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Abstract

In recent years, information and communication technologies have been implemented in organizations to support the management of organizational knowledge and facilitate more effective knowledge sharing and problem solving. These technologies are collectively termed knowledge management systems *(KMS). Unfortunately, the results of implementing KMS in organizations have not been as encouraging as expected. Specific problems facing organizations involve information overload, not using the systems effectively, or reinventing the wheel. Considering the fact that KMS were expected to solve exactly this latter problem, there is a need for studying why these systems fail and how we can improve them. In this paper, we focus on one aspect of the problem—namely, that organization members are not utilizing the knowledge stored in KMS. We propose that by incorporating some knowledge about the knowledge—termed meta-knowledge—we may improve the ability of organization members to locate knowledge and form attitudes about it. This, in turn, can result in better use of KMS and the application of organizational knowledge. To identify the specific meta-knowledge required for the design of KMS, we conduct an exploratory Delphi study using a panel of 28 professionals from seven organizations. Our results show that the relevance of the knowledge, the experience of the knowledge source in the problem domain, and the credibility of the knowledge are the three most important elements of meta-knowledge.*

Keywords: Meta-knowledge, knowledge management systems, Delphi methodology

Introduction

For several years,information and communication technologies (ICTs) have been implemented in organizations to support the management of organizational knowledge and facilitate more effective knowledge sharing and problem solving methods. These technologies are collectively termed Knowledge Management Systems (KMS).

Unfortunately, the results of implementing KMS in organizations have not been as promising as expected. A 2000 report on knowledge management (KM) in organizations, based on a survey conducted by KPMG (2000), finds that many of the firms that implemented KM practices—mostly through the use of technology—are still experiencing the same problems as firms without KM practices and technologies in place. For example, information overload was reported as a problem by 65 percent of the

companies with KM and 69 percent of the companies without KM. Similarly, 62 percent of the companies that implemented KM practices and technologies reported that they had no time to share knowledge. This was close to the 72 percent of the companies without a KM that reported this problem. Finally, 45 percent of the companies with a KM program in place reported the problem of "reinventing the wheel." This is surprising, considering the fact that KMS were expected to solve exactly this latter problem. Thus, there is a need to study why KMS fail to deliver the benefits expected from them and how they could be improved.

Common technologies used to manage knowledge in organizations include various forms of knowledge repositories, knowledge maps, and communication tools (Alavi and Leidner 2001; Bowman 2002; Ruggles 1997). However, as Alavi and Tiwana (2002) discuss, these technologies are often not being used and the knowledge retained in them not applied by organizational members. There are two potential reasons for this shortfall of knowledge application. First, inefficient storage, management, and search and retrieval mechanisms may prevent people from finding the knowledge they need. Second, successful application of the knowledge depends on the motivation of the receiver of the knowledge to pay attention to it and act upon it. However, lack of trust in the knowledge source or of absorptive capacity of the receiver of knowledge might hinder the application of knowledge (Szulanski 2000).

To improve the management of organizational knowledge and its application, and to ensure greater benefits to organizations from the use of KMS, we posit that some knowledge about the knowledge—*meta-knowledge*—should be collected and incorporated into the design of these systems. The motivation for including meta-knowledge in KMS is twofold. First, meta-knowledge can be used to improve the management of organizational knowledge in a way similar to the use of metadata in databases. To understand this, consider the role of KMS as managing the organizational resource termed *knowledge*. In this role, KMS are not different than any other information system intended to manage organizational resources, for example, a human resources application. In a typical human resources application, organizations maintain information about their employees such as employee identification, years with the company, positions held, and so on. Similarly, a KMS would maintain some information *about* the knowledge—namely, meta-knowledge. Meta-knowledge is especially useful for managing organizational knowledge since this knowledge is often kept in various retainers, either human or computerized, across the organization (Walsh and Ungson 1991) and can be either tacit or explicit (Nonaka 1994). Meta-knowledge can point at relevant retainers of knowledge and provide information about them and about their knowledge. Thus, meta-knowledge can facilitate the management and use of both tacit and explicit knowledge. In addition, meta-knowledge is generally less volatile than the knowledge itself (e.g., if a person is a computer expert, his/her *knowledge* might change with time but the fact that he/she is an expert in this domain—the *meta-knowledge*—does not change as much). This, again, can result in more efficient knowledge management since often a problem with KMS is the difficulty in maintaining updated knowledge.

