Where Performance Measurement and Knowledge Management Meet: Evaluating and Managing Corporate Knowledge

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This study develops a conceptual framework for the integration of knowledge management and the performance measurement system focusing on the role of performance measures in the exchange and production of tacit and explicit knowledge. We develop six testable propositions and use data from eighteen subsidiaries to draw insights on the design of the performance measurement system and its relationship with corporate knowledge management. We find that performance measurement systems are currently evolving, and that as knowledge transfers become more explicit, firms are more likely to have a formal performance measurement system that relies primarily on non-financial knowledge metrics.

INTRODUCTION

Knowledge management (KM) is a relatively new field that originated when the traditional business model that relied on tangible assets expanded to include reliance on intellectual capital. KM is often defined as "the practice of creating, capturing, transferring, and accessing the right knowledge and information when needed to make better decisions, take actions, and deliver results in support of the underlying business strategy" (Horwitch & Armacost, 2002). KM can provide businesses with a means of achieving and sustaining competitive advantage by enabling management to use knowledge assets more effectively. Bob Jones, a Chief Knowledge Officer (CKO) of a high-technology firm,[1] explains how his firm uses knowledge as a strategic weapon in order to compete against larger firms. He states,

> We compete against firms that are much bigger than we are and we have to appear as big as they are in some ways. Thus we need to leverage our size and respond quickly. We have to be really smart about this and bring everything we know to bear on any given problem that we have. So all of this adds up to the basic tactic that the more knowledge we can share the better off we will be. We can appear bigger because we have more knowledge and can respond more quickly because people have the information that they need when they need it.

A performance measurement (PM) system that provides managers with relevant information should facilitate the success of an effective KM program. Lucy Smith, a Chief Executive Officer (CEO) of another high-technology firm, states, "what we measure we can manage and what we manage we can

accomplish." Since managing intellectual capital and monitoring relevant performance measures has become increasingly important to firms (Lev, 2001), we are surprised that little empirical research has been performed at the intersection of knowledge management and performance measurement.

The knowledge management literature is primarily found in the area of organization theory, economics, and strategic management (Gupta & Govindarajan, 2000). Most of this research investigates organizational design issues such as the transfer of knowledge within an alliance (Oxley, 2002), the management of knowledge flows (Gupta & Govindarajan, 2000; Schulz, 2001), organizational learning (Huber, 1991), resource-based strategy (Barney, 1991), and general knowledge management (Nonaka, Umemoto, & Sasaki, 2000). In the last few years the accounting literature has investigated management and control of intangible assets in terms of management control (Mouritsen, 1998), organizational design (Morris and Empson, 1998), organizational learning (Kloot, 1997) and reporting issues related to intangibles (Johanson, Martensson, and Skoog, 2001). There is also a stream of accounting literature that focuses on the role of the PM system in implementing, changing, and managing strategic objectives. Various publications consider specific strategies, strategic resources, and the use of financial and non-financial measures as they relate to the PM system (Abernethy & Lillis, 1995; Kaplan & Norton, 1996; Widener 2006).[2]

The current literature base does not address the relationship between KM and performance measurement. Situating our study directly at the intersection of PM and KM contributes to the integration of the current literature through investigating how to effectively evaluate and manage corporate knowledge. The purpose of this paper is twofold. First, it is to set forth several definitions important to the study of KM and then to integrate KM with the PM system resulting in a framework that allows us to carefully think about the interaction of performance measurement and KM. The second purpose is to present insights based on data from eighteen subsidiaries about the role of performance measures in KM.

This paper is organized as follows. Section 2 discusses issues regarding knowledge that researchers must think about and clarify prior to beginning a study. Background information on the PM system is presented in Section 3. Section 4 integrates the PM system with KM in order to develop six testable propositions. A description of the data and resulting insights regarding the specific use of knowledge metrics are presented in Section 5. Finally, we present discussion and conclusion in Section 6.

KNOWLEDGE

What Is Knowledge?

Gupta and Govindarajan (1991, p. 777) define knowledge as "either expertise (e.g., skills and capabilities) or external market data of strategic value." Schulz (2001, p. 662) incorporates "insights, interpretation, and information" as part of the definition of knowledge. Barney (1991) considers knowledge from the perspective of resourced-based strategy and identifies human capital, or the skills and thoughts held by the firm's employees, as a primary type of resource that firms can use strategically to establish and sustain their competitive advantage. While different definitions of knowledge exist, most will agree that the firm's store of knowledge is found in procedures, operating manuals, and organizational routines, as well as inside the minds of its employees. Knowledge thus may be defined in terms of written materials and/or human capital.

