December 2004

Development and Validation of a Knowledge Management Capability Assessment Model

Uday Kulkarni
Arizona State University

Ron Freeze
Arizona State University

DEVELOPMENT AND VALIDATION OF A KNOWLEDGE MANAGEMENT CAPABILITY ASSESSMENT MODEL

Uday Kulkarni and Ronald Freeze
W. P. Carey School of Business
Arizona State University
Tempe, AZ U.S.A.
uday.kulkarni@asu.edu **ronald.freeze@asu.edu**

Abstract

*Although many assessment tools and methodologies for measuring knowledge management capabilities are becoming available in the practitioner world, none of them has been tested for validity. In this paper, we first present a knowledge management capability assessment (KMCA) methodology for determining the capability levels of an organization in various knowledge areas. The KMCA defines the knowledge capability areas and a five-level metric for assessing capabilities within each area. We then present the results of an empirical study conducted to validate the ability of the KMCA methodology to correctly ascertain capability levels within knowledge areas. The validation consists of two different tests: The first test, called the **absolute** test, validates the five-level metric within the KMCA by showing that a lower capability level is a prerequisite for achieving the next higher level. The second test, called the **relative** test, demonstrates the ability of the KMCA to compare relative capabilities (1) across knowledge areas within a single organization and (2) across multiple organizations for a given knowledge area. The KMCA was developed in concert with a leading manufacturing company in the semiconductor industry. The data for this study was collected from over 700 knowledge workers from multiple large organizational units within the company. The results show that the KMCA is robust, in that it is able to correctly estimate the capabilities of the knowledge areas it was designed to measure.*

Keywords: Knowledge management, knowledge management capability, knowledge management maturity, key capability area, capability assessment

Introduction

Knowledge management is becoming increasingly important as organizations realize that sustainable competitive advantage hinges on effective management of their vast and varied knowledge assets. In order to be able to get "better" at managing knowledge, one needs to know how well one is managing it in the first place. "That which doesn't get measured, doesn't get managed" (Redman 1998, p. 80). Hence the first step in any large scale KM initiative or project should be that of assessment or benchmarking. A scientific methodology concerning KM projects would allow an organization to gauge progress against assessment goals and can serve to guide the overall KM strategy.

There are two significantly challenging tasks that need to be addressed by a KM assessment methodology. One is defining knowledge and the other is constructing the metrics to assess how effectively an organization is managing its knowledge assets. Knowledge is described as information combined with experience, context, interpretation, and reflection (Davenport et al. 1998). It is a multidimensional concept that shows itself in the form of individuals with domain expertise, lessons learned from past similar experiences, documents, routines, methods, etc. As far as the metrics are concerned, we have encountered a number of tools and methodologies developed by practitioners that could be used for assessment of KM capability of organizations. Some of these tools are used internally by the organizations that have developed them (Ehms and Langen 2002; Langen 2002), while others are available as consulting services or commercial tools (Maier and Moseley 2003; Skyrme 2000). While these tools and methodologies may be serving the purpose for which they are designed, none of them have been scientifically validated or their validation made publicly available.

The main objective of this research is to present a comprehensive methodology for KM assessment and to empirically validate its content and construct validity. For this purpose, we present a knowledge management capability assessment (KMCA) methodology with measures that accurately capture a firm's knowledge management ability. Although developed in concert with a large semiconductor manufacturing company (henceforth, the company), the KMCA is designed to be sufficiently generic that it can be applied to organizations across a wide range of industries. The company provided access and active participation of a range of knowledge workers in the process, making this one of the most rigorously tested methodologies in the KM assessment area. We completed assessments of a diverse set of functional and business units within the company and present the results of our validation study.

KMCA Framework and Development

A large number of KM assessment tools and methodologies have become available during the last few years, but, to our knowledge, there has not been any scientific study reporting the validation of any of those methodologies. Hence, the brief list of references we site here is mostly from practitioner articles and Web sites of the service providers. Langen (2002) and Ehms and Langen (2002) describe a structured method developed at Siemens which divides KM-related issues into eight "key areas." A five-level development model offers a progressive scale for maturity. A similar approach to KM assessment was developed by InfoSys Technologies (Kochikar 2002), with the focus on three "key result areas" and a five-level maturity model. Both of these assessment models are based on the five-level capability maturity model (CMM) of the Software Engineering Institute (1995, 2002). Apart from the terminology used for naming the levels and some semantic transformations from software engineering to KM, there is no description of the development of the model. For example, the general and specific goals of each level of maturity, as specified in the CMM, and the detailed specification of the activities needed to attain the various levels are not detailed in these models. Neither is there any attempt made to test for content and construct validity of the measurement instrument or the process.

We undertook a considerably structured conceptual development process to design our assessment instrument as described below. Like the Siemens and InfoSys models, we also adapted the framework of the CMM (i.e. the five maturity levels) to structure the KMCA. However, the CMM framework was used only as a shell; the substance within the framework, including the terminology, is specific to knowledge management. When designing our questionnaire, we worked closely with the company to identify knowledge areas, define general goals for each maturity level, and outline specific goals and practices for each area. The KMCA team included, in addition to the external academic researchers (authors), experts from the company in the areas of process management, value measurement, change management, and information technology.

