

Factors that Contribute to the Success of Knowledge Management: An Empirical Investigation of Primary Activities of the Knowledge Chain Model

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Abstract

It is often claimed that knowledge management (KM) initiatives are important, even essential, to advance organizational performance. The main goal of such improvement is to make an organization more competitive in delivering values to its stakeholders. However, KM initiatives are of little value without a concrete plan that link KM activities to organizational performance. The Knowledge Chain model has been advanced as basis for understanding factors that contribute to the success of KM initiatives. This model identifies five primary and four secondary activities as focal points for an organization's competitiveness. This paper uses the Knowledge Chain model as the theoretical base for an empirical study of the linkage between primary activities and approaches to competitiveness. It finds that every one of the five primary KM value adding activities can be performed in ways that improve organizational competitiveness in any of four ways: enhanced productivity, agility, innovation, and reputation.

Keywords: Agility, competitiveness, innovation, knowledge management, knowledge, productivity, reputation, survey research

1. Introduction

Knowledge management (KM) has been growing in importance and popularity as a research topic and business initiative since the mid-1990s. In an economy where the only certainty is uncertainty, one source of lasting competitive advantage is knowledge and its manipulation (Nonaka, 1995). Researchers in the field of sustainable competitive advantage have discovered that knowledge, which includes what the organization knows, how it uses what it knows, and how fast it can know something new, is the only thing that offers an organization a competitive edge (Prusak, 1996; Sharkie, 2003). Knowledge and its management are more powerful and valuable than natural resources, big factories, or fat bankrolls (O'Dell and Hubert, 2011). Critical to our understanding of the value of knowledge management is its link to organizational performance outcomes (Kalling, 2003).

Many empirical studies such as those conducted by Delphi, Hughes Space and Communications Company, and Ford Motor Company support the assertion about competitiveness through KM. Ernst and Young Center for Business Innovation conducted a survey of 431 US and European organizations and reported "that more active management of knowledge is possible and advisable - indeed, that it is critical if a firm is to gain and sustain a competitive advantage" (Holsapple and Singh, 2005). In the same study, 875 of the respondents describe their businesses as knowledge-intensive, indicating knowledge and its management is critical to their competitiveness. User success stories via KM are reported in KM journals such as Knowledge Management Research and Practice and Journal of Knowledge Management. In one survey conducted by the latter journal, over 90% of respondents perceived their organizations to be knowledge intensive (Holsapple & Singh, 2005). However, only 6% admitted that their organizations do enough to leverage knowledge very effectively to yield better performance. On the other end of the spectrum, unmanaged organizational knowledge led to failures such as those concerned with risk management at Barings Bank, Kidder Peabody, and Metallgesellschaft and insufficient knowledge management activity was a contributing factor to the 9/11 disaster (Simon & Gilgoff, 2003).

Since knowledge has become the core enabling asset, maximum leverage of this intellectual capital is imperative. Many organizations have felt the need to better utilize its intellectual assets and started to develop KM systems and foster a knowledge management culture. Hundreds of companies around the world are committed to KM principles and processes, including many of the Fortune 500 firms (O'Dell & Hubert, 2011). KM is certainly becoming part of corporate culture, diffused throughout organizations in the same fashion as safety consciousness. Holsapple et al. (2007) noted that there has been a phenomenal growth in interest and activity in KM, as seen in many new publications, conferences, IT products, and job advertisements.

