The Dimensions of Tacit & Explicit Knowledge: A Description and Measure

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Abstract

Knowledge workers are often employed to extract knowledge from domain experts in order to codify knowledge held by these experts. The extent to which workers rely on tacit or explicit knowledge may produce inefficiencies and reduce productivity if the information is not shared among those who need it or it encapsulates strategic goals and is inadvertently shared with those who might undermine the firm's competitive advantage. This paper discusses the nature of tacit versus explicit knowledge in terms of the dimensions thought to contribute to its degree of tacitness. We present an instrument designed to elicit perceptions regarding the nature of knowledge used by workers and their degree of reliance on tacit knowledge. Use of this instrument by managers would help them identify pockets of tacit knowledge within the firm that could either be made explicit so that other workers can benefit from it or prevented from becoming explicit should its strategic value require protection.

1. Introduction

Knowledge is created, stored, transferred, and used at all levels of an organization in an attempt to achieve the goals of the organization. The organization's performance is strongly influenced by the extent to which the appropriate knowledge is available and utilized by those who need it [4]. Thus, organizations engage in a variety of methods of knowledge management in order to make available the knowledge that is needed. However, even when knowledge is available it is not always accessed by organization members [22]. Some organization members may prefer or rely on certain types of knowledge rather than accessing all of the appropriate types of knowledge. This can result in suboptimal outcomes.

One knowledge characteristic that organization members may rely upon in differing amounts is its degree of tacitness. After Polanyi [23, 24] introduced the concept, the tacit character of knowledge has long been studied in the field of psychology and has begun to play a large role in other disciplines such as organizational behavior and management. Although success has been achieved in indirectly measuring tacit knowledge [cf. 31], research has not yet been conducted that aligns the degree to which individuals rely on tacit knowledge with tasks that are completed using varying degrees of tacit knowledge.

Increasing our understanding of what types of knowledge that organization members are most likely to utilize can help organizations improve their knowledge management practices. For example, efforts by an organization to increase the amount of explicit knowledge that is created and made available to organization members for a particular project may be ineffective if organization members rely primarily on tacit knowledge. Instead the organization could consider increasing the amount of tacit knowledge available to the organization members or it could identify members who rely more on explicit knowledge and have them carry out the project. To do so implies that we can identify what tasks require a greater reliance on tacit knowledge to complete and which organizational members rely more on tacit and/or explicit knowledge in general.

An additional area of concern to managers is the degree to which tacit knowledge can affect competitiveness [11]. Explicit knowledge is typically much easier for competitors to copy because it can be codified and transferred easily [23]. Therefore, if management can identify both the areas of their business that are more likely to use tacit knowledge and those who might be more inclined to rely on tacit knowledge, they can better match workers to tasks and thereby improve protection of knowledge which may have a strategic or other competitive value.

From a researcher's perspective, the explicit/tacit character of knowledge is important to consider because studies that include knowledge as a variable of interest can have differing or erroneous outcomes if they do not measure the explicit/tacit character of the knowledge. For example, if organizations are being examined in regard to the amount of

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knowledge they possess and the resulting effect on organizational performance, the results may become muddled because firms may have a significant amount of explicit knowledge to help them create new products or processes, but those products and processes are easily imitated by competitors and the organization's performance suffers as a result. Measuring the amount of knowledge in an organization may therefore not be positively associated with organizational performance. Moreover, researchers may find that a firm is very effective while appearing to possess limited knowledge when only explicit knowledge is measured and the amount of tacit knowledge is not also included in the measurement.

The purpose of this paper is to present a description of the components of tacit and explicit knowledge and the results of the development of a survey instrument designed to tap these components. The following sections present the dimensions of tacit knowledge which have been drawn from previous research, discuss the nature of these dimensions and present an instrument aimed at measuring them. We then provide a discussion of how the scale might be used, the limitations of such a measurement, the implications to both theory and practice and some ideas for continued research in this area.

2. Description

2.1 Tacit and Explicit Knowledge; Its Effect on Organizations

Knowledge is considered to be *the* basis of competitive advantage for organizations (e.g. [8], [9]). The knowledge-based view of the firm posits that organizations with better knowledge resources and the ability to utilize them will fare better than other organizations across the competitive landscape. The value of any particular knowledge resource is, of course, dependent on the situation to which it is being applied. However, characteristics of knowledge, such as its tacit and explicit character, can have a broader influence on the ability of a particular piece of knowledge to enhance an organization's performance. For example, good customer service is probably more valuable for high-end, women's clothing retailers than it is for self-service gas stations. However, if a high level of customer service at a women's clothing retailer is codified into easily teachable steps, this knowledge of how to serve customers well is more likely to leak to competitors. This leakage can prevent a competitive advantage from being sustainable, with competitive parity the result.