Knowledge Capability Areas

Knowledge is a broad and complex concept and there are differing perspectives on the nature of knowledge. Knowledge is viewed by some as an object to be stored, manipulated, etc., while others extend this concept by emphasizing "organization" of knowledge to facilitate access, and a third goes further by viewing knowledge as a process as in "applying expertise" (Carlsson et al. 1996; McQueen 1998; Zack 1999). According to an alternate perspective, knowledge is with the knower and is "shaped by one's initial stock of knowledge and the inflow of new stimuli" (Fahey and Prusak 1998, p. 267).

We recognize that the richness of knowledge needs to be captured through multiple dimensions. Drawing upon the KM research literature and working closely with a team of five employees assigned by the company to the KMCA project, we divided the diverse set of knowledge into four areas that represent *knowledge* in most organizations: expertise, lessons learned, knowledge documents, and data. We call these *knowledge capability areas (KCA)* and describe them below. Every organization may possess varying levels of capability across the four areas.

Expertise is viewed as the knowledge that may be gained through experience or formal education. The *personalization strategy* (Hansen et al. 1999) relied on the identification of experts and their expertise and viewed knowledge transfer as occurring through mentoring. Alavi and Leidner (2001) identify corporate directories and systems to capture knowledge about experts (meta-knowledge) as ways to facilitate knowledge sharing in this area.

Lessons learned are successes and failures from similar past projects and are sometimes referred to as best-known-methods. The *codifications strategy* presented by Hansen et al. (1999) identified the creation of *knowledge objects* that allows reuse without the need to contact the originator. The process of documenting lessons learned has been termed as *internal benchmarking* (O'Dell and Grayson 1998), post-mortem, debriefing, etc. Since lessons learned are highly context dependent, their re-use needs careful discernment while applying them to other similar situations.

Knowledge documents are explicit knowledge codified for future use. This includes text based documents, such as project reports, technical reports, operations manuals, policies, etc., or diagrams, audio and video clips. The most important goal in this case is efficiency of access and targeted search. The processes for using knowledge documents include cataloging with intuitive taxonomies, storage, and retrieval methods.

Data includes the facts or figures obtained originally from operations (and from other sources such as experiments, surveys, etc.) and stored in databases and dimensional data warehouses. This is not the operational data, but summarized historical data that can be used for planning, drawing inferences, pattern matching, mining, and model building. Such data can be a constant source of knowledge. Effective management of this capability area includes ensuring data quality and organization, as well as fully utilizing its potential through analysis techniques and models.

KMCA Instrument Development Process

We developed the final instrument over three distinct phases: (1) the conceptual design and the initial instrument build, (2) prototype evaluation, pilot test, and redesign, and (3) the survey administration for validation.

Phase 1: Conceptual Build and the Initial Questionnaire (May—September 2002)

After background research and identification of the four knowledge capability areas described above, we adopted a structured conceptual development process for designing our assessment instrument. To our knowledge, no comprehensive validated assessment instruments are readily available in this area. Figure 1 illustrates the top-down conceptual structure of the KMCA design process, which shows that we started with the *general goals* for each capability level. General goals were then translated into one or more *specific goals* which are specialized instances of general goals for each knowledge capability area. Specific goals for each capability area were then mapped to one or more specific practices that were, in turn, converted into questions for the first version of our questionnaire.

An important design aspect of the KMCA is that the goals for each level are distinct and that the lower-level goals are easier to achieve than the higher-level goals. Unlike the CMM, where the higher maturity levels strictly build on top of the lower ones (because of the objective nature of the CMM), the KM capability assessment has to achieve this through careful design. This is because almost all of the questions in a KM context have to be subjective—opinion-based. This progression from a lower level (easy to achieve) to a higher level (difficult to achieve) gives the questionnaire the ability to discern between organizational KM capability levels accurately. The KMCA team arrived at the definitions of general goals for each capability level after many rounds of brainstorming and structured discussions. Hence, the progression and distinctiveness of the capability levels is largely intuitive and, therefore, one of the purposes of the validation tests is to ascertain that the characteristics associated with each level have been attained.

Table 1 shows the general goals of each capability level. As one can see, the goals are divided into two columns: those that pertain to the perception of behavior of employees and those that relate to the availability of knowledge and the infrastructure to share it across the organization. Level 0 (Not Possible), the lowest level, describes a condition where the organizational culture discourages knowledge sharing. There is a lack of appreciation of benefits of knowledge sharing and hoarding may actually be the norm. Level 1 (possible), the next higher level, is attained if employees are generally willing to share knowledge, existence of knowledge assets is acknowledged, and those who understand the value of knowledge do participate in sharing. Level 2 (encouraged) characterizes an organizational culture that actively encourages knowledge sharing, possibly with rewards and recognition. Knowledge assets are not only recognized, but are also stored or tracked in some fashion. Level 3 (enabled/practiced) is reached if employees actually practice knowledge sharing. This level is distinct from level 2 in that knowledge sharing is part of normal work practices. Enabling technologies in the form of KM systems and tools, searchable repositories of different types of knowledge, and knowledge assets with context-specific taxonomies are available. Level 4 (managed) signifies a condition where the organization monitors the extent to which knowledge sharing takes place. Employees not only practice knowledge sharing, but there is a high degree of expectation about easily finding the needed knowledge. KM related systems are easy to use, they are supported by training and education, and new KM initiatives are introduced using principles of change management to ensure their success. Level 5 (continuously improved), the highest level, is reached if an organization not only monitors how well it is performing in KM related tasks, but also constantly strives to improve them. KM systems are periodically reviewed for possible enhancements and knowledge-intensive business processes are reviewed and redesigned to make knowledge capture, transfer, and reuse more effective.