All businesses involve creation, dissemination, renewal, and application of knowledge toward organizational sustenance and survival in the face of increasingly discontinuous environment change (Turban et al., 2011). In order to systematically improve the leveraging of knowledge, it is essential to have a model that identifies the possible fulcrums. These fulcrums are the KM classes of activities that can yield competitive advantage if designed and executed better than those of other organizations. A key to understand KM and fully exploit its competitive potential is a model that identifies value-adding KM activities. Each can be a candidate for enhancements that add value to an organization. Practitioners could use the model to structure their consideration and evaluation of KM initiatives. Researchers could use the model to structure their exploration of connections between KM and competitiveness. Educators could use it to structure coverage of KM activities and impacts in their courses. These motivations, coupled with the absence of such a model in the literature, led to the creation of the Knowledge Chain (KC) model by Holsapple and Singh (2003). The KC model posits nine distinct, generic value activities that an organization performs in the course of managing its knowledge resources. It contends that these activities are focal points for achieving competitiveness through knowledge management, in the sense that an organization can perform one or more of them better than competitors in order to achieve a competitive advantage. The nine KM value activities are divided into five *primary* activities that an organization can perform in manipulating knowledge resources, plus four *secondary* activities that support and guide performance of the primary activities. Anecdotal evidence has been reported that illustrates the direct role of each of the nine KC activities in adding value to an organization and increasing its competitiveness (Holsapple and Singh, 2003).

This paper takes a step beyond the anecdotal evidence by further substantiating the KC model via an empirical investigation. Specifically, it investigates the relationship between each *primary* activity in the KC model and the organizational performance achieved through four approaches of competitiveness: Productivity, Agility, Innovation, and Reputation. The study uses the perceptions of chief knowledge officers and other leaders of KM initiatives from different industries. We intend to investigate and report the empirical evidence in support of the four *secondary* activities in a subsequent paper at a later date.

We begin with a background examination of the KC model as theoretical basis for our investigation of the five *primary* KM activity classes. Next, we discuss the research methodology employed in the study, and followed by the presentation of the results and findings. Finally, the concluding section points out the strengths and limitations of this study, along with directions for future research.

2. The Knowledge Chain Model

Knowledge management aims to ensure that the right knowledge is available in the right representation to the right processors (human or machines) at the right time for the right cost (Turban et al., 2011). To achieve this objective, KM activities are undertaken that involves a landscape of knowledge flows and processing within a knowledge-based organization. In many cases, the manipulation activities and the flows that connect them can be performed, enabled, or facilitated with computer support. We contend that one key to more fully exploit the competitive potential of knowledge management is to develop a model that identifies key value-adding KM activities (Holsapple & Singh 2003). We advanced one such model called the Knowledge Chain model that identifies and characterizes KM activities an organization can focus on to achieve competitiveness. The Knowledge Chain (KC) model is based on a KM ontology developed via a Delphi-study involving an international panel of prominent KM practitioners and academicians (Joshi, 1998). The model is analogous to Porter's value chain. It is comprised of five primary activities that an organization's knowledge processors perform in manipulating knowledge resources, plus four secondary activities that support and guide their performances. Table 1 and Table 2 provide a summary of the primary and secondary activities.

Table 1: Primary KM Activities in the Knowledge Chain Model

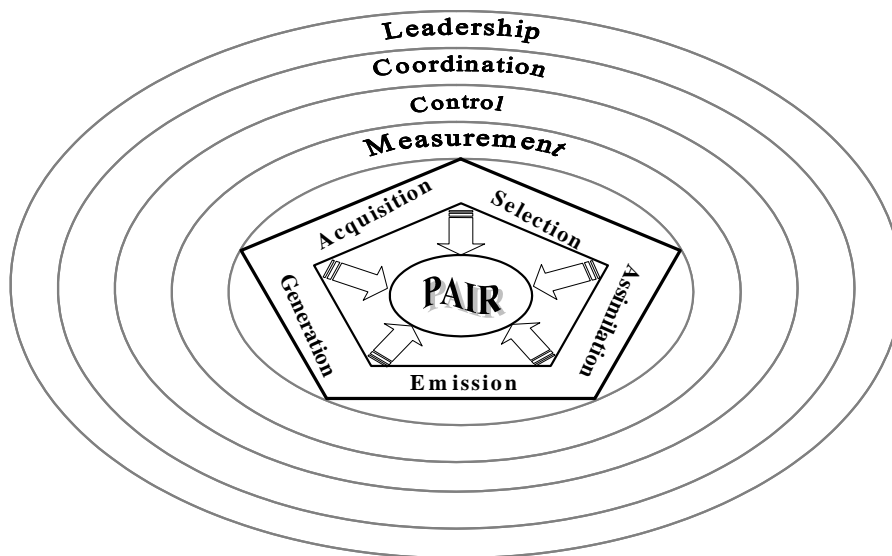
Knowledge Acquisition	Acquiring knowledge from external sources and making it suitable for subsequent use.
Knowledge Selection	Selecting needed knowledge from internal sources and making it suitable for subsequent use.
Knowledge Generation	Producing knowledge by either discovery or derivation from existing knowledge.
Knowledge Assimilation	Altering the state of an organization’s knowledge resources by distributing and storing acquired, selected, or generated knowledge.
Knowledge Emission	Embedding knowledge into organizational outputs for release into the environment.