Polanyi [24] originally identified tacit knowledge, and his conception of it has been consistently applied by researchers in a variety of fields. Evolutionary economics [21] and evolutionary and experimental psychology [28] have both placed importance on the tacit characteristic of knowledge as playing a critical role in decision making and individual action. Evolutionary economics has also expanded the construct to demonstrate how knowledge can be stored at the organizational level thorough the execution of routines that involve multiple organizational members [21]. The management literature has continued this approach and suggested that organizational-level routines are a warehouse of tacit, organizational knowledge. It is proposed that this type of knowledge is both difficult to imitate by competitors and difficult to actively manage because of its hidden and complex nature [7], [16].

Tacit knowledge is knowledge that is difficult to describe and transmit to others, and in its pure form the user is unaware of its usage [24]. It typically is created through personal experience, but the experience has occurred in the past and to such a frequency or repetition that the possessor is no longer aware of the particulars of its existence [12]. It becomes a habit or routine [21]. Explicit knowledge, on the other hand, is completely transmissible—users are consciously aware of its usage—and its creation and usage is either very recent or infrequent such that the user is aware of its particulars.

These characteristics are of vital importance to managers and researchers as the competitive playing field expands, because they influence the nature of the creation, storage, transfer and use of knowledge. As such, knowledge that is more explicit can be knowingly created, stored in an accessible manner, easily transferred, and used in a conscious and intentional manner. On the other hand, knowledge that is more tacit is likely to be unknowingly created, stored in a manner that is only accessible in a non-conscious manner, difficult to transfer, and used in a non-conscious and unintentional manner. When inquiry is made of the tacit knowledge user to identify the specific knowledge or process that was used to complete a task, the user often must generate an artificial explanation because the actual tacit knowledge is beyond their conscious awareness [26]. Thus, for managers to decide upon the types of knowledge they want their organization to focus on, they should evaluate the degree to which their organization will need to be able to consciously develop the knowledge, how accessible it needs to be

when stored, how easily it needs to be transferred, and the manner of its use. Additionally, identifying those members who utilize explicit knowledge instead of tacit knowledge can help an organization determine which projects are more at risk of competitive imitation through leakage of explicit knowledge. On the other hand, organization members who utilize tacit knowledge tend to provide fewer opportunities for knowledge leakage to competitors [11]. However, if these employees are hired by competitors then any personal tacit knowledge goes with them and it can assist competitors in their imitation efforts. Prescriptively, organizations could determine their knowledge transfer and protection needs and act accordingly. For example, knowledge that must remain tacit for competitive reasons may be put into the hands of employees who rely more on tacit skills than on explicit and are in an area that relies heavily on tacit approaches.

Based on the characteristics of explicit and tacit knowledge, one may initially believe that focusing on explicit knowledge seems to provide more benefits. This is particularly true when knowledge needs to be transferred to many organizational members. However, there are some disadvantages of explicit knowledge that enable tacit knowledge to be a preferred choice in a variety of situations [5]. One disadvantage of explicit knowledge is that it can be easily transferred to competitors intentionally or otherwise. It can be grasped without an individual needing to be in the situation. This, of course, can lead to imitation attempts being made easier and more effective [17]. Another major disadvantage is the intermittent nature of its use. It must be consciously and intentionally accessed and used. This can lead to more variance in outcomes depending on the individual who is accessing it, and it can require more simplistic approaches to problem solving. Tacit knowledge, on the other hand, is engaged automatically without conscious awareness and is appropriate for use in complex situations [24].

2.2 Components of Tacit and Explicit Knowledge

Tacitness actually has several major elements to it. One of these elements is lack of conscious awareness. Typically, when tacit knowledge is being used the user is not consciously aware of it. The tacit knowledge is built up over time and is stored in the individual in a manner that limits the individual's ability to explicate it. That is, although a knowledge base from previous experience is present, an individual may automatically [21, 29] utilize this knowledge base when needed but does not consciously think through the steps required to apply the knowledge. As an example, consider an experienced typist who does not consciously think about each key stroke but rather types words without being aware of exactly where each finger is on the keyboard at any given moment. Tacit knowledge is generally cued for use directly from the environment [29], thus bypassing the consciousness of the individual. This reduced conscious awareness, as shown in Reber's [25, 26] artificial grammar experiments, contributes to the inability of the individual to fully explain their behavior [27, 29].

A second element of tacitness is the degree to which it is not expressible. Tacit knowledge is difficult to express to others [23, 24]. Expressibility can be in written or oral form. The main issue is the extent to which the knowledge cannot be codified and directly communicated to another individual. Much of the extant research has focused on written expressibility, but oral explication is generally regarded as equivalent.