The application of meta-knowledge to manage organizational knowledge is similar to the view taken in the transactive memory literature (Wegner 1987), where the creation and application of collective knowledge is supported through use of directories of meta-memory for locating knowledge in individuals' memories. The transactive memory literature shows that the use of meta-memories can lead to improved group performance and better problem solving mechanisms (Moreland et al. 1996; Moreland and Myaskovsky 2000). This provides a second motivation for the inclusion of meta-knowledge in KMS: facilitating the transfer of knowledge in groups. This addresses the trust and absorptive capacity issues mentioned above and indicates that the use of meta-knowledge can improve the *application* of knowledge stored in the KMS. In this context, knowledge application can be examined using the concept of knowledge transfer from retainers to knowledge seekers. Knowledge transfer is a concept different from the more traditional *knowledge sharing* in the sense that it requires the knowledge shared to actually be assimilated by its receiver (Argote and Ingram 2000). Therefore, knowledge transfer can be used as an indicator of knowledge application. Szulanski (2000) studied knowledge transfers in organizations and identified factors inhibiting their success. Among these factors were the recipient's lack of ability to identify, value, and apply knowledge, lack of perceived utility of the transferred knowledge, and perception of the source as unreliable. Providing users with meta-knowledge, such as the trustworthiness or expertise of the source, the source's education and background, or details on previous applications of the knowledge, may facilitate more effective transfers. This motivation for using meta-knowledge in KMS is also supported by the persuasion literature, which requires that some knowledge about the source or the message be provided to support the persuasive communications (Stiff 1994). Finally, Watts-Sussman and Siegel (2003) showed that a specific type of meta-knowledge, namely source credibility, could increase people's motivation to adopt the knowledge.

These potential benefits from the use of meta-knowledge in KMS lead us to examine it more closely. The objective of this paper is to investigate and explore what meta-knowledge should be collected and maintained in order to effectively manage organizational knowledge and to increase its acceptance. Despite the fact that existing KMS often offer the ability to include meta-knowledge, the specific types of meta-knowledge vary among the different tools and there is no unified approach toward the inclusion of meta-knowledge in KMS. In addition, some tools enable the designers to decide on the meta-knowledge they

wish to include and thus it is important to identify the set of meta-knowledge that is relevant in the context of organizational KMS. We begin with a review of the literature related to meta-knowledge and follow with a description of a Delphi study identifying the meta-knowledge requirements of potential KMS users.

Meta-Knowledge

Meta-knowledge refers to knowledge about the knowledge. For example, knowing the subject of the knowledge—what the knowledge is about—is considered meta-knowledge. A review of the literature shows that the specific meta-knowledge requirements in the context of knowledge management systems have not yet been identified. Instead, meta-knowledge appears in different forms depending on the context of the study and the application of the knowledge itself. One approach to meta-knowledge that can be termed the *conceptual approach* views it as a "structure that defines other structures" (Plant and Gamble 1997). Based on this approach, meta-knowledge consists of a combination of models that describe the knowledge domain – such as ontologies, problem solving methods, or guidance patterns (Kalfoglou et al. 2000). The conceptual approach identifies numerous benefits to the use of meta-knowledge in the construction and maintenance of knowledge-based systems. Meta-knowledge in such applications facilitates better communications through the use of the ontology as a shared language, enables inter-operability of systems with different modeling methods and paradigms, assists in intelligent knowledge search, and can be used as a starting point in exploring new domains (Menzies et al. 2000). The latter benefit of meta-knowledge was also noted in an empirical study by Cross et al. (2001) who reported the benefits of meta-knowledge as a pointer to potential knowledge sources.

While the conceptual approach to meta-knowledge is mostly used in projects focusing on the design of knowledge-based systems, the notion that meta-knowledge plays an important role in problem solving links us to the role of meta-knowledge in the cognitive science literature. This *cognitive approach* defines meta-cognitive knowledge, or "knowing about knowing" as an important dimension of professional expertise (Van Der Heijden 2000). Meta-cognitive knowledge refers to acquired knowledge about cognitive processes and can be further divided into three categories. Knowledge of *person* variables refers to beliefs about the nature of your, and others', learning processes. Knowledge of *task* variables refers to the knowledge about the requirements of the task and the suitability of the information available for completing the task. Finally, knowledge of *strategy* variables refers to beliefs on what cognitive strategies should be employed for achieving a specific goal (Flavell 1979).