Table 2: Secondary KM Activities in the Knowledge Chain Model

Knowledge Leadership	Establishing conditions that enable and facilitate fruitful conduct of KM.
Knowledge Coordination	Managing dependencies among KM activities to ensure that proper processes and resources are brought to bear adequately at appropriate times.
Knowledge Control	Ensuring that needed knowledge processors and resources are available in sufficient quality and quantity, subject to security requirements.
Knowledge Measurement	Assessing values of knowledge resources, knowledge processors, and their deployment.

Competitiveness due to KM practices can manifest itself in such ways as increasing profits and bolstering an organization’s reputation, employee’s creativity, productivity, efficiency, flexibility, and innovation. Analysis of the extensive anecdotal evidence from the KM literature has revealed that KC activities can yield four important approaches to high performance: productivity, agility, innovation, and reputation (Holsapple & Singh, 2003). Accordingly, as illustrated in Figure 1, the KC model claims that various combinations and implementations of primary and secondary activities lead to four organizational performance implications: performance, agility, innovation, and reputation. Referred to as the PAIR approaches to competitiveness, the competitive role of each KM activity in the Knowledge Chain is examined in terms of one or more of these PAIR approaches.

Figure 1: The Knowledge Chain Model



Productivity is the rate at which goods and services are produced per unit cost. Although it is commonly defined in terms of labor, it can also be seen as the value people contribute to business. Due to the increasing dynamism of the global market, the competitive advantage provided by *agility* has emerged as an important priority. *Innovation* is the means whereby organizations exploit change as an opportunity for a different business or a different service, and it is capable of being learned and practiced (Drucker, 1993). The innovation process can be defined as bringing ideas to market.

Now and in the future, more than at any time in history, the secret to competitive advantage is innovation (O’Dell & Hubert, 2011). Jeffrey Brown from Opinion Research Corporations states that: “Think of your *reputation* as a reservoir of goodwill. You can only go to the well so often before it dries up. Protect your reputation whenever you can” (Garone, 1998). Reputation derives from the interpretation by a public of a particular set of knowledge cues emanating from an organization; thus, an organization’s conduct of KM activity impacts its reputation.

3. Research Study

Anecdotal evidence can be complemented usefully by a survey that studies perceptions of KM leaders toward the connection between KM activity and organizational performance. Accordingly, we conducted a study to ascertain answers to the following questions with regard to each of the nine KC activities. Does the activity contribute to a competitive advantage by:

- a. Improving productivity (e.g., lower cost, greater speed)?
- b. Enhancing organizational agility (e.g., more alertness, rapid response ability, greater flexibility and adaptability)?
- c. Fostering innovation (e.g., inventing new products, services, processes)?
- d. Enhancing reputation (e.g., better quality, dependability, brand differentiation)?

3.1 Survey Instrument

The research methodology chosen is a field survey involving one instrument. The instrument begins with brief instruction to respondents. Next, a two-page quick reference guide is provided including an overview of the KC model and brief description of its value activities. Next, we ask the following question using a Likert-type scale for each of the nine activities (for demonstration purposes, all the sample questions in this paper use the general phrase *Knowledge Activity* and this generic name is substituted with the actual name of the specific activity under consideration (e.g., Knowledge Acquisition) on the survey distributed to respondents):

1. In your organization, to what degree is *Knowledge Activity* performed in a way that is instrumental in achieving a competitive advantage?