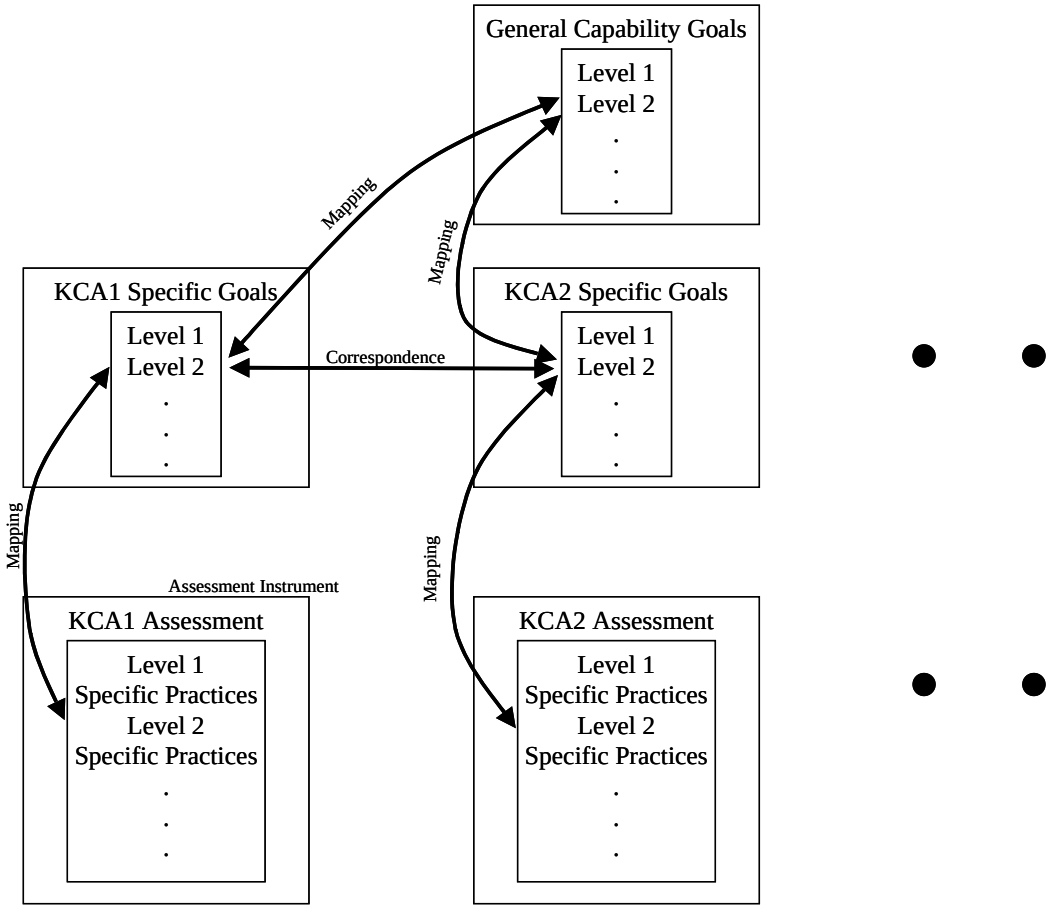

Figure 1. KMCA Design Architecture

Once the general goals of each capability level were established, the translation into specific goals for each capability area was initiated. Taking an example of capability level 3 (see Table 1), if general goal is "knowledge management systems/tools and mechanisms enable activities with respect to knowledge sharing," then one of the corresponding specific goals for the expertise area may be "mechanisms (templates/software) to capture expertise profile exist." Other specific goals corresponding to this General Goal may refer to taxonomies, repositories, collaboration tools, etc., for enabling sharing of expertise. Each Specific Goal was then translated into one or more scale items in the questionnaire. By strictly adhering to this procedure, we were able to include questions representing all levels (level 1 through level 5) and maintain the relative progression of capability within each area.

The original survey was composed of about 145 questions concerning the various aspects of the four capability areas. A focus group was assembled with 10 to 12 senior and mid-level managers to assess the meaning, relevance, and completeness of the instrument in terms of concept coverage for the capability areas and applicability to the work environment. The discussions and feedback resulted in a questionnaire that was to be delivered to a pilot-group of knowledge workers.

Phase 2: Prototype Evaluation, Pilot Test, and Redesign (October 2002—August 2003)

Phase 2 began with distribution of the survey to a small business unit that had volunteered to participate in the study. We collected 38 responses. This initial part of Phase 2 was designed to increase the face and content validities of the survey instrument. Although the low number of responses did not allow us to make any statistical inferences, the qualitative feedback collected on potential problems with the questionnaire, including understandability, length, etc., was invaluable.