Explicit knowledge is the organizational knowledge that has been captured and stored in some form of written materials, such as the knowledge contained in procedure manuals. Nonaka et al. (2000, p. 147) says that explicit knowledge is a "meaningful set of information articulated in clear language including numbers or diagrams." Explicit knowledge is owned by the organization, codified, and easily shared with others. Organizational knowledge in the form of human capital, that which is held in the minds of the firm's employees, is referred to as tacit knowledge. Nonaka et al. (2000, p. 147) define tacit knowledge as "intuitions, unarticulated mental models and embodied technical skills." Tacit knowledge resides within an organizational unit and is not easily observed. For example, tacit knowledge can reside within an employee and consist of his or her "know-how" and expertise that he or she brings to bear on a problem. Tacit knowledge can also reside within a team and consist of the organizational routines and

understanding of the socialization processes that the team engages in to realize success. It is apparent that explicit and tacit knowledge differ in important respects and may have differential influences on the choice of performance measures.

What Makes Knowledge Valuable?

Knowledge alone will not sustain a firm's competitive advantage. A firm must be able to capitalize on its knowledge reserves by producing knowledge, transforming it into explicit knowledge, and exchanging knowledge with others (Schulz, 2001). Jones, CKO, stated

> You have to get knowledge embodied. You have to get it out of the employees' heads, transfer it into some other type of storage [paper or documents, etc.], disseminate and share the knowledge, and then you are able to capitalize on the knowledge and use it effectively.

Since as much as 80 percent of the firm's organizational knowledge is tacit (Oakes & Rengarajan, 2002), firms risk losing significant advantage if an employee chooses to terminate employment. Therefore it is in the firm's best interest to continually engage in the process of converting tacit knowledge to explicit knowledge. Nonaka et al. (2000) characterize the conversion process as one that is complementary, thus as explicit and tacit knowledge interact the effectiveness of knowledge increases.

Along with transforming knowledge from tacit to explicit, knowledge must be exchanged. Schulz (2001, p. 661) notes, "Knowledge production by individuals or subunits is of limited value if they do not share the resulting knowledge with other parts of the organization." The exchange process is typically referred to as knowledge flows and characterized as either vertical or horizontal flows (Schulz, 2001). A vertical flow is a channel that distributes knowledge between hierarchical units within an organization. For example, a subsidiary can provide knowledge to its parent company. A horizontal knowledge flow is a channel that connects peers within the organization. For example, a subsidiary can exchange knowledge with another subsidiary.

Knowledge may flow at different rates across different organizational units. For example, a parent company may have great stores of knowledge that they are constantly channeling to subsidiaries, while the subsidiaries are designed to simply use the knowledge within their unit. In this scenario the parent company produces and distributes information, while the subsidiary uses the knowledge internally. Figure 1 is adapted from Gupta and Govindarajan (1991, p. 774) and characterizes organizational units according to the use of knowledge.

FIGURE 1
A FRAMEWORK OF KNOWLEDGE FLOWS

High Inflow	Collaborative Knowledge Units	Knowledge Users
Low Inflow	Knowledge Creators	Non-Knowledge Units
	High Outflow	***Low Outflow***

Recognizing that knowledge flows both in and out of units, each unit can be characterized by the amount of knowledge they receive and then use, or they produce and then distribute. Gupta and Govindarajan (1991) identify four roles: the collaborative knowledge unit (high inflow, high outflow), the knowledge creator (low inflow, high outflow), the knowledge user (high inflow, low outflow), and the non-knowledge unit (low inflow, low outflow). The collaborative knowledge unit is dependent on the receipt of knowledge from other units, but also has the responsibility to produce knowledge that is useful for others. Thus this type of unit has high interdependencies with other units. The knowledge creator

generates knowledge. They are not dependent on other units for knowledge inputs, but they do have the responsibility of generating knowledge that other units need. The knowledge user is very dependent on other units in order to perform at a high level since they require infusions of knowledge, while the non-knowledge unit has no interdependencies with other units and a low overall reliance on knowledge.[3]

Unit of Analysis

As discussed above, the exchange process makes knowledge more valuable, and this exchange process can occur at any, and all, levels of the organization.[4] One can visualize employees engaging in the exchange process. A common example is a new hire that is mentored by a more senior colleague. In the mentoring process the senior colleague shares tacit knowledge with the new hire. Moving more broadly through the organizational structure changes the focus to work teams, departments, divisions, and subsidiaries (collectively referred to as "organizational subgroups"). Work teams are quite common, particularly in manufacturing facilities that rely on advanced manufacturing processes.[5] Work teams both create knowledge within the team and exchange knowledge with other teams. At the highest level, the unit of analysis becomes the firm and the focus is on knowledge exchanges between the firm and its environment (e.g., customers, suppliers).