Not At All			Moderately			Extensively
1	2	3	4	5	6	7

The next question on the survey deals with understanding in more depth how the performance of the knowledge activity contributes to competitive advantage.

2. Your organization’s approach to Knowledge Activity contributes to a competitive advantage by

- a. **Improving productivity (e.g., lower cost, greater speed)**

Not At All			Moderately			Extensively
1	2	3	4	5	6	7

- b. **Enhancing organizational agility (e.g., greater flexibility, rapid responsiveness; adaptability)**

Not At All			Moderately			Extensively
1	2	3	4	5	6	7

- c. **Fostering innovation (e.g., learning; new products, services, processes)**

Not At All			Moderately			Extensively
1	2	3	4	5	6	7

- d. **Enhancing reputation (e.g., better quality, dependability; brand differentiation)**

Not At All			Moderately			Extensively
1	2	3	4	5	6	7

The evaluative characterizations for the Likert-type scale responses are: Not At All (1); Moderately (4); and, Extensively (7). Characterizations of the remaining scale levels (i.e., 2, 3, 5, and 6) are not explicitly defined on the questionnaire. The survey concludes with general demographic questions. A cover letter and survey instrument were mailed to each of the potential respondents in the sample.

3.2 Pilot Testing

For the validation of the survey items, the survey instrument was pilot tested with two academics and two experienced practitioners in the KM area.

All pilot test candidates were sent a cover letter inviting them to participate in pilot testing, a model cover letter to be used during the actual survey, and the questionnaire. The testers' comments and suggestions were used to refine, extend, and correct the questionnaire as needed.

3.3 Identification of Potential Respondents

In this study, we are solely interested in organizations with ongoing KM initiatives. We set the qualification of a potential survey respondent to be someone in the leader position for a KM initiative within an organization. Candidates should hold positions such as CKO (Chief Knowledge Officer), CLO (Chief Learning Officer), Director of KM, Knowledge Officer, and so forth. Based on these criteria, we searched a variety of online and printed sources to get a mailing list for leaders in the KM initiatives. Consequently, the survey instrument was sent to 102 candidates worldwide with readily available mailing lists, out of which thirty two had responded for a response rate of 31.4%.

3.4 Analysis Approach

For expository convenience, we define some qualifiers that are used in the ensuing data analysis and discussion. For analyzing and explaining the empirical evidence, we aggregate the degrees of contribution into three categories as shown in Table 3: Weak, Moderate, and Strong, with the latter two being referred to as Substantial.

Table 3: Degree of Contribution for Each KM Activity for Competitiveness

	Degree of Contribution		
	Not Substantial	Substantial	
	Weak	Moderate	Strong
Likert Scale	1 to 3	4	5 to 7

3.4.1 Existence Criterion

The rationale for doing empirical study is to search for evidence that supports the *inclusion* of each KM activity in the KC model. The inclusion of an activity in the model means there are indeed ways in which the activity are performed that result in competitive advantage. The primary criterion for assessing if a specific KM activity is appropriate to include in the KC model is the existence of cases where it is instrumental in achieving a competitive advantage. For example, looking at an extreme case, if no respondents perceive the way in which a given KM activity is performed contributes to competitive advantage, then inclusion of that activity in the KC model would be highly questionable.

In another scenario, if there is just one seemingly isolated case whereby the performance of the KM activity is perceived as contributing strongly to competitive advantage, then several possible reasons could exist: (a) Perhaps the respondent is mistaken about the connection between the activity and its benefits; or (b) it is perhaps a rare or capricious situation; or (c) the respondent's organization is extremely innovative and is a pioneer in achieving competitive advantage through such an activity.