Table 1. General Goals of Capability Levels

Capability Level	General Goals	
	Behavior	**Infrastructure**
Level 0: Difficult/Not Possible	• Knowledge sharing is *discouraged.* • There is general *unwillingness* to share knowledge. • People *do not seem to value* knowledge sharing.	• There is a *lack of identification* of knowledge assets.
Level 1: Possible	• Knowledge sharing is *not discouraged.* • There is a *general willingness* to share. • Some people, who understand the value of knowledge sharing, *do it*.	• Knowledge assets are *recognized/ identified.*
Level 2: Encouraged	• *Value of knowledge assets* is *recognized* by the organization. • Organization's *culture encourages* all activities with respect to sharing of knowledge assets. • Leadership/senior management *communicates the value of* and *shows commitment* to knowledge sharing • Sharing is *recognized/rewarded*.	• Explicit knowledge assets are *stored* in some fashion. • Tacit and implicit knowledge is *tracked*.
Level 3: Enabled/Practiced	• Sharing of knowledge assets is *practiced.* • Leadership/senior management *sets goals* w.r.t_knowledge sharing. • KM related activities are a *part of normal workflow*.	• Knowledge management systems/tools and mechanisms *enable* activities with respect to knowledge sharing. • Centralized *repositories* exist. • Knowledge *taxonomies* exist.
Level 4: Managed	• Employees *find it easy to share* knowledge assets. • Employees expect to be successful in locating knowledge assets if they exist. Knowledge sharing is formally/informally monitored/measures.	• *Training and instruction* is available for KM systems usage. • *Change management* principles are used to introduce KM practices. • Tools for supporting KM activities are *easy to use*.
Level 5: Continuously Improved	• Mechanisms and tools to leverage knowledge assets are *widely accepted*. • There is a *systematic* effort to *measure and improve* knowledge sharing.	• Tools and mechanisms for sharing are *periodically updated/improved*. • Business processes that incorporate sharing of knowledge assets are *periodically reviewed.*

The revised questionnaire was then administered to a pilot group of 300 individuals in one business unit. In all, 79 responses (26 percent response rate) were received with an average time of 45 minutes to complete survey. Of the 79 respondents, only 47 actually completed the final sections of the questionnaire. This non-completion rate was a serious concern and was primarily due to the length of the survey. Hence, in conjunction with the company experts, we reevaluated the list of specific practices and many similar practices spanning multiple capability areas were combined. In particular, many specific goals of levels 1 and 2 stem from an organization's culture and are similar in spirit across the different knowledge areas. We also addressed formatting issues to reduce the number of pages and facilitate ease of use for the questionnaire. After these extensive revisions, another focus group was assembled to ensure that the survey had not lost its face and content validity with the reduced number of questions. All comments from the focus group were evaluated and where applicable incorporated into the survey. As a result, the final questionnaire consisted of about 100 questions and required about 20 minutes to complete. Table 2 shows a summarized version of the scale items and their related capability levels. These were used to compose the questions in the the survey which was administered to the two large business units of the company.

Table 2. KMCA Scale Items and Capability Levels

Q #	Q Level	Question	Q #	Q Level	Question
		Culture			**Expertise**
cq1	2	Leadership: Commitment to knowledge sharing (KS)	eq1	1	Acknowledgment of existence of experts/expertise
cq2	2	Leadership: Communication about the value of KS	eq2	2	Importance of Experts and expertise
cq3	3	Leadership: Setting strategy and KS goals	eq3	3	Availability of expertise repository(ies)
cq4	2	Leadership: Encouragement w.r.t. KS	eq4	3	Accessibility of repository(ies)
cq5	1	Employees' consideration of knowledge as an asset	eq5	3	Usefulness of repository content
cq6	1	Willingness of employees to share within own group	eq6	3	Information in repository about internal and external experts
cq7	3	Practice of KS within own group	eq7	3	Repository search capabilities
cq8	1	Willingness of employees to share within own BU	eq8	4	Ease of searching repository
cq9	3	Practice of KS within own business unit	eq9	4	Multiple search criteria for repository
cq10	1	Willingness of employees to share within the firm	eq10	3	Existence of taxonomy
cq11	3	Practice of KS within the firm	eq11	4	Clarity and standardization of taxonomy
cq12	4	New technologies accompanied by training	eq12	4	Comprehensiveness of taxonomy
cq13	4	Availability of appropriate amount training	eq13	5	Extensibility of taxonomy
cq14	2	Recognition/rewarding of activities associated with KS	eq14	3	Existence of a registering and profiling process
		Lessons Learned	eq15	4	Ease of use of registering and profiling
lq1	1	Acknowledgement of previously learned Lessons	eq16	4	Ease of updating of own profile
lq2	2	Importance of looking for Lessons Learned (LL)	eq17	4	Consistency/management of profiles
lq3	2	Importance of referring to Lessons Learned	eq18	3	Practice of looking for available expertise
lq4	3	Successful application of Lessons Learned	eq19	4	Ease of locating relevant experts
lq5	3	Availability of LL repository(ies)	eq20	3	Accessing experts as part of normal work practices
lq6	3	Accessibility of LL repository(ies)	eq21	5	Collaboration tools are widely accepted/routinely used
lq7	3	Usefulness of LL repository content	eq22	4	Easy of use of collaboration tools
lq8	3	Search and retrieval capabilities of repository	eq23	3	Access to internal/external experts with collaboration tools
lq9	4	Ease of searching the repository	eq24	4	Multiple tool sets for collaboration
lq10	4	Multiple search criteria for repository	eq25	3	Participate in Special Interest Groups
lq11	3	Existence of taxonomy	eq26	2	Encouragement for SIG participation