Summary

Within a firm various units of analysis exist. For example, knowledge may reside, be produced, and distributed in individuals, organizational subgroups and the organization (Schuppel, Muller-Stewens, & Gomez, 2000). Knowledge may be exchanged either laterally or vertically between organizational units. Finally, it is important to remember that knowledge may be either tacit or explicit and the usual transformation is to convert tacit knowledge to explicit knowledge. The discussion presented here provides an initial starting point to consider the design of the PM system and its role in KM.

ROLE OF PERFORMANCE MEASUREMENT

Performance measures convey information about activities within an organization. Performance measures are expressed in either financial or non-financial terms. One useful way to classify performance measures is in conjunction with the firm's organizational processes consisting of inputs, processes, and outputs (Simons, 2000). To provide an illustration within the context of KM, envision that the firm relies on the exchange of ideas and suggestions among employees in order to create innovative product offerings for the market. The number of employees is an input to the process, the time spent in brainstorming meetings is part of the process, and the revenue generated from a new product introduction is an outcome. A typology of performance measures is illustrated in Figure 2.

FIGURE 2
PERFORMANCE MEASURES IN A KNOWLEDGE MANAGEMENT FRAMEWORK

	Input Measures	***Process Measures***	***Outcome Measures***
Non-financial Measures	Percent of employees with advanced degrees	Number of times expert intranet (database) is accessed on project-related materials	Number of ideas/suggestions implemented
Financial Measures	Labor dollars	Research and development expenditures	Revenue from new products and services

One important question to consider is how managers select appropriate measures for inclusion in a firm's PM system. Jones states, "We are sort of overwhelmed now because there are so many measures that we can track." Simons (2000, p. 62) offers guidance and suggests that while the monitoring of input

measures is a key component of the performance measurement system, it is not sufficient. Thus managers must make a further choice regarding the use of process and outcome measures. The contingency framework proposes that strategy is an important consideration in the selection of performance measures (see e.g., Chenhall, 2003). The notion is that measures are selected that are aligned with a firm's strategic objectives and help translate that strategy throughout the firm (Kaplan & Norton, 1996). This is also consistent with Simons (2000, p. 234) who recognizes that firms select critical performance variables based on their importance in the process of converting strategic objectives from an "intended" state to a "realized" state. Brown, CEO, illustrates the alignment of strategy with performance measures by stating,

> Our performance measurement system is called a balanced dashboard. We pick elements that are aligned with corporate goals for the year. I keep reminding all of the employees that we must set goals, create ownership, and then report on those goals. The dashboard is on the intranet so it is available to all employees at all times. I have been on a campaign of re-education so that all employees can read it with intelligence, understand where we are, and see how they can help.

In addition, Simons (2000, p. 62) suggests that the choice of measures depends on (1) whether the process or the output can feasibly be monitored and measured, (2) whether there is an understanding of the cause and effect process, (3) how costly it is to observe (or not observe) processes or outputs and (4) the effect on innovation.

The question that many research studies investigate is whether firms align strategy with performance measures, and secondarily, whether that matters to performance. Studies investigating quality and customer related strategies have found that focused measures aligned with strategy are effective. For example, firms engaged in either new manufacturing practices or flexible manufacturing processes rely more on quality and productive measures (Banker, Potter, & Schroeder, 1993) and less on cost-based measures (Abernethy & Lillis, 1995). Several studies have investigated firms that employ a customer-focused strategy and conclude that they rely more on non-financial measures that can provide operational information directly focused on the key drivers of the customer-focused strategy (e.g., Abernethy & Lillis, 1995; Perera, Harrison, & Poole, 1997). Widener (2006) provides evidence that the use of performance measures mediates the association between the use of strategic resources and firm performance. In other words, some of the positive effects of the use of strategic resources are transmitted to firm performance through the use of appropriate performance measures. In summary, it is widely accepted that performance measures are aligned with strategy (e.g., see Langfield-Smith, 1997; Chenhall, 2003) and evidence is mounting that selecting and using appropriate performance measures matters to firm performance. This study investigates the role of performance measures when knowledge management is a key strategic objective.

DEVELOPMENT OF PROPOSITIONS

Although numerous frameworks have been developed and proposed on KM (see Nonaka et al., 2000; Schuppel et al., 2000), there is no explicit role carved out for performance measurement in the extant literature. For example, Schuppel et al. (2000) state that a critical key to success in today's business world is to effectively and efficiently manage the knowledge flows but fail to integrate performance measures in the framework. In this study we explicitly consider the role of performance measurements in the process of KM. We do this by developing six testable propositions at the level of the subsidiary based on three key arguments. First, different types of knowledge are more or less transparent to managers. Second, degrees of interdependence differ depending on the subunits use of knowledge flows. Third, different types of performance measures support different managerial behaviors and different knowledge flows. The first three propositions address the type of knowledge and the last three propositions address knowledge flows.