Existence of the phenomenon of achieving competitive advantage through an activity may be established when "appreciable" proportion of respondents may regard it as being so. A question in this connection then is what proportion should be sufficient to overcome the concerns listed in (a), (b), and (c) above. Methodologically, there is no magic dividing line. However, for the purpose of this study, we use 25% as a rule of thumb. If one quarter of the subjects recognize an activity as being a **strong** (i.e., 5 through 7 on the Likert scale) contributor to competitive advantage, then we contend that this is compelling evidence to include this activity in the KC model. We recognize that 25% is quite arbitrary. It is true that the higher the percentage is, the greater the comfort level. It could well be that this phenomenon does exist for an activity even though it is not so widely experienced (e.g., 10%). We believe that this cutoff of 25% is fairly a high hurdle to pass. Some observers may argue for a number lower than 25% and others for a higher number. They are free to do so. In this research, we report the actual percentages given by empirical evidence so others can use the threshold figure that they deem proper.

3.4.2 Pervasiveness Criterion

Existence of each KM activity is the main objective of our study because it is the key to inclusion of these activities in the KC model.

Using empirical evidence, we also study the *pervasiveness* with which KM activities are performed in organizations in ways yielding competitive advantage. Existence of an activity does *not* necessarily mean that it is commonly executed in organizations. It is conceivable that 25% of the respondents may regard an activity as strongly contributing towards a competitive advantage, but the other 75% may have rated it on the low end of the Likert scale. The scenario may present evidence for the existence of competitive advantage through the practice of the said KM activity in an organization, but it does not fundamentally mean that this result is commonplace across organizations.

One way to get some insight into the pervasiveness phenomenon is by looking at the relative frequency graphs of each KM activity. Relative frequency is a simple effective method of organizing and presenting data so that one can get an overall picture of where measurements are concentrated and how spread out the measurements are. A more formal way to examine the pervasiveness is by testing the mean values of the participants' responses to question 1 for each KM activity. For each KM activity, the null and alternative hypotheses were stated as follows (the phrase *Primary Activity* should be replaced by a specific primary KM activity under consideration such as Knowledge Acquisition):

H_0 : On average, *Primary Activity* as it is performed in knowledge-based organizations today does not contribute substantially to achieving a competitive advantage.

H_1 : On average, *Primary Activity* as it is performed in knowledge-based organizations today does contribute substantially to achieving a competitive advantage.

This hypothesis was operationalized as:

μ = The mean of the responses to question number 1 for a primary activity.

μ_0 = The tested Likert scale value (3).

H_0 : $\mu \leq \mu_0$ (where $\mu_0 = 3$)

H_1 : $\mu > \mu_0$

We predict that, on average, a given primary activity as it is performed in an organization today contributes **substantially** to achieving a competitive advantage. As indicated in Table 3, the Likert scale of 3 is the cut-off between *substantial* and *not substantial*. Accordingly a test value of 3 was used (In a similar way, "substantial" could be replaced by "strong" with a test value of 4). This prediction of pervasiveness of an activity could be confirmed if the null hypothesis can be statistically rejected. The t-test is performed to examine the analysis with a sample size exceeding 30 in every test.

The same approach is followed to examine the pervasiveness of the four approaches of competitive advantage (i.e., PAIR) in survey question number 2. For example, for each of the five primary activities, the null and alternative hypotheses for improving *productivity* are stated as follows (the phrase *Primary Activity* should be replaced by a specific primary activity under consideration such as Knowledge Acquisition):

H_{0-p} : On average, organization's approach to *Primary Activity* does not contribute substantially to achieving a competitive advantage by improving *productivity*

H_{1-p} : On average, organization's approach to *Primary Activity* contributes substantially to achieving a competitive advantage by improving *productivity*

In a similar fashion, we can formulate the hypothesis statements for the other three organizational performance implications (i.e., agility, innovation, and reputation) for each of the primary KM activities by replacing the word *productivity* in the above hypothesis statements with the terms *agility*, *innovation*, and *reputation*.

4. Results and Discussions

This section discusses the empirical evidence in support of KC model with respect to the model's five *primary* KM activities: Knowledge Acquisition, Knowledge Selection, Knowledge Generation, Knowledge Assimilation, and Knowledge Emission. In particular, it explores, in a respondent's organization, to what degree each primary KM activity is performed in a way that is instrumental in achieving a competitive advantage. On the survey instrument, this investigation is reflected in question number one for each primary activity (see Section 3.1). In other words, question number one studies the *overall* contribution of each primary activity's contribution towards competitive advantage.