A third element of tacitness is demonstrability. This is represented by a person's ability to perform the necessary tasks based only on seeing the activity performed or the final outcome. The greater this ability is, the greater the reliance on tacit knowledge and the better able is the person to complete all the steps within a task without as much detailed explicit instruction. Especially in complex situations that contain steps that are relatively unobservable, an individual with the appropriate tacit knowledge can more easily perform the functions necessary to complete the task [10]. It is important to note that demonstrability may only have meaning if there is something that can be visualized as a final outcome or if steps are easily observable. Thus, working backwards may not always be appropriate, especially if it involves activities that have not yet been attempted (e.g. putting a man on the moon prior to 1969).

A fourth dimension is associated with prior learning and arises in the degree to which a person appears to be applying the knowledge base in a formal or informal manner. When an individual undergoes training or experiences a task in a step by step fashion, the individual is initially cognizant of the steps he or she has learned. At these early stages of learning and practice, the individual is explicitly trying to remember and use the steps. Over time the steps become second nature, and the individual loses cognizance of their existence in their memory [21]. Reliance on the steps becomes automatic by nature. Individuals who use this knowledge at a later date are

likely to appear to have jumped to a conclusion even though they have implicitly followed the steps without realizing it. In the case of an individual not realizing he or she has followed implicit steps learned long ago, it can appear that the individual is using a disorganized or informal approach to complete a task [30] because specific steps are not consciously identified and explicitly followed. Thus the logic of the individual's actions appears to be missing when viewed by an outsider (similar to intuition [28]). When the steps are not already learned, or at least not learned as well, the individual is more likely to knowingly follow the explicit steps in a formal manner. The degree to which a person can recall that the steps he or she used in performing a specific task is based on prior learning of the task is reflective of the degree of informality of his or her thought process. Thus, the higher the reliance on prior learning, relative to current learning, the greater the use of tacit knowledge by the individual. We distinguish prior learning from newer learning by the effect it has on how an individual uses it. While newer learning is characterized by adherence to specific rules that still require mindful application, prior learning is already committed to the subconscious through experience and is used without the individual being aware of the specific steps involved. The individual may realize he or she is relying on prior experiences but they are unable to accurately identify all of the steps that are followed. Thus, when knowledge is used from prior learning the mental process used to apply the prior learning appears more informal than when knowledge from current learning is used. When current learning is relied upon, the individual is more likely to be seen as using the specific, concrete steps associated with the current learning. This process takes on a more formal character as compared to when prior learning is used. Theses arguments follow from Scribner [30], who suggests that the use of previously learned knowledge (working knowledge) is typified by an *ad hoc* approach and maintains a more informal character compared to currently learned knowledge that tends to be applied in a formal, step-wise fashion. We gain additional support from Wagner and Sternberg [31] who reiterate this point when they speak of the perceived disorganized nature of tacit knowledge stemming from its prior learning. Therefore, our measurement of the use of formal or informal mental processes is indirectly captured using items relating to prior learning.

Our hypothesized model is depicted in figure 1.

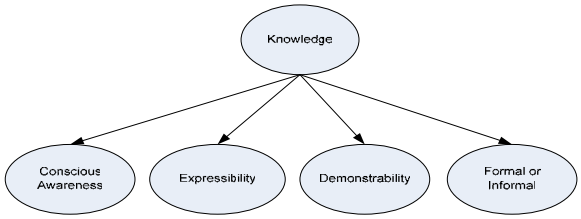

Figure 1. Hypothesized Model

3. Measuring Tacit and Explicit Knowledge

It is apparent that the ability to measure knowledge would be very useful to organizations. Organizations could better determine the extent to which they can successfully complete future projects, improve existing processes, and, in general, compete against other organizations. Measuring knowledge, and in particular tacit knowledge, has continued to be a thorn in the side of academic researchers and managers, because there are several aspects of knowledge that magnify its difficulty of measurement. There is the volume of knowledge, its form, its detail, and its value to name a few. The more of these aspects we simultaneously concern ourselves with, the more difficult measurement becomes. We suggest an initial step toward measurement would be to ascertain how much a particular type of knowledge is relied upon by an individual when working on a project. This approach would focus on the relative degree of a type of knowledge that is used.

Because the tacit nature of knowledge has received significant theoretical attention, we have chosen it as a good place to start. We have also selected the information technology (IT) realm as the research domain because of the inherent nature, and therefore importance, of information and knowledge to this industry. IT organizations develop automated systems that help users process information into knowledge. In so doing, the IT worker must elicit both tacit and explicit knowledge from users. In addition, the IT workers themselves also possess both tacit and explicit knowledge that is used for developing these systems. These conditions make IT workers an excellent occupational group to use as the basis for the study.

