.07	−0.58	1.07
com87	0.64	0.64	−0.01	0.28	0.02
com88	0.24	0.86	−0.58	1.05	0.27
com89	−0.53	1.61	0.15	−0.39	0.56
com90	0.44	0.22	−0.14	−0.00	1.09
com91	0.94	−0.33	−0.16	0.77	−0.12
com92	−0.23	0.34	−0.10	−0.97	0.61
com93	−0.28	−0.77	0.68	−0.65	−0.27
com94	0.71	0.49	0.93	1.26	−1.66
com95	1.21	0.78	−0.03	−0.57	−0.94
com96	−0.04	−0.15	−0.81	−0.02	−0.38
com97	1.93	−0.06	0.49	1.54	0.54
com98	−0.30	0.76	−1.81	−0.17	0.29
com99	−1.15	−0.49	−0.86	0.03	−0.05
com100	0.10	0.85	0.20	0.32	−0.38
com101	−0.54	−1.05	0.70	0.31	−1.13

Table 7
KMPI calculation

Organization	KMPI	Organization	KMPI
com4	0.800	com95	0.509
com25	0.798	com13	0.507
com64	0.750	com31	0.496
com43	0.712	com92	0.496
com97	0.712	com59	0.491
com71	0.671	com58	0.487
com82	0.671	com1	0.487
com29	0.662	com98	0.482
com63	0.646	com61	0.481
com52	0.642	com33	0.480
com56	0.641	com5	0.474
com77	0.641	com44	0.473
com37	0.637	com40	0.473
com66	0.636	com69	0.472
com78	0.634	com46	0.470
com80	0.615	com62	0.468
com86	0.615	com74	0.467
com55	0.608	com26	0.464
com88	0.608	com8	0.463
com23	0.603	com41	0.461
com90	0.603	com45	0.452
com79	0.599	com7	0.445
com85	0.599	com42	0.441
com73	0.596	com96	0.441
com2	0.580	com15	0.441
com49	0.580	com24	0.441
com87	0.580	com67	0.434
com89	0.576	com21	0.434
com20	0.570	com65	0.429
com17	0.567	com50	0.429

Table 7 (*Continued*)

Organization	KMPI	Organization	KMPI
com47	0.564	com68	0.422
com27	0.559	com48	0.416
com91	0.559	com6	0.416
com22	0.555	com93	0.416
com54	0.543	com72	0.412
com100	0.543	com34	0.410
com32	0.542	com16	0.407
com35	0.540	com38	0.405
com19	0.538	com51	0.400
com12	0.536	com36	0.397
com94	0.536	com53	0.391
com28	0.535	com99	0.391
com39	0.530	com30	0.390
com70	0.528	com101	0.379
com10	0.519	com9	0.373
com76	0.518	com3	0.346
com84	0.518	com60	0.345
com14	0.516	com11	0.340
com57	0.515	com81	0.273
com18	0.509	com75	0.259
–	–	com83	0.259

three financial measures. Hypotheses 1 and 2 were proved at the 0.1 significance level, while Hypothesis 3 was proved at the 0.05 significance level. This shows the value of KMPI by indicating the significance of correlation between KMPI and the three financial measures.

The empirical results in Tables 4–7 show that, as theorized, the five components of KCP significantly affected KMPI, which in turn represented the quality of organizational knowledge that was utilized in a wide variety of decision-makings in the firm. Thus, if the quality of organizational knowledge is good, we can conclude that management performance improves significantly.

Table 8
Correlation between KMPI and three financial measures

Financial measures	Correlation with KMPI
Stock price	0.23*
PER	0.21*
R&D expenditure	0.26**

* $P < 0.1$.
** $P < 0.05$.

7. Concluding remarks

This paper proposed a new metric for assessing KM performance. KCP can affect the efficiency of work processes and performance of management activities. Based on the argument regarding KCP characteristics, we claim that KMPI, can measure the quality of organizational knowledge, and that it is related to management performance. Our study shows that there is no conflict between the effects of KCP and KMPI. As the efficiency of the five components of KCP increases, KMPI is enhanced based on a review of the literature, several conclusions may be drawn.

The complexity and multifaceted nature of organizational knowledge and KM has resulted in a need to develop a new metric for assessing KM performance. To deal with this, we introduced a concept of KCP and applied it to devise a function of KMPI.

The KMPI function was basically a logistic model in which the contribution of organizational knowledge accumulated by performing KM for years starts slowly but then increases rapidly, slowing down at some point at a mature level.

The power of KMPI to represent the financial performance of firms was tested. We used three major financial indices and showed that there is a statistically significant correlation between them and KMPI.

When KMPI increases, KM performance likewise improves. Thus, KMS designers should invest their limited IS resources in the design of an appropriate KCP. KMS designers can learn about the idea level of KCP by reviewing it, and thus leading to higher performance. It is difficult for IS staff members to predict the quality or level of knowledge management but it is much easier to estimate the level of each aspect of KCP. The use of KMPI will enhance the quality of decision-making in the investment of IS resources and establishing KCP. It improves the organization where knowledge is not optimally used. This supports the improvement of the learning capacity of organizations in evaluating results of knowledge-intensive work processes, adapting knowledge, and applying new knowledge immediately.

Thus, KMS designers can recognize the value of KCP as it relates to organizational performance, allowing them to identify each pertinent KCP and develop a more accurate model of the KMS system.

KMPI provides some preliminary insights on how corporate knowledge activities should be organized to contribute maximally to KM performance.

IT has a strong impact on the effectiveness of the five components of KCP. The Internet may become a crucial factor in making KMPI successful because it is used in daily management activities and is considered essential.

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