A competitive advantage may be achieved by means of improving productivity, enhancing organizational agility, fostering innovation, and enhancing reputation. Thus, this section also explores to what degree a respondent’s approach to each primary activity contributes to a competitive advantage via these four criteria. On the survey instrument, this investigation is reflected in question number 2 (parts a, b, c, and d) for each primary activity (see Section 3.1).

4.1 Empirical Evidence Specific to Existence of Primary Activities

As mentioned in Section 3.4, for the purpose of analyzing and explaining the empirical evidence, we aggregate the degrees of contribution of each KM activity as shown in Table 3. Using these qualifications, Table 4 shows the relative frequency distributions of responses to survey question number 1 for each primary activity.

Table 4: Relative Frequency of Responses to Question Number 1 for Each Primary Activity

	Degree of Contribution		
	Not Substantial	Substantial	
	Weak	Moderate	Strong
	1 to 3	4	5 to 7
Statistics	Relative Freq.	Relative Freq.	Relative Freq.
Primary KM Activity	%	%	%
Acquisition	23.3	16.7%	60.0%
Selection	26.6	26.7%	46.7%
Generation	13.3	26.7%	60.0%
Internalization	33.3	13.3%	53.4%
Externalization	25.0	14.3%	60.7%
Average	24.3	19.5%	56.2%

As discussed in Section 3.4.1, to assess the extent of empirical evidence in support of *inclusion* for each primary activity in the KC model, we decided to use the 25% existence criterion for “strong contribution.” Applying the 25% cut-off yields the results shown in Table 4 that selected a threshold Likert scale of 5 or greater for survey question number 1. The order of strong contribution from the highest to the lowest is:

Emission → Generation/Acquisition → Assimilation → Selection
 60.7% 60.0% 53.4% 46.7%

Every one of the primary activities exceeds our cut-off figure of 25%. In terms of current practices, Emission, Generation, and Acquisition exhibit almost equally (about 60%) strong contributions to competitive advantage followed by Assimilation (53.4%) and Selection (46.7%). The evidence indicates that Emission makes use of knowledge in such a way that it exhibits the strongest contribution to a competitive advantage. Generation and Acquisition are both involved in helping organizations to have new knowledge. Organizations are able to either produce or acquire knowledge that other companies don’t have, and they make use of that knowledge to achieve a competitive advantage.

Among the five primary activities, it is interesting to note that Assimilation and Selection are the weakest reported in our survey. In actual practice, these activities are well known and they are very widely discussed among practitioners. It may well be that the common practice of these two activities by various organizations is not providing a competitive edge as strongly as the other three activities to our respondents. On the other hand, Acquisition, Generation, and Emission are activities that may be more unique to an organization.

Except for Selection, more than half of the surveyed respondents currently regard primary knowledge activities as being performed in a way that contributes strongly towards a competitive advantage in their organizations. Even though the percentage for Selection is 46.7%, it is considerably higher than our cut-off of 25%. Therefore, at such a response rating, the evidence for these activities is compelling enough to include them in the knowledge chain model. Chief knowledge officers and others concerned with the planning and administration of KM initiatives in organizations should pay careful attention to the model's primary activities. Not to do so, could result in a competitive disadvantage.

4.2 Empirical Evidence Specific to Four Approaches to Competitive Advantage

Next, for each of the primary KM activity, we examine the four approaches (PAIR) of achieving competitive advantage. The percentages of "strong contribution" for the PAIR dimensions are shown in Table 5.