Another, common type of meta-knowledge is as metadata in databases and, more recently, in repositories on the Web. According to this more *descriptive approach*, metadata is used to facilitate the location and use of data and information that resides in structured databases and other repositories. Metadata can be classified into five types: *administrative* metadata is used in administering information resources; *descriptive* metadata is used to describe information resources; *preservation* metadata relates to the preservation of information resources; *technical* metadata relates to how a system functions; and *use* metadata relates to the level and type of use of information resources (Lazinger 2001). Some benefits associated with the use of metadata include the increased accessibility to the data, the retention of context, the expansion of the use of the data, and the ability to create many versions of the data (Gilliland-Swetland 1998). On the Web, there are several initiatives to create interoperable metadata standards in order to facilitate information exchange and discovery. For example, CanCore (**http://www.cancore.ca**) is one initiative intended to facilitate the exchange of data and records related to educational resources in Canada. The Dublin Core (**http://dublincore.org**) is another example for such an initiative that spans the entire Web. The Dublin Core's mission is to facilitate finding resources using the Internet, through developing metadata standards for discovery across domains; defining frameworks for the interoperation of metadata sets; and facilitating the development of community (domain) specific metadata sets (**http://dublincore.org/about/overview/**). Examples for the type of metadata included in the Dublin Core are title, creator, subject, description, publisher, contibutor, date, type, and format.

The components of metadata are mostly informative in nature. For example, the author's information, the scope of the knowledge, the intended audience, and the format and currency of the knowledge (Basch 1990; Katz 1992; Stoker and Cooke 1995). However, meta-knowledge can also be used to influence attitudes of potential users of the knowledge. Attitudes are "psychological tendencies expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly and Chaiken 1993). The *persuasive approach* to meta-knowledge identifies characteristics such as source credibility, expertise, and trustworthiness as affecting attitudes toward a specific message (Higgins 1999; Hovland et al. 1953). In addition, the literature about persuasion has also identified message-specific characteristics such as the number of arguments or the type of appeal presented in the message (Petty and Cacioppo 1986; Stiff 1994).

The task of searching for knowledge in a knowledge management system includes components from all of the above categories of meta-knowledge. We require meta-knowledge to facilitate the location of knowledge in the knowledge base (the role of metadata), to link to other relevant knowledge (the role of ontologies and conceptual meta-knowledge), to provide some evaluation of the knowledge (the role of persuasive meta-knowledge), and to provide some indication of the best source and the best knowledge to use given our background, education, and experiences (the role of meta-cognitive knowledge). Therefore, an effective KMS should include all of the above types of meta-knowledge. This, however, raises two potential problems. First, possible information overload, in this case—having too much meta-knowledge. Second, meta-knowledge might be costly to obtain and update (consider, for example, assessing the credibility of a multitude of sources). Hence, it would be useful to identify the meta-knowledge most likely to alleviate the problems of knowledge management mentioned above. The goal of this study is, therefore, to identify the most important meta-knowledge that should be included in a KMS in order to facilitate more effective knowledge application. Accordingly, our research question is:

> What meta-knowledge do people consider when making a decision on whether to use a specific piece of knowledge and a specific knowledge source?

Specifically we ask the following questions:

1. What knowledge about the knowledge source do people consider when seeking knowledge?
2. What knowledge about the knowledge itself do people consider when seeking knowledge?
3. What is the relative importance of the meta-knowledge elements to the knowledge seekers in their knowledge use decision?
4. Is there agreement among knowledge seekers as to the relative importance of the meta-knowledge elements?

The fourth question is intended to identify whether the same set of meta-knowledge can be used in different contexts. This is important when considering the design of effective KMS since a lack of agreement would imply the need to identify required meta-knowledge for each application separately.

In order to answer these questions, we designed a Delphi study involving a panel of professionals experienced with knowledge search. The next section describes the Delphi process we employed.

The Delphi Study

Delphi is a method for exploring ideas or producing information for decision-making. It aims at obtaining a consensus of opinions from a group of experts using repeated questionnaires and controlled feedback. The method was first developed in the 1950s to improve forecasting methods but today it is also used to achieve a group consensus about the relative importance of issues (Schmidt 1997). Some examples for such Delphi studies include identifying the most critical issues facing IS executives (Brancheau and Wetherbe 1987), identifying typical project risk factors (Schmidt et al. 2001), and characterizing organizational knowledge resources (Holsapple and Joshi 2000).