Explicit Versus Tacit Knowledge

When designing a PM system one must consider that humans have limited information processing capabilities (Miller, 1956). Thus there is an upper limit on the number of performance measures that managers can effectively use. Additionally, each type of measure provides different information. Therefore, trade-offs among measures must be made and the selection of performance measures depends on the requisite informational criteria. For example, process measures are often leading indicators that provide timely information to managers while outcome measures are ex post measures that indicate the results of processes.

Relative to tacit knowledge, explicit knowledge is observable and the process by which the use of explicit knowledge results in favorable outcomes is also likely to be more observable. Thus in an environment characterized by the use of explicit knowledge, managers are likely to choose process performance measures over outcome measures since the process is known and observable and will provide leading (thus more timely) information to the managers. In contrast, tacit knowledge is unobservable and, hence, the process by which the use of tacit knowledge results in a favorable outcome cannot be observed. Simons (2000) states that process measures will not be relied on in the performance measurement system if the process is unobservable. However, the KM process must produce deliverables in order to provide competitive advantage (e.g., a new product or service, new solutions, etc.). Thus in an environment characterized by the use of tacit knowledge, managers are likely to choose observable outcome measures over process measures.[6] The preceding discussion suggests the following:

Proposition 1

There is a negative (positive) association between the use of tacit (explicit) knowledge and the use of process performance measures.

Proposition 2

There is a positive (negative) association between the use of tacit (explicit) knowledge and the use of outcome performance measures.

Environment and Transfer of Knowledge

An environment of trust and cooperation are essential to the transfer of tacit knowledge and the production of explicit knowledge. A key competitive advantage that an individual holds in the market place is his or her own tacit knowledge. Investing that asset into the corporation by sharing one's tacit knowledge with others and allowing it to be codified into explicit knowledge requires relationships built on trust and cooperation among individual employees in the corporation along with a level of trust and cooperation between the individuals and the corporation as a whole. Thus the transformation of tacit knowledge to explicit knowledge requires a culture based on trust and cooperation. Often, this type of environment is not well-suited for a formal, tight, monitoring system and firms will opt to rely less on a formal PM system and place more emphasis on other types of informal, "soft" controls (Simons, 2000).[7] Bob Jones, CKO, states,

> An important part of our knowledge management system is our values. We thought about what kind of culture we wanted to have and these values are still important today. Our CEO provides a talk about values and our company culture to all new hires. An important aspect of our culture is the focus on teamwork and sharing. Because of the strength of our company culture, we don't have problems with employees that want to maintain their personal competitive advantage and power base by withholding key knowledge.

This discussion supports the following proposition:

Proposition 3

Firms that rely more (less) on tacit knowledge will rely less (more) on the performance measurement system and more (less) on cultural and personnel controls.[8]

Knowledge Flows and Unit-Level Focus

The focus of managers of collaborative knowledge units and knowledge creators is on system-wide exchanges and uses of knowledge. Collaborative knowledge units are dependent on receiving knowledge from other subsidiaries and responsible for the production of knowledge to provide to other subsidiaries. Thus collaborative knowledge units are highly interdependent with other subsidiaries in the firm. Knowledge creators are also interdependent with other organizational units since they are responsible for the production and provision of knowledge to other subsidiaries. The organization may only be successful if the knowledge creator produces information that is useful to a related subsidiary. In contrast, knowledge users are highly concerned with the internal use of knowledge received from other subsidiaries. Thus the outcomes of the knowledge user are localized. Likewise, non-knowledge units do not share any knowledge interdependencies with other subsidiaries.

This discussion suggests that managers of collaborative knowledge units and knowledge creators focus on system-wide outcomes, while knowledge users and non-knowledge units focus on the individual subsidiary. Linking incentive compensation to network or intraorganizational measures[9] will weaken the link between performance and rewards for knowledge users and non-knowledge units, while it will strengthen the link for collaborative knowledge units and knowledge creators. Accordingly, incentive compensation will differ across subsidiaries (Salter, 1973). Gupta and Govindarajan (1986) investigate the incentive compensation system for strategic business units (SBUs) that share resources and find empirical support that those SBUs more engaged in resource sharing have incentive compensation linked to clusters of SBUs while those SBUs less engaged in resource sharing are compensated based on the local SBUs performance. The proposition follows:

Proposition 4

Compensation will be based more on firm-based measures (e.g., network or cluster measures) for collaborative knowledge units and knowledge creators than for knowledge users and non-knowledge units.