Table 5: Percentages of "Strong Contribution" Responses for PAIR Dimensions

Primary Activity	Productivity	Agility	Innovation	Reputation
Acquisition	43.3	36.7	56.7	53.3
Selection	46.7	53.3	53.3	53.3
Generation	58.6	65.5	67.9	65.5
Assimilation	37.0	31.0	51.9	36.0
Emission	50.0	32.1	42.9	53.6

From the figure, no major or crippling reservations are detected in terms of current practices. Range of percentages of strong contributions for these four approaches is Productivity (37.0% - 58.6%), Reputation (36.0% - 65.5%), Agility (31.0% - 65.5%), and Innovation (42.9% - 67.9%).

Looking at Acquisition, the strongest approach to achieving a competitive advantage comes from innovation. It is not too surprising because Acquisition brings in fresh ideas into the organization from the external environment. The innovation process is defined as "bringing ideas to market." For Selection, there is not much difference among the four approaches. Interestingly, Generation has the highest percentages for all the four approaches among all the primary activities in terms of current practices: Productivity (58.6%), Reputation (65.5%), Agility (65.5%), and Innovation (67.9%). The way in which Generation contributes strongly to competitive advantage is not so much by being productive as by allowing the organization to be more agile and innovative. This, in turn, fosters reputation (Higgins, 1995).

Assimilation and Acquisition go in parallel in that both foster innovation. This is understandable because, while Acquisition acquires fresh and new ideas from the outside, Assimilation exposes participants to existing in-house knowledge thus rendering provocative and stimulating effects that consequently promote innovation. As for Emission, competitive advantage is achieved more through productivity and reputation than agility and innovation. Knowledge Emission results in projections. When an organization transfers an output (e.g., in the form of products, services, and knowledge artifacts), it is projecting. The process of effective projection adds value to an organization. The empirical evidence suggests that the added value come more strongly in the forms of productivity and reputation and less so with agility and innovation. The justification may be that, in many cases, agility is something that happens prior to Emission. Similarly, in many organizations, learning (i.e., innovation) happens prior to Emission. Therefore, it is not too astonishing that agility and innovation take a backseat to productivity and reputation. Even so, the evidence confirms that Externalization can lead to competitive advantage via agility and innovation.

The 25% existence criterion is passed by the four PAIR approaches for every one of the primary activities. Respondents agree that these four performance strategies are useful to judge success in their KM endeavor. For example, if an organization is planning a competitive strategy that identifies, say *productivity*, as a focal point for achieving competitive advantage, then the question is how to implement this strategy. In KM terms, Table 5 shows KM activities that most commonly lead to competitive advantage through productivity.

4.3 Empirical Evidence Specific to Pervasiveness of Primary Activities

One formal way to determine the pervasiveness is by testing the mean values of the participants' responses to survey question number 1. For each primary KM activity, the null and alternative hypotheses stated in Section 3.4.2 were tested. The mean and median of responses to survey question number 1 for each KM activity is shown in Table 6.

Table 6: Mean and Median of Responses for Each Primary Activity

Primary Activity	Mean	Median
Acquisition	4.83	5.00
Selection	4.57	4.00
Generation	4.93	5.00
Assimilation	4.23	5.00
Emission	4.36	5.43

We predict that, on average, a given primary activity as it is performed in an organization today contributes substantially to achieving a competitive advantage. As indicated in Table 3, the Likert scale of 3 is the cut-off between “substantial” and “not substantial.” Accordingly a test value of 3 is used. This prediction can be confirmed if the null hypothesis can be statically rejected. The t-test is performed to examine the analysis with a sample size of about 32 per test. Statisticians generally choose 30 as the dividing line between large and small samples (Ott and Hildebrand, 1983). Table 7 lists the results of the t-tests for the primary activities.

Table 7: t-Test Results of the Means of Responses for each Primary Activity

Primary Activity	Test Value = 3	
	t-value	p-value
Acquisition	7.04	0.00
Selection	5.84	0.00
Generation	6.94	0.00
Assimilation	3.45	0.00
Emission	4.31	0.00

In all cases, the results show that t-values are significant at $\alpha = 0.01$ level and the null hypotheses are rejected. This empirical finding supports that each one of the primary KM activity as it is practiced today in the respondents’ organizations does indeed commonly contribute in a substantial way to achieving a competitive advantage. Thus, the primary KM activities are not only included in the knowledge chain model on the basis of existence criteria, but also there is evidence that each of the activity is fairly pervasive in contributing to competitive advantage.