The Delphi method is most useful when one cannot use precise analytical techniques, when the problem is new and unexplored, or when the problem requires the exploration and assessment of numerous issues (Adler and Ziglio 1996). The results of a Delphi study can serve to ensure that all major possible options concerning a particular issue have been discovered. These characteristics of the Delphi method make it useful for identifying the set of meta-knowledge characteristics involved in the evaluation of knowledge and knowledge sources, which is the objective of this study.

Methodology

The Delphi study involved a panel of 28 members from seven different organizations and was conducted over the Web. We carried out two pilot tests to evaluate the suitability of the questionnaire and technology to the task.

Table 1. Demographics of Panel Members

N = 28	
Age (average)	30-40
Level of education	
High School	0
Some college	3
Bachelor	9
Master's or higher	14
Professional certificate	2
Other	0
Years working	13 (Range: 3 to 35)
Years with company	6 (Range: 0.5 to 29)
Years in current position	3 (Range: 0.75 to 25)
Knowledge Intensity[a]	Mean: 2.3 (Range: 1.0 to 5.33)
Formalization[b]	Mean: 4.3 (Range: 2.5 to 5.83)
Knowledge Use	
Frequency of using external knowledge in your work	
Often	22
Sometimes	5
Rarely	1
Never	0
Average number of knowledge sources used.	3
Percent of panel members that used each source:	
People	86%
Books	54%
DB	39%
Web	96%
Other (professional publications; media; research facilities; documentation)	18%
Familiarity with knowledge source	
Very familiar	10
Somewhat familiar	18
Not familiar	0
Familiarity with the concept of KMS	
Yes	17
No	11
If yes, what KMS are you currently using?	
Intranet	57%
Lotus Notes	21%
Best Practices database	11%
ERP	4%
Other (discussion groups, newsgroups and forums; in house developed systems; data warehouse; decision support system)	29%

[a]Knowledge intensity was measured using Autio et al. (2000) three-items scale of 1(low intensity) to 7 (high intensity). $\alpha = 0.85$
[b]Formalization was measured using Ferrell and Skinner (1988) six-items scale of 1(low formalization) to 7 (high formalization). $\alpha = 0.75$

The demographics of panel members are described in Table 1.

The demographic items in Table 1 are intended to reflect two types of expertise that panel members posses: (1) the expertise of panel members in their domain (e.g., years of experience, years in position, level of education, etc.) and (2) the expertise of panel members as knowledge seekers, particularly in using technology (e.g., frequency of knowledge search, familiarity with KMS, etc.). These items were included since the expertise of panel members in the study's domain is an important factor in the success of Delphi studies. Table 1 also includes measures of two characteristics of the organizations to which the participants belonged, namely knowledge intensity and formalization. *Knowledge intensity* is the extent to which a firm depends on its knowledge as a source of competitive advantage (Autio et al. 2000). *Formalization* is the extent to which rules, procedures, instructions, and communications are written in the organization (Pugh et al. 1968). These values were provided by the participants. We included these two items in order to gain some indication of the level of familiarity of the respondents with knowledge searches and, potentially, with accepted meta-knowledge used in current organizational systems. This is used to ensure external validity in terms of the panel selected. Since the majority of panel members were at the management level of the organizations (21 of the 28 panelists), we feel comfortable in their ability to identify the level of formalization and knowledge intensity of their organizations.

The underlying task of the Delphi study was to identify the most important characteristics of a knowledge source and the most important characteristics of knowledge required when searching for a specific answer or solution to a problem. We referred to *knowledge* as the answer required to complete a given task successfully. *Knowledge source* was limited in our study to people only.[1]

To facilitate the understanding of the task, we employed specific knowledge search examples to provide a context for participants. However, to maintain external validity and to ensure that we elicit a wide set of responses, we used three different knowledge search examples. In the first example, we asked participants to find the correct answer to a multiple-choice question from the psychology domain (similar to a standardized test question). In the second example, we asked participants to assist the MBA office in the admission decision of new MBA students. Finally, for the third example, we asked participants to provide a knowledge search example from their everyday work. Some examples provided by participants are: "I need to understand the manufacturing technology currently used by a potential customer," "I need to know how Cardiac Centers are evaluated and ranked," "I need to know how to perform a protein purification procedure," and "I need to know the preferable technology path for electronic procurement given [*Company*'s] architectural considerations and operating requirements."