Knowledge Flows and Innovation

The production of knowledge is highly innovative. Simons (2000) suggests that imposing formal control over processes stifles creativity and innovation. Instead, Simons (2000) suggests that organizational units that rely heavily on innovative processes will rely more on outcome controls to compensate for less reliance on process controls. Collaborative knowledge units and knowledge creators are responsible for producing knowledge that will be disseminated throughout the organization. Thus, since the production of knowledge is highly innovative, managers are likely to monitor outcomes.[10] In contrast, relative to collaborative knowledge units and knowledge creators, the production of knowledge in knowledge users and non-knowledge units is not as critical (e.g., the effect is only local) and thus managers in these organizational users will rely less on outcome measures.

Proposition 5

Collaborative knowledge units and knowledge creators will rely more on outcome-related knowledge metrics than will knowledge users and non-knowledge units.

Knowledge Management and Non-financial Metrics

Knowledge management concerns an intangible resource; one which is not designed to be recorded in the financial statements. Therefore, financial statements are incomplete and poorly capture information about knowledge management (Kaplan & Norton, 1996; Lev, 2001). Information that is captured by the financial statements may even be misleading to firms focused on knowledge management since many of

the expenditures connected with knowledge management are expensed in the current period thus showing decreased profitability in the short-run (Lev, 2001). If firms rely on traditional financial measures, managers may have incentives to poorly manage knowledge by disallowing investments in people, training, information systems, and other inputs to the process that may facilitate the knowledge management process. Instead of solely relying on financial information, firms will also need more focused, relevant, non-financial information that provides information on their strategic objective: one of managing knowledge (Lev, 2001; Balkcom, Ittner, & Larcker, 1997; Kaplan & Norton, 1996).

Proposition 6

The importance of knowledge management within the subsidiaries will be positively associated with the use of non-financial measures.

EMPIRICAL INSIGHTS

In this section we report the results of a pilot test based on a convenience sample of data obtained from eighteen subsidiaries located in the U.S. The purpose of the pilot test is to gain insights into current knowledge management practices and begin to investigate constructs and build definitions for appropriate measures to further the study of the KM-PM relationship.

Descriptive Statistics

We obtained data from the President's of eighteen subsidiaries. Thirteen of the participants report to the board of directors, the Chief Executive Officer, or the President of the consolidated entity. The remaining five participants report to various operating and administrative persons. The majority of participants (11 or 61%) define knowledge as "knowledge is what has been learned from experience or study, and includes insights, interpretations, and information;" a statement which combines Gupta and Govendarajan's (1991) definition of knowledge with that of Schulz (2001).

Descriptive data on the subsidiaries in the pilot test are shown in Table 1. Although our subsidiaries are fairly small, they exhibit tremendous variability. The subsidiaries operate in several different segments including manufacturing, service, and construction. The number of subsidiaries within each consolidated entity ranges from 1 to 81. Participants indicate that knowledge is important to the achievement of organizational objectives and, on average, have established PM systems.

TABLE 1
DESCRIPTIVE STATISTICS

Panel A: Description of Subsidiaries

		N	Min	Max	Mean	Std. Dev.
	Sales (in $ and 000s)	17	4,000	839,000	76,736	198,350
	Number of employees	17	150	723	287	172
Q. 1.	# of subsidiaries in consolidated entity	17	1	81	9.76	18.900
Q. 7.	Importance of knowledge	18	5	7	6.56	.616
Q. 11.	Have a formal performance measurement system	17	1	7	5.53	1.807

Panel B: Segment Description

Industry Description	One-Digit SIC Code	Number of Participants	Percent of Participants
Agric., forestry, fishing	1	0	0.00%
Mining	2	1	5.886%
Construction	3	2	11.76%
Manufacturing	4	6	35.29%
Trans, comm, electric	5	1	5.88%
Wholesale	6	0	0.00%
Retail	7	0	0.00%
Finance, insur., real estate	8	1	5.88%
Services	9	6	35.29%
Total firms		17	

Variable Measures and Pilot Results

This section describes the initial evidence on the validity of two primary constructs: knowledge flows and type of knowledge (illustrated in Table 2).

TABLE 2
EXPLORATION OF CONSTRUCTS FACTOR ANALYSES

Panel A: Engage in Knowledge Transfers

	Factor 1	Factor 2
Marketing know-how	.469	**.501**
Distribution know-how	**.852**	.130
Packaging design/technology	**.738**	.334
Product designs	.103	**.896**
Process designs	.215	**.899**
Purchasing know-how	**.836**	.056
Mgmt systems and practices	**.602**	.410

Panel B: Stored as Explicit Knowledge

	Factor 1	Factor 2	Factor 3
Marketing know-how	**.786**	.386	.007
Distribution know-how	**.664**	**.669**	-.163
Packaging design/technology	.127	**.916**	.118
Product designs	-.004	**.627**	**.682**
Process designs	.230	-.010	**.937**
Purchasing know-how	**.821**	-.111	.258
Mgmt systems and practices	**.766**	.135	.137

All eigenvalues > 1 are reported. The total cumulative explained variance is 68% and 82% in Panels A and B, respectively. The factor patterns presented are rotated using Varimax to aid in interpretation. All factor loadings > .50 are highlighted for illustration. Missing values are excluded on a pairwise basis.