4.4 Empirical Evidence Specific to Pervasiveness of Four Approaches to Competitiveness

In a similar vein, for each of the primary activity, we can examine the pervasiveness of the four approaches to achieve a competitive advantage (i.e., Productivity, Agility, Innovation, and Reputation) in terms of each primary KM activity. Please see Section 3.4.2 for the corresponding hypothesis statements. Table 8 lists the results of the t-tests for the PAIR dimensions for each primary activity.

Table 8: t-Test Results of the Means of Responses for PAIR Dimensions

Primary Activity	Test Value = 3	
	t-value	p-value
ACQUISITION		
Productivity	5.90	0.00
Agility	4.11	0.00
Innovation	5.17	0.00
Reputation	6.16	0.00
SELECTION		
Productivity	3.96	0.00
Agility	4.19	0.00
Innovation	3.75	0.00
Reputation	4.32	0.00
GENERATION		
Productivity	6.65	0.00
Agility	7.43	0.00
Innovation	5.16	0.00
Reputation	6.50	0.00
ASSIMILATION		
Productivity	2.64	0.01
Agility	2.50	0.01
Innovation	3.32	0.00
Reputation	2.00	0.03
EMISSION		
Productivity	2.67	0.01
Agility	2.06	0.02
Innovation	1.53	0.07
Reputation	3.33	0.00

We notice that in all cases but three, the results show that t-values are significant at $\alpha = 0.01$ level and the null hypotheses are rejected. At $\alpha = 0.05$, only one case has a p-value higher than 0.05. This supports the view that each primary KM activity as it is practiced today in the respondents' organizations commonly contributes substantially to achieving a competitive advantage in almost all of the four approaches.

For Emission, the approach of Innovation to achieve a competitive advantage has a p-value of 0.07 and, therefore, the null hypothesis in this case cannot be rejected. Hence, using Emission practices to achieve competitive advantage through innovation does not seem to be commonplace, although it does exist (recall 42.9% for Emission vs. Innovation in Table 5).

5. Conclusion

Among organizations with active KM initiatives, we have found compelling evidence for including every one of the five posited primary KM activity in the knowledge chain model. Moreover, we have found that it is commonplace for these organizations to perform each activity in a way that yields substantial competitive advantage. Thus, the knowledge chain model provides structure to researchers, practitioners, and educators for considering specific KM activities that can be sources of competitive advantage. Researchers may ask if they can determine a set of potential best practices for each of these primary activities to help achieve competitive advantage. Practitioners in their planning and execution of KM initiatives in their organizations should pay close attention to the primary knowledge chain activities. For, if overlooked, it could be detrimental and could well become a source of competitive disadvantage. For educators, the knowledge chain outlines the topics to be covered in teaching a KM course.

We also found existence and pervasiveness evidence for each of the four approaches of productivity, reputation, agility, innovation, to achieve competitiveness advantage. The model is not intended to identify the source or modus operandi for the four approaches.

Rather, it seeks to identify basic KM activities that can be performed in ways that foster productivity, reputation, agility, and innovation. The empirical evidence has found that the way in which primary KM activity is done can give a competitive edge via these four approaches. Therefore, future research becomes “what specific practices should be followed to make the organization’s primary knowledge activities comparable to or better than those competitors with respect to fostering the four approaches?”

The KC model is descriptive in nature. The intent is to identify KM activities that researchers and practitioners need to consider in managing knowledge to achieve competitiveness. Therefore, future research should focus on providing practitioners with such prescriptive guidance as identifying “best methodologies” and “best technologies” for contributing to competitiveness via the PAIR approaches. Future research could also focus on the technological aspect of KM. Using the KC model as the basis, the linkage between KM technology and competitive advantage could be investigated. This could, perhaps, pioneer new KM products and approaches that fuel the current knowledge economy.

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