The choice of these specific examples is based on evidence from the literature that meta-knowledge might be affected by a person's level of expertise in the domain and by the equivocality of the task. We therefore selected examples that vary in equivocality (examples one and two, following Dennis and Kinney 1998) and expertise (the examples we provided as opposed to the examples provided by participants). We believe that doing so increased the set of responses since we ensured that participants considered various knowledge search situations and did not limit their responses to one specific example.

The Delphi Process

The Delphi process employed in this study included four rounds, following the procedure proposed by Schmidt et al. (2001). **Round one** was a brainstorming round in which we asked participants to identify the most important characteristics of a knowledge source and the most important characteristics of knowledge for the different knowledge search examples described in the previous section. To reduce the load on panel members, we first randomly assigned each panel member to one of two examples, either the multiple-choice question or the MBA admission question. We presented participants with the following situation:

> You are asked to find an answer to this question [i.e., the correct answer to the multiple choice question, or a decision on which students to admit to the MBA program]. To help you in your task you may consult with any one of 20 people who indicated that they have some knowledge on the topic. What information about these people and their knowledge would you require in order to select the best person to turn to?

[1]At the beginning of the study, we asked participants to consider four other sources, books, documents, Web, and internal databases, in order to see how their responses would differ for the different sources. We found that the characteristics requested about these four types of sources did not differ much from those available in the metadata literature. This result is encouraging since it validates the procedures and the other results in our study. Nevertheless, to be able to attain new and meaningful results—without overloading respondents—we decided to focus only on people as the knowledge source.

After participants considered their required meta-knowledge for one of these examples, we also asked them to provide their own knowledge search example and to identify the meta-knowledge they would require for selecting the knowledge and knowledge source for this example.

At the end of the round, two judges (the first author and a Ph.D. candidate) each analyzed the results and created a combined list of characteristics of knowledge and of knowledge sources that were identified by panel members, as well as definitions for each characteristic on the list. Agreement between the two judges was good (Cohen's Kappa = 0.75). This initial list included 30 characteristics overall. To ensure the reliability of the list, two more judges (Ph.D. candidates in two different areas) were asked to review both the responses from round one and the combined list created by the first two judges and to assign the responses from round one to the corresponding item on the combined list. Agreement between these two judges was also good (Cohen's Kappa = 0.74)

In order to reduce the size of the list and facilitate the ranking of characteristics, in **round two** we requested panel members to review the list created and to pare down the list to a manageable size. Participants were asked to select at least six characteristics that they felt were most important to them. All 28 participants completed this round of the study as well as the next two ranking rounds. Based on the number of votes for each characteristic, we ranked the list of 30 characteristics and identified a drop in the number of votes after the fourteenth characteristic. Thus, the resulting ranked list from round two included this distinct group of the top 14 characteristics. This list is displayed in Table 2 with an initial ranking based on the number of panel members that selected each characteristic as important in this round.

Round three and **round four** were similar in the task provided for participants. In each of these rounds, panel members were asked to review the list of 14 characteristics and to rank it in order of importance to them (avoiding ties). Initial consensus after round three was medium (Kendall's W, used to measure consensus, was 0.37) and we therefore initiated another ranking round. After round four, consensus has increased to 0.76. According to Schmidt (1997), good consensus exists when Kendall's $W > 0.7$ and therefore this was the last round of our study. The final results are described in the last column of Table 2.

Results

Table 2 shows the 14 characteristics that panel members felt were the most important to them when searching for knowledge. Interestingly, the list consists of an equal number of characteristics of the source and of the knowledge itself. Nevertheless, with the exclusion of the experience of the source, all the characteristics of the knowledge itself were ranked higher than the characteristics of the source of the knowledge. At the top of the list are the relevance of the knowledge to the current problem and the experience of the knowledge source. This is in line with the literature on metadata, which emphasizes the importance of ranking the relevance of query results, especially in Web searches, and the literature on knowledge management (e.g., Davenport and Prusak 1998) and persuasion (Hovland et al. 1953; Petty and Cacioppo 1986), which emphasize the importance of the source's experience and expertise in the problem domain.