We examine knowledge outflows and type of knowledge using a set of questions from Gupta and Govindarajan (2000) and a measure taken from Schultz (2001) respectively. Relating to knowledge outflows, two factors have an eigenvalue greater than 1, and together, explain 68% of the variance. Examining the rotated factor scores indicates that all questions load onto one factor only. The second construct measures the type of knowledge. Three factors have an eigenvalue greater than 1, and together,

explain 82% of the variance. Examining the rotated factor scores of the second construct indicates that with the exception of distribution know-how and product designs, all questions load onto one factor only. Overall, these findings indicate that there is good variability in the questions.

Use of Knowledge Metrics

To gain insights into the role of the performance measurement system in knowledge management, we presented the participants a set of financial and non-financial metrics and asked about both the actual reliance on the metric and the level of reliance they would like to place on the measure. We selected the measures based on underlying literature and two interviews. We also asked participants to rank the level of importance the metrics have in a number of decision-making areas. The survey questions use a one-to-seven scale with one indicating no reliance and a seven indicating great reliance. Overall, financial measures are relied on more than non-financial measures. However, managers would like to rely more on both financial and non-financial measures than they do. This indicates that the role of the PM system in KM is evolving and has not yet achieved a steady state.

Table 3 presents the uses of the financial and non-financial measures in evaluating performance. A summary of the financial measures is presented in Table 4 and a summary of non-financial measures is presented in Table 5. Please see Appendix A for Tables 3, 4, and 5.

PROPOSITIONS

The propositions primarily revolve around the nature of information and the production and exchange of knowledge. To gain preliminary empirical insights into the propositions, we investigate the association between the type of knowledge, transfer of knowledge, and different measures and attributes of the PM system.[11] The results are shown in Table 6.

TABLE 6
CORRELATION ANALYSES

Panel A: Association with Knowledge Type

Question	Description of Question	Knowledge Type
16e	# of senior staff hrs explaining strategy/tactics	5.80**
16f	# of solutions/products suggested	.507*
16k	# of new colleague-to-colleague relationships	.529**
16l	Reuse rate of frequently accessed knowledge	.661**
16m	# entries to expert database	.768***
16n	# of read-access log-ins to expert database	.720***
16o	# of knowledge sharing proficiencies gained	.757***
11	Have a formal performance measurement system?	.108
12	Does the PM system contain knowledge metrics?	-.542**
	Mean of the actual reliance placed on financial measures	-.042
	Mean of the "would like to place" reliance on financial measures	-.412
	Mean of the actual reliance placed on non-financial measures	.410
	Mean of the "would like to place" reliance on non-financial measures	.432

Panel B: Association with Knowledge Transfer

Question	Description of Question	Knowledge Transfer
16b	% of employees with advanced degrees	.510**
16c	Information technology literacy	.628***
16d	Average duration of employment	.493**
16e	# of senior staff hrs explaining strategy/tactics	.520**
16f	# of solutions/products suggested	.453*
16g	# of new products introduced	.503*
16k	# of new colleague-to-colleague relationships	.597**
16m	# entries to expert database	.492*
16o	# of knowledge sharing proficiencies gained	.560**
16p	# of best practices applied to add value	.572**
16r	# interactions with consultants and advisors	.490*
11	Have a formal performance measurement system?	.567**
12	Does the PM system contain knowledge metrics?	-.464*
	Mean of the actual reliance placed on financial measures	.380
	Mean of the "would like to place" reliance on financial measures	.488*
	Mean of the actual reliance placed on non-financial measures	.778***
	Mean of the "would like to place" reliance on non-financial measures	.654**

The actual reliance on all financial and non-financial measures was included in the analysis. Only significant results for these questions are shown. Knowledge Type in Panel A is measured as the mean of the following question across seven areas within the firm: "To what extent is knowledge in each of the following areas stored and/or captured as numbers and codes, in words and text, or in pictures and images (1 = not at all and 7 = a high extent)?" Knowledge Transfer in Panel B is measured as the mean of the following question across seven areas within the firm: "To what extent does your subsidiary engage in transfers of (or provide) knowledge and skills to your sister subsidiaries and/or your parent company (1 = not at all and 7 = a high extent)?"