Q #	Q Level	Question	Q #	Q Level	Question
lq12	4	Clarity and standardization of taxonomy	eq27	3	Availability of relevant SIGs
lq13	4	Comprehensiveness of taxonomy	eq28	4	Financial support/work time for SIG participation
lq14	3	Practice of capturing LL	eq29	5	Periodic review/improvement of profiling/search tools
lq15	4	Consolidation and management of LL	eq30	5	Periodic review of expertise sharing processes
lq16	3	Capture of LL as individual/group responsibilities			**Knowledge Documents**
lq17	4	Existence of a systematic processes for capturing LL	kq1	2	Importance of Knowledge Documents (KD)
lq18	3	Application/use of Lessons Learned	kq2	2	Important of referring to KD's
lq19	4	Ease of finding relevant LL	kq3	3	Availability of repository(ies)
lq20	3	Embedding of looking for LL in normal work practices	kq4	3	Accessibility of repository(ies)
lq21	5	Evaluation/updating of accuracy/currency of LL	kq5	3	Usefulness of repository content
lq22	5	Periodic review of capture/reuse processes	kq6	3	Access to internal and external documents in the repository
		Data	kq7	4	Repository support for rich formats
dq1	2	Importance of Data-driven decision-making	kq8	4	Clarity of meta-data
dq2	3	Data driven decision-making as part of one's job	kq9	3	Existence of taxonomy
dq3	3	Availability of repository(ies)	kq10	4	Clarity and standardization of taxonomy
dq4	3	Accessibility of repository(ies)	kq11	4	Comprehensiveness of taxonomy
dq5	4	Currency	kq12	3	Existence of a categorization process
dq6	4	Appropriateness of level of summarization	kq13	4	Ease to use of categorization process
dq7	4	Clarity of meta-data	kq14	4	Categorization process as part of normal work practice
dq8	3	Timeliness/time period	kq15	4	Categorization process managed to ensure adherence
dq9	3	Completeness	kq16	3	Practice of referring to and using KD's
dq10	4	Usefulness of presentation format	kq17	4	Ease of finding documents
dq11	4	Accuracy	kq18	4	Easy to use of tools for finding KD's
dq12	4	Ease of use of decision support tools	kq19	4	Tools retrieving relevant KD's
dq13	3	Sufficiency of support tools	kq20	4	Tools to support multiple search criteria
dq14	5	Periodic review/improvement of access/analysis tools	kq21	5	Periodic review/improvement of search/retrieval tools
			kq22	5	Periodic review of KD classification schemes

Phase 3: Data Collection and Validation (September 2003—February 2004)

Phase 3 began with the administration of the final instrument to two independent organizational units within the company with a population of about 1,000 and 700 employees, respectively. Due to the nature of their work, these employees can be classified as knowledge workers. Each member of the two business units received an introductory e-mail from a senior level sponsor concerning the administration of the survey, its potential impact on knowledge management, and the importance of the survey.

A second e-mail was then sent with a link to the survey instrument. Each business unit utilized follow-up e-mail, as well as various incentives, to boost participation. Data collection occurred over a four-week period. The participation rates for the two business units were 37 percent (BU1) and 56 percent (BU2), respectively. Recognizing that these response rates represent voluntary participation, we conducted two discriminant analyses tests to determine if a response bias existed. The first method involved solicitation of 29 non-respondents from the population to see if they could be discriminated from the original respondents. The second method compared early respondents (first quartile) and late respondents (fourth quartile). Neither analysis provided evidence of a response bias.

Validation of the KMCA

In validating both the instrument and the methods to analyze the assessment, we use the construct validation principles of translation validity (face and content validity) and criterion-related validity (predictive, concurrent, convergent and discriminant validity) (Trochim 2001).

Translation Validity

Translation validity attempts to assess the degree to which accurate translation of the constructs occurred while operationalizing the instrument. This includes both face and content validity for the inclusion of items within the instrument. Translation validity was a major focus in the early phases of the project. The focus group in Phase 1 provided substantial input as to the applicability of the concepts to industry.

In Phase 3, the survey was subjected to an inter-rater reliability test. We selected six business professors at our institution knowledgeable in KM and who have taught, researched, and/or published in the area of KM. They were asked to comment on the consistency of translation of the KM concepts into the questions and to also rank individual questions as to the capability level guided by the general goals given in Table 1. The results of the inter-rater reliability test indicated that the framework was a consistent translation of knowledge management concepts. Moreover, the average of the absolute difference between the ranking of the raters and our original designations was less than one-half a level. These tests provide further evidence of both the content and face validity of the questionnaire and the distinctiveness of the capability levels attached to each question.

Criterion-Related Validity

The criterion-related validity assesses the measurement accuracy of the instrument. It checks the predictive capability of the instrument based on the theory of the construct. In our case, this is the ability of our instrument to accurately measure the capability level of an organization in each knowledge area.

When the KMCA is administered to any organization, because of the design considerations that have gone into its development, we expected to observe that, for each capability area, all questions pertaining to a lower level of capability would be "positively answered" (defined below) before all the questions from any of the higher levels were positively answered. If the results bore out this requirement for every capability area, then one could conclude that the relationship between the capability levels is a progression, i.e., the higher capability level (designation) really does represent a higher capability in every capability area. It also simultaneously ascertains that the mapping from general goals to specific goals and the translation from specific goals into practices and actual questions has been accurately done.

For the purpose of operationalizing positively answered questions, we used the following thumb rule: If more than 50 percent of the respondents chose strongly agree or agree categories for a question, we interpreted that as a positively answered question. We use this rule for the validity tests described later.