The next group of characteristics refers to elements of the knowledge, specifically the credibility, accuracy, validity, currency, extent (breadth and depth), and accessibility of the knowledge. Finally, the second half of the list concerns characteristics of the source of knowledge, namely the extent of domain knowledge that the source has, the currency of the source in the domain, the trustworthiness of the source, the source's willingness to help, the communication skills of the source, and the source's awareness of other resources.

Table 2 also shows the changes in responses between study rounds. It is interesting to examine the responses to round two (the paring round) that sort characteristics according to the number of people who selected them as most important, and round four, the final ranking round. We can see a large shift in the ranking of two specific characteristics: the accuracy of the knowledge and the extent of domain knowledge of the source. Smaller changes are also apparent in the ranking of the validity of the knowledge and the accessibility of the knowledge. This can be attributed to the "no ties" constraint imposed in the ranking rounds, which forced participants to make trade-offs between factors in rounds three and four. We intend to examine this trade-off further in our future research as it represents more closely the real-life situation in which knowledge seekers are forced into weighing the importance of each characteristic when making their knowledge selection decision.

Table 2. Ranking of Meta-Knowledge Characteristics

Characteristics	Definition	Rank[a] – Round 2 (with ties)	Rank – Round 3 (no ties, W=0.37)	Rank – Round 4 (no ties, W=0.76)
Relevance of the knowledge	The knowledge is relevant for the current problem	2	2	1
Experience of source	Extent of past experience that the source has dealing with this domain or with similar problems	1	1	2
Credibility of the knowledge	The knowledge can be trusted (is believable)	4	3	3
Accuracy of the knowledge	The knowledge contains no errors	9	4	4
Validity of the knowledge	The knowledge can be verified and supported by other sources or by empirical results	8	5	5
Currency of the knowledge	The knowledge is up-to-date	4	6	6
Extent of knowledge	The depth (level of detail) and breadth (coverage) of the knowledge	7	7	7
Accessibility of the knowledge	Availability of the source to answer questions in a timely manner	4	9	8
Extent of domain knowledge of the source	The extent of knowledge about the domain that the source has	3	8	9
Source is up-to-date	The source is current in the knowledge domain	11	10	10
Trustworthiness of the source	The source is honest and provides credible responses	14	11	11
Source is willing to help	The source is approachable and willing to help or provide feedback	11	12	12
Communications skills of the source	The source can clearly communicate ideas and explain the topic in a simple way	9	13	13
Source is aware of other resources	The ability of the source to locate relevant resources that may provide additional knowledge on the topic	11	14	14

[a]Rank in round two is computed by summing the number of people that selected a characteristic as one of the most important characteristic to them.

Discussion

The study described in this paper focused on the identification of meta-knowledge required by users of a knowledge management system in order to facilitate the search and use of organizational knowledge. A main result of the study is that knowledge seekers require a combination of meta-knowledge that provides both objective and subjective information about the knowledge and the source of the knowledge.

The results of the Delphi study provide some meaningful insights on the nature of meta-knowledge required for the design of more effective KMS. Some of the characteristics identified in the Delphi study were already identified in previous literature, for example the relevance and currency of the knowledge or the trustworthiness and expertise of the knowledge source. However, our study shows the need to use several different measure of the quality of the knowledge (e.g., accuracy, credibility, and validity) rather than just a general relevance rank, as is often the case in existing KMS. In addition to these characteristics, our study reveals some new characteristics that should be included in the meta-knowledge represented by KMS. First, the accessibility of

the knowledge and knowledge source was identified as important by panel members and can indicate a constraint that is imposed by users of the KMS that only accessible knowledge should be managed. This also raises the possibility that one reason for ineffectiveness of knowledge management is inaccessibility of sources. In addition, information about the availability of knowledge, such as cost, time, or technical consideration, should be represented in the KMS. Second, the communication skills of the source, the source's ability to communicate the knowledge to the knowledge seeker, play an important role in our results. This specific result can be tied to Szulanski's (2000) work on predictors of knowledge stickiness (inability to transfer knowledge) that identified the lack of existing relationship between the source and recipient as an inhibitor of knowledge transfer. Szulanski identified that part of this relationship involved the ease of communications between the source and recipient. Finally, the awareness of the source to other resources was also identified as important in our study. We are not aware of studies that identified, in the context of meta-knowledge, the requirement to know whether the source is familiar with other resources in case he or she does not have the answer sought. This result is especially interesting since Cross et al. (2001) identified pointers to other knowledge as one of five benefits that people derive from a knowledge search. Our study shows that people actually use this criterion as a prerequisite to the search. This result also emphasizes the importance of building an underlying network model in the design of KMS.