Panel A, Table 6, provides insights on the first three propositions. The type of knowledge is significantly and negatively correlated with the use of knowledge metrics ($r = -.542$, $p < .05$). The PM system contains knowledge metrics when the knowledge transfer to related entities is more explicit in nature. There are also positive correlations with seven non-financial measures, and no significant associations with financial measures. The seven non-financial measures primarily relate to the knowledge production process. Overall, these results provide some support for propositions one and three and suggest that as the knowledge transfers become more explicit and codified, firms rely more on process measures that are non-financial in nature. Conversely, as knowledge transfers become more tacit in nature, there is a negative association with process measures and less emphasis placed on a formal PM system.

Panel B, Table 6, provides insights, and support, for the fifth and sixth propositions.[12] As firms engage more in the transfer of knowledge they are more likely to have a formal PM system ($r = 5.67$, $p < .05$) and it is more likely that the PM system contains knowledge metrics ($r = -.464$, $p < .10$). The transfer of knowledge is positively associated with 11 non-financial performance measures, but not with any financial measures. The eleven non-financial performance measures contain input, process, and output measures. Overall, these results suggest that the more firms engage in the production and transfer of knowledge the more they rely on a formal PM system and the use of knowledge metrics that are non-financial in nature. In addition, they rely on performance measures throughout the knowledge chain: input, process, and output measures.

CONCLUSION

Firms are increasingly relying on intangible resources, especially intellectual capital and knowledge, in order to compete in today's global and rapidly changing environment (Lev, 2001). Performance measures, used to provide information and as a source of control, are essential to effective management processes (Simons 2000), yet there has been little academic research thus far at the intersection of KM and performance measurement.[13] Thus, this study contributes to the growing and needed debate on the role of performance measures in the KM arena.

We suggest a conceptual framework of six testable propositions that investigate the relation between the use of performance measures and the type of knowledge (e.g., explicit versus tacit) and the knowledge flows in and out of the organizational unit. In addition, our study presents data from a convenience sample of eighteen subsidiaries that provide information on knowledge flows, types of knowledge, and the design of the performance measurement system. The data allow us to draw several insights. First, the Presidents of the subsidiaries primarily rely on financial measures. This provides more evidence that non-financial measures serve as complementary measures and not as substitutes for traditional financial measures (e.g., Fisher, 1995). Second, the PM system is in an evolving state. The participants indicate many differences between the design of the PM system that they would like to rely on versus the one that they currently have in place. Third, knowledge metrics are not used as a basis for compensation decisions. Fourth, we find that the nature of knowledge appears to matter to the design of the PM system. As knowledge becomes more codified, more reliance is placed on process measures that are non-financial in nature. Finally, we find that the degree to which the organizational unit is involved in the knowledge exchange process also matters to the PM system. As organizational units become more involved in the exchange process, the PM system and the use of non-financial knowledge metrics becomes more important. We suggest that further study into the integration of performance measurement and knowledge management will aid firms with the effective evaluation and management of corporate knowledge capital.

ENDNOTES

1. We interviewed a Chief Executive Officer ("Lucy Smith") and a Chief Knowledge Officer ("Bob Jones") at two small high-technology companies. The interviews were tape-recorded and later transcribed. The purpose of the interviews was to gain institutional knowledge regarding knowledge management and performance measurement systems. Due to confidentiality agreements, the identities of the firms and officers are not disclosed.
2. For review papers in this area see Langfeld-Smith (1997) and Chenhall (2003).
3. Gupta and Govindarajan (1991) devised this model to illustrate the organization of multinational corporations. They use Citicorp's software development and marketing subsidiary as an example of a knowledge creator, IBM's Japanese subsidiary as an example of a collaborative knowledge unit, 3M Corporation's Finland subsidiary as an example of a knowledge user, and KFC franchises as an example of a non-knowledge unit. The non-knowledge unit in their study represents one that generates knowledge that does not provide competitive advantage outside of the local region or country.
4. Although knowledge exchange certainly exists with both customers and suppliers, the discussion in this paper is focused on relationships within the firm boundary. Investigating the relationships that extend beyond the firm boundary would be an interesting extension of the problem.
5. For example, Ittner and Larcker (1995) suggest and find that TQM systems are associated with greater reliance on teams and team-based performance measures.
6. We recognize that some measures may be complements instead of substitutes (Fisher, 1995); however, when a firm is in steady state trade-offs must occur (Simons, 2000) since there is an upper limit on the number of measures that firms can effectively use (Kaplan and Norton, 1996). This discussion also assumes that the cost of observing processes does not preclude managers from choosing to rely on process measures.
7. See footnote 6.
8. This study focuses on the PM system to the exclusion of other controls. For completeness of the proposition we include cultural and personnel controls; however, we leave this to be more fully developed in future work.