We attempt to test for this validity using two tests that we invented for this purpose. We call these (1) absolute test and (2) relative test. We believe that taken together, the results of the two tests indicate criterion-related validity of the instrument.

Absolute Test

The absolute test validates the five-level metric within the KMCA model by showing that, for every capability area, achieving a lower capability level is a prerequisite for achieving the next higher level. This condition is verified by checking the number of questions at each level that were positively answered out of the total number of questions at that level. (Recall that positively answered means more than 50 percent of the respondents answered strongly agree or agree to that question). For the capability in a certain area to be at Level *n*, according to this test, *all* of the questions belonging to level *n* and below (Level *n-1*, Level *n-2*, …) must have been positively answered *and*, in none of the higher levels, *all* of the questions should have been positively answered. For the KMCA to be valid according to this test, the above rule needs to be satisfied for each of the four capability areas of the KMCA.

Our data showed that the absolute test rule was satisfied for *every* capability area in the case of *both* the business units. Thus, absolute test results confirmed the criterion-related validity of the five-level metric. As a sample of the results, Table 3 shows the responses from the lessons learned area of BU1. In this table, for ease of exposition, the data are arranged in ascending order of question level. Note that, due to response rate concerns, the industry team partners removed the questions pertaining to levels 1 and 5 from the final version of the survey to reduce its length. It was felt that the responses to these questions were going to be obvious (level one and level 5 questions would have received very high and very low positive responses, respectively, and would not have affected our analysis materially). One can see that all of the level 2 questions are positively answered and for none of the higher levels, (levels 3 and 4 in this case), are all the questions positively answered. In this case, the results can be interpreted as the business unit is at least at capability level 2 in the area of lessons learned. (Based on the need, a finer granularity may be assigned to capability levels depending on how many of the Level 3 and 4 questions are positively answered.)

Table 3. Lessons Learned Response Percent—BU1

Question Number	*Question Level*	*Positive Response %*
LQ3	2	**79%**
LQ2	2	**78%**
LQ16	3	**72%**
LQ4	3	**70%**
LQ18	3	**60%**
LQ20	3	**53%**
LQ14	3	49%
LQ5	3	46%
LQ6	3	42%
LQ8	3	39%
LQ7	3	38%
LQ11	3	28%
LQ17	4	37%
LQ10	4	33%
LQ15	4	31%
LQ9	4	30%
LQ19	4	27%
LQ13	4	23%
LQ12	4	20%

Relative Test

The relative test examines the direction of change between each pair of capability areas. For testing the predictive validity, we conduct this test in two parts: (1) across knowledge areas within a single business unit and (2) between the two business unit for each knowledge area. For validation, we compare the direction of change between a pair of knowledge area capability levels as determined by the KMCA with the difference in means of the raw responses obtained directly from the questions. Simply speaking, if area 1 is at a higher capability level than area 2 (as determined by the KMCA), then the mean raw scores of questions in area 1 should be higher than those in area 2. The argument is that the relative difference between capability levels should be reflected in the relative means of raw scores. For this test, we defined more finely scaled capability levels (e.g., 2, 2+, 2++, 3, etc.) depending on the proportion of the positively answered questions in the next higher level of capability. Each increment (+) indicates approximately a one-third unit of capability level. For example in Table 3, 100 percent of the level 2 questions, approximately one-third of the level 3 questions, and none of the level 4 questions are answered positively. Therefore, the capability level of the Lessons Learned would be estimated as 2+.

Figures 2 and 3 show the capability levels and mean raw scores of the four capability areas of the two business units, respectively. Tables 4 and 5 show the difference between means of the raw scores and their significance. The last column of the tables has a "pass/fail" entry, depending on if the one-sided t-test concludes whether these differences track the differences in the capability levels determined by the KMCA. We conducted 12 pair-wise t-tests ($^4C_2$ for each business unit) comparing each capability score to determine if there exists a significant difference between the means of each area. For example the entries in row 1 of Table 4 mean comparing expertise and lessons learned of BU1, the change in capability levels is positive (from 2 to 2+) and the difference in the mean raw scores of the two areas is in the opposite direction and significant; hence, the relative test failed. Overall, the results show that in the case of 9 out of the 12 comparisons, the relative test was successful.