Apart from identifying new characteristics that should be included as meta-knowledge, the results of our study also identify the ranking of meta-knowledge characteristics. We learn that the descriptive (metadata) and persuasive meta-knowledge are most important to knowledge seekers. Characteristics such as *related knowledge* that represent conceptual meta-knowledge or *source's education (background)* that can support meta-cognitive knowledge were included in the initial list of the 30 characteristics but not included in the top 14 characteristics. In addition, very strong agreement was attained in the study (Kendall's coefficient of concordance was 0.76), which indicates that the same meta-knowledge can be used in different applications.

The contribution of our results to practice lies in their potential to improve the design and effectiveness of knowledge management systems. Systems' designers can use these results as guidelines for the specific meta-knowledge that should be provided by the system. Similarly, since many tools enable the definition of meta-knowledge at the implementation stage, companies can collect and represent the meta-knowledge identified in this study when implementing a new KMS. One limitation of our study in this context comes from the subjective nature of some of the characteristics indicated as important meta-knowledge (e.g., credibility of the knowledge, source's willingness to help, etc.). Some of these subjective measures have already been operationalized in the literature, for instance, relevance ranking or trustworthiness of the source, and we hope that the other measures will also be operationalized soon.

In addition to specifying the meta-knowledge that should be included in a KMS and providing guidelines for systems' designers, other benefits arise from identifying the set of meta-knowledge. As mentioned in the introduction to this paper, some of the problems organizations experience when using KMS include information overload, lack of time to share knowledge, and problems of reinventing the wheel or having difficulties sharing tacit knowledge (KPMG 2000). Using the meta-knowledge identified in this paper can alleviate some of these problems. For example, incorporating a measure of the relevance of the knowledge can ease the problem of information overload. The relevance measure, combined with other descriptive meta-knowledge, can also be used to reduce the time needed to share knowledge since knowledge seekers can immediately identify the knowledge (or the knowledge source) that is most suitable for their needs. Moreover, the meta-knowledge approach in general can improve the sharing of knowledge since the knowledge itself does not have to be captured by the system, but only the meta-knowledge that would link knowledge seekers to both tacit and explicit knowledge. Finally, the persuasive meta-knowledge might increase the likelihood of using the knowledge provided by the KMS, as proposed by the persuasion literature (Hovland et al. 1953; Petty and Cacioppo 1986; Watts-Sussman and Siegal 2003). This last benefit of meta-knowledge in KMS design also highlights an additional contribution of the Delphi study's results: improving our understanding of how people accept knowledge from a KMS. This can contribute to the literature on attitudes and persuasion as well as to the knowledge adoption literature.

An interesting question remains, however, as to the factors that may potentially affect the selection of meta-knowledge by knowledge seekers. In this study, we varied the levels of domain expertise and task equivocality in order to gain external validity and to ensure the completeness of our results. However, the Delphi method is limited in its ability to examine the exact effects of these factors. A qualitative examination of the number of characteristics identified in the different examples provided in round one indicates that expertise and equivocality might indeed affect the meta-knowledge selection of knowledge seekers. Thus, for example, more characteristics were identified by the group that responded to the MBA admission example than the group that responded to the multiple-choice question. In addition, within the MBA admission group, people who indicated that they had higher expertise in this domain came up with more meta-knowledge characteristics. Moreover, these differences were more apparent in the identification of knowledge about the knowledge than in knowledge about the source. Nevertheless, Delphi is not a method intended to rigorously test hypotheses and, therefore, a more robust study is required to test these differences further.

While some benefits of meta-knowledge have been noted in the literature, there is still need to conduct studies to evaluate the actual benefits of using meta-knowledge in KMS. Such studies should examine the two expected benefits of meta-knowledge: (1) facilitating the management of organizational knowledge in various knowledge bases and (2) supporting effective use of the knowledge by members of the organization.

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