9. For example, "network" measures would include team measures for individuals, business unit measures for teams, and firm measures for managers of business units. A "network measure" for a business unit manager could be firm profitability while a "local" measure could be business unit profitability.
10. Note that not only is this an innovative process, but the process might be unobservable; either of which is sufficient to force managers to rely on outcome measures where available (Simons, 2000).
11. Recall that the type of knowledge is measured on a 7-point scale where 1 is tacit and 7 is explicit (see question 10 in the appendix) while the transfer of knowledge is measured on a 7-point scale where 1 is a low transfer of knowledge and 7 indicates that knowledge is transferred to a high extent (see question 8 in the appendix).
12. Unfortunately there is no data on compensation.
13. Although there is little academic research that focuses directly on performance measures and knowledge management (see earlier discussion in paper), it should be noted that there is a broad practitioner literature, especially in journals such as Knowledge Management Review.

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APPENDIX A

TABLE 3
PERFORMANCE MEASUREMENT SYSTEM METRIC USE

	Financial Measures						Nonfinancial Measures				
	N	Min	Max	Mean	Std. Dev.		N	Min	Max	Mean	Std. Dev.
Operating decisions	17	4	7	5.59	1.004		16	2	7	5.06	1.482
Evaluation of employees responsible for knowledge management	16	1	7	4.63	1.857		16	1	7	4.56	1.672
Evaluation of employees involved in generating, collecting and/or codifying knowledge	16	2	7	4.19	1.424		16	1	6	3.56	1.632
Compensation of employees responsible for knowledge management	15	1	7	3.67	2.193		16	1	7	3.63	1.962
Compensation of employees involved in generating, collecting and/or codifying knowledge	15	1	7	4.13	1.685		15	1	6	3.27**	1.624

** difference in means significant at p < .05.

TABLE 4
USE OF FINANCIAL MEASURES
EXTENT OF RELIANCE
(1 = No Reliance, 7 = Great Reliance)

	Actual Reliance						Would Like to Place Reliance On				
	N	Min	Max	Mean	Std. Dev.		N	Min	Max	Mean	Std. Dev.
R&D expenditures	17	1	7	3.65	2.621		14	1	7	3.86**	2.316
Training expense per employee	17	1	7	4.29	1.829		14	3	7	5.21**	1.424
Revenues from new business/product	17	1	7	4.35	2.178		15	1	7	5.20**	1.781
ROA from new business/product	17	1	7	4.12	2.118		15	1	7	5.07***	1.831
Investment in information technology	17	1	7	4.82	1.845		14	2	7	4.79	1.578

***, ** difference in means significant at p < .01, .05, respectively.

TABLE 5
USE OF NON-FINANCIAL MEASURES
EXTENT OF RELIANCE
(1 = No Reliance, 7 = Great Reliance)

	Actual Reliance						Would Like To Place Reliance				
	N	Min	Max	Mean	Std. Dev.		N	Min	Max	Mean	Std. Dev.
# of patents pending	15	1	7	3.07	2.463		13	1	6	2.85	2.444
% of employees with adv. degrees	16	1	7	3.56	2.097		14	1	7	4.00	1.922
Information technology literacy	17	2	6	4.00	1.173		15	3	7	5.13***	1.356
Average duration of employment	17	1	7	4.94	2.045		15	1	7	4.93	1.792
# of senior staff hrs. explaining strategy/tactics	16	1	7	2.63	1.857		15	1	7	3.60**	1.993
# of solutions/products suggested	15	1	7	2.80	2.426		15	1	7	3.53**	2.100
# of new products introduced	15	1	7	4.20	2.569		14	1	7	4.50	1.990
# of ideas/suggestions implemented	14	1	7	3.29	2.555		14	1	7	4.43**	2.102
Average age of patents	14	1	7	2.50	2.279		13	1	7	2.23	1.964
Time spent in training	17	1	6	3.94	1.345		15	2	7	5.13***	1.356
# of new colleague-to-colleague relationships	16	1	6	2.63	2.062		15	1	7	3.33**	2.225
Reuse rate of frequently accessed knowledge	14	1	7	2.93	2.303		13	1	7	3.92**	2.37
# of entries to expert database	14	1	7	2.71	2.400		13	1	7	3.38**	2.599
# of read-access log-ins to expert database	14	1	7	2.79	2.455		13	1	7	3.23	2.522
# of knowledge sharing proficiencies gained	14	1	7	3.00	2.253		13	1	7	3.77**	2.127
# of best practices applied to add value	13	1	7	4.15	2.577		12	2	7	5.25**	1.765
# of apprentices mentored	15	1	5	2.73	1.751		13	1	5	3.85**	1.405
# of interactions with consultants and advisors	15	1	7	2.53	1.685		13	1	7	2.46	1.761

***, ** difference in means significant at $p < .01, .05$, respectively.

For Tables 3, 4, and 5, we calculated the test statistic using the Wilcoxon signed ranks test. For robustness we also calculated the t-test. The statistical inferences do not change across the different test statistics.