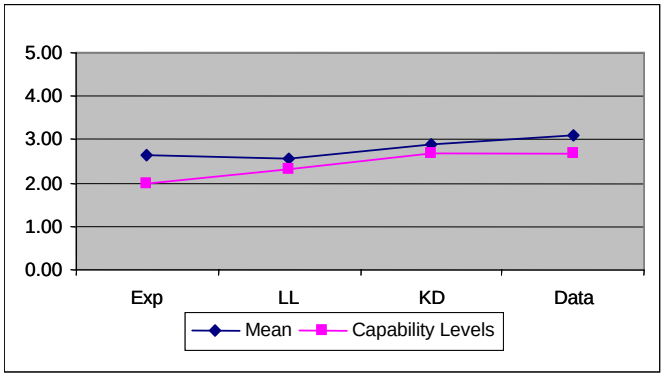

Figure 2. Mean vs. Capability Level Comparsion for BUI

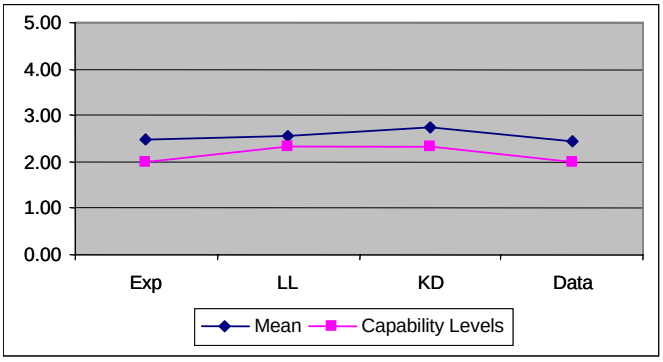

Figure 3. Mean vs. Capability Level Comparsion for BU2

Similar analysis is used to ascertain whether a difference exists between the two business units. We conducted univariate F-tests to determine any significant difference that may exist between the two business units for each capability area (see Table 6). The results show that two of the four comparisons passed the relative test.

In summary, the data passed all 8 of the 8 absolute tests (4 capability areas in each business unit) and 11 out of the 16 relative tests (within and between business units). Taken together, these results provide adequate indication of the ability of the KMCA to measure what it is designed to measure. Combining these results with the content validity of the KMCA derived from the process of its development, we believe that it is a robust instrument for accurately assessing KM capabilities of organizations.

Table 4. BUI—Pair-Wise Comparison

Paired Comparison for BU1		Direction of Difference in Cap. Levels	Mean Diff.	t - statistic	df	Significance		
Expertise vs.	Lessons Learned	Positive	-0.106	-1.910	212	0.028	**	Fail
	Knowledge Documents	Positive	0.210	3.117	193	0.001	***	Pass
	Data	Positive	0.424	5.310	187	0.000	***	Pass
Lessons Learned vs.	Knowledge Documents	Positive	0.290	4.517	206	0.000	***	Pass
	Data	Positive	0.489	5.866	198	0.000	***	Pass
Knowledge Documents vs.	Data	No Change	0.206	2.734	197	0.007	***	Fail

Table 5. BU2—Pair-Wise Comparison

Paired Comparison for BU2		Direction of Difference in Cap. Levels	Mean Diff.	t - statistic	df	Significance		
Expertise vs.	Lessons Learned	Positive	0.082	1.548	261	0.061	*	Pass
	Knowledge Documents	Positive	0.273	4.440	247	0.000	***	Pass
	Data	No Change	-0.060	-0.861	255	0.390		Pass
Lessons Learned vs.	Knowledge Documents	No Change	0.192	3.258	257	0.001	***	Fail
	Data	Negative	-0.150	-1.970	262	0.025	**	Pass
Knowledge Documents vs.	Data	Negative	-0.310	-3.816	254	0.000	***	Pass

Table 6. Between-Group Analysis

Univariate F-Test	Direction of Difference in Capability Levels	BU1 Mean	BU2 Mean	F-Value	Significance of F		
Expertise	No Change	2.645	2.477	3.0810	0.080	*	Fail
Lessons Learned	No Change	2.574	2.554	0.0283	0.867		Pass
Knowledge Documents	Negative	2.893	2.758	1.2985	0.127		Fail
Data	Negative	3.122	2.455	30.1693	0.000	***	Pass

Conclusion and Contributions of the KMCA

The rush to embrace knowledge management has resulted in many assessment tools and methodologies. One can easily find claims as to the success of these assessment tools, but the evidence of their validity is often lacking. We have presented a KM capability assessment instrument, the KMCA, that recognizes the diversity of knowledge existing in many organizations and assesses an organization's capability in each area of knowledge. Via its rigorous construction process, we have demonstrated the content validity of the KMCA. We empirically tested the KMCA with data obtained by surveying knowledge workers from two independent business units in a large semiconductor manufacturing organization. In order to verify the criterion-related validity, we presented two methods to test the ability of the KMCA to correctly measure capability levels in knowledge areas: the absolute and the relative test. The results show that the data passed the absolute test in every one of the 8 instances and the relative test in 9 out of the 12 instances. Taken together, we believe that the results of the tests successfully verified the criterion-related validity.

Finally, although beyond the scope of the current paper, the KMCA analysis has acquired substantial knowledge to guide KM initiatives within each of the business units. Each unit has begun to invest in resources to improve the capability in areas that the KMCA has recommended, which is the purpose of the overall project. The implications to business in general are that an instrument for measuring KM capabilities is now available that has undergone rigorous and structured development, experimental testing, and analysis. Using the KMCA, organizations can focus on particular aspects of their KM capabilities through efficient use of scarce organizational resources. Specific competencies of individual business units can be exploited and transferred to other units with lower capabilities in similar areas. Longitudinal tracking of how organizations improve their KM capabilities and business performance can add value to business research.

Limitations

We can think of four limitations that should be considered while evaluating the results of our research. The first limitation stems from the focus on a single company during the development of the survey instrument. While this sounds like a narrow focus, one must note the size of the subject organization (about 85,000 employees), the composition of the project team (academic researchers and a diverse set of internal experts), and the independent input received from the participating client business units. The second limitation is that the data was collected from within a single company. While this reduces the external validity of our instrument, we believe that the decentralized nature of the company leading to a self-governing style of the business units and the complete independence of the operations of the two subject units provided a setting similar to multiple smaller organizations. Our third, relatively minor, limitation results from the lack of ability to fully assess the response bias. We believe that ascertaining adequate representations from each segment based on, say, years of service, home base region, and job level may have provided increased reliability in assessing response bias, but such data was not readily available because of the strict anonymity of responses. Finally, a major limitation resulted from the lack of prior rigorous empirical studies on which we would have liked to build our knowledge management measurement methodology. We have attempted to heed the calls to provide better measures of knowledge management (Teece 1998). However, while our survey and assessment methodology attempt to tackle this complex task, we recognize the research field's adolescent state and the lack of adequate groundwork to draw from and benchmark our work.

Future Research

In addition to the capability related questions, the KMCA has embedded in it a number of questions that measured user attitudes, satisfaction, and perception of benefits from various IT solutions to KM. Hence, one of the by-products of the KMCA would be to use the context of KM to test and extend the theories proposed in various models in the IS literature such as the technology acceptance and theory of planned behavior models. Since the identification of capability levels in each of the knowledge areas, the units have begun initiatives designed to improve their knowledge management capabilities. A longitudinal study that would provide causal relationships of the capability levels to firm performance in terms of measurable outcomes is currently in progress. We are also exploring partnerships with other organizations to be able to perform cross-industry validation of this assessment methodology. In this regard, it would also be interesting to explore how firms move across different levels, in different areas over a period of time. Future research is also aimed at studying the complementarities between knowledge capability areas and their effect on the outcome measures. Models and interrelationships depicting the impact of each capability area to firm performance should assist executives in targeting resources, improving firm profitability, and confirming that KM capabilities can not only be measured but effectively managed and continuously improved.

References

Alavi, M., and Leidner, D. "*Review*: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues," *MIS Quarterly* (25:1), March 2001, pp 107-136.

Carlsson, S. A., El Sawy, O. A., Driksson, I., and Raven, A. "Gaining Competitive Advantage Through Shared Knowledge Creation: In Search of a New Design Theory for Strategic Information Systems," in *Proceedings of the Fourth European Conference on Information Systems*, J. D. Coelho, T. Jelassi, W. König, H. Krcmar, R. O'Callaghan, and M. Sääksjärvi (Eds.), Lisbon, 1996.

Davenport, T. H., De Long, D. W., and Beers, M. C. "Successful Knowledge Management Projects," *Sloan Management Review* (39:2), Winter 1998, pp. 43-57.

Ehms, K., and Langen, M. "Holistic Development of Knowledge Management with KMMM," *Siemens AG*, 2002 (available online at **http://www.knowledgeboard.com/doclibrary/knowledgeboard/kmmm_article_siemens_2002.pdf**).

Fahey, L., and Prusak, L. "The Eleven Deadliest Sins of Knowledge Management," *California Management Review* (40:3), Spring 1998, pp. 265-276.

Hansen, M. T., Nohria, N., and Tierney, T. "What's Your Strategy for Managing Knowledge?," *Harvard Business Review* (77:2), March-April 1999, pp. 106-116.

Kochikar, V. P. "The Knowledge Management Maturity Model: A Staged Framework for Leveraging Knowledge," in *KM World 2002*, 2002 (available online at **http://whitepapers.zdnet.co.uk/0,39025945,60008205p,00.htm**).

Langen, M. "Knowledge Management Maturity Model—KMMM Methodology for Assessing and Developing Maturity in Knowledge Management," Siemens Corporate Department Technology, 2002 (available online at **http://www.kmmm.org/objects/KMMM_Flyer.pdf**).

Maier, D. J., and Moseley, J. L. "The Knowledge Management Assessment Tool," *Pfeiffer*, 2003 (available online at **http://www.pfeiffer.com/WileyCDA/**).

McQueen, R. "Four Views of Knowledge and Knowledge Management," in *Proceedings of the Fourth of the Fourth Americas Conference on Information Systems*, E. D. Hoadley and I. Benbasat (Eds.), Baltimore, MD, 1998, pp. 609-611.

O'Dell, C., and Grayson, C. J. "If Only We Knew What We Know: Identification and Transfer of Internal Best Practices," *California Management Review* (40:3), Spring 1998, pp. 154-174.

Redman, T. C. "The Impact of Poor Data Quality on the Typical Enterprise," *Communications of the ACM* (41:2), February 1998, pp. 79-82.

Skyrme, D. "Knowledge Management: Making Sense of an Oxymoron," *Insight* (22), 2000 (available online at **http://dev.skyrme.com/insights/22km.htm**).

Software Engineering Institute. A Systems Engineering Capability Maturity Model[SM], Version 1.1," Carnegie Mellon, Pittsburgh, PA, November 1995 (available online at **http://www.sei.cmu.edu/pub/documents/95.reports/pdf/mm003.95.pdf**).

Software Engineering Institute. "Capability Maturity Model Integration (CMMI[SM]), Version 1.1," Carnegie Mellon, Pittsburgh, PA, August 2002 (available online at **http://www.sei.cmu.edu/cmmi/models/sw-continuous.doc**).

Teece, D. J. "Research Directions for Knowledge Management," *California Management Review* (40:3), Spring 1998, pp 289-292.

Trochim, W. M. *The Research Methods Knowledge Base*, atomicdogpublishing.com, Cornell University, Ithaca, NY, 2001.

Zack, M. H. "Developing a Knowledge Strategy," *California Management Review* (41:3), Spring 1999, pp. 125-145.