The presence of tacit knowledge has been assessed in individuals by experimental psychologists. In early research, Reber [25], [26] examined the differences between explicit and tacit knowledge bases through the use of artificial grammar experiments. He hypothesized and found

that tacit knowledge resulted in a more invariant outcome relative to explicit knowledge across individuals who had the same experiences in a laboratory setting. The invariance presumably comes from the routinized nature of its use. In contrast, explicit knowledge had a higher variance probably due to its conscious and more sporadic application. Other researchers have found support for this distinction (e.g. [13]). In addition, Langer, Blank, and Chanowitz [18] found support for the lack of conscious awareness trait when they found that subjects had difficulty accurately recalling the reasons for their behavior. Research involving causal mapping (e.g. [2]) has labeled knowledge that individuals have difficulty expressing but finally do so as tacit.

Based on the above-mentioned research, we created survey items intended to capture the degree to which knowledge being used during an activity was either tacit or explicit. This strategy would enable us to identify the subject's perceived reliance on tacit and explicit knowledge and avoid the problems associated with attempting to identify the actual knowledge itself. Explicit knowledge could potentially be delineated, but any tacit knowledge would, by definition, be difficult to extricate accurately. Therefore, our approach is to identify each type of knowledge based on its unique characteristics. We geared the items around a project task that would take about a week to complete. The items were worded in a manner that would identify the degree to which the subject relied upon either tacit or explicit knowledge to complete the project. This indirect approach was used because tacit knowledge is unavailable for conscious inspection [19]. As we developed the item pool, we relied on our theoretical model discussed previously and shown in figure 1, and we sought the basic elements that distinguished between the two types of knowledge, tacit and explicit. We devised 27 items aimed at each of the four dimensions listed in figure 1. Our logic in developing these items is discussed below.

Because a person is more consciously aware of the knowledge he or she is applying when that knowledge is explicit, the items designed to tap this dimension were predicated on the degree to which the individual consciously thought about his or her actions during the project and if those actions were automatic or not. An example item in the CA dimension is, "to what extent were you conscious of the steps required?"

We next selected a set of items that covered both oral and written expressibility. This set of items was was adapted from a set used by Kogut and Zander [17] to reveal the codifiability of knowledge. They used four items that focused on whether elements of the manufacturing process were embodied in manuals, software, and documentation. Their position was that to the extent that the manufacturing process was part of written documentation (including manuals and software), then the process was codified (and therefore explicit rather than tacit). We added some items to expand it to include verbal as well as written expressibility. An example item for this dimension is, "to what extent could the steps be written down so that any student could be successful?"

We then developed some items designed to measure the degree of demonstrability of the actions used during the project. We sought to discover the degree to which seeing the activity or seeing the big picture or end result would help an individual engage in appropriate actions during the project. An example item for this dimension is, "to what extent would viewing the finished product allow you to understand the steps involved?"

Finally, we developed a set of items intended to measure the degree to which thought processes progressed in a formal way (indicating greater reliance on explicit knowledge) or an informal way (indicating greater reliance on tacit knowledge). Items addressing this dimension are intended to reflect the degree to which actions were planned or were executed in concrete steps (formal and not from prior learning) or not (informal and from prior learning). Our goal was to measure this with items concerned with how much prior learning might affect the activities performed relative to the state of current learning, because this indicates whether a formal or informal thought process is involved. The premise is that formal thought processes are induced more by current learning than prior learning, while informal thought processes are induced more by prior learning than by current learning. An example item for this dimension is, "to what extent did you rely on what you had learned previously?"

Our scale incorporates the bipolar nature of the tacit/explicit knowledge construct. That is, most knowledge is neither completely explicit nor completely tacit, but retains components of each to varying degrees. Thus, the approach we use here is to measure the degree of explicitness or tacitness of the knowledge based on a continuum ranging from entirely tacit to entirely explicit.

Any scale designed to measure tacit knowledge must consider whether the approach of asking subjects to consciously recall their use of knowledge invalidates the results. This is because the very process of recollection involves making explicit that

which was formerly tacit. This is similar to the effect proposed by Ajzen and Fishbein [1] in which they suggest that explaining the details of an intention or behavior can increase its conscious awareness. Transforming knowledge from tacit to explicit could have the adverse effect of introducing systematic error into the measurement. Thus an inaccurate assessment of tacit knowledge is possible because of its very nature [2]. This characteristic has helped the measure of tacit knowledge remain elusive. In order to minimize this effect, we limit the subject's need to make the tacit knowledge explicit by asking questions related to the behavior itself, rather than asking the details of the knowledge that was used to perform the behavior. So, in essence, the subject's recollection is about the activities and not about the knowledge itself.

3.1 Instrument Development

We constructed an instrument based on the theory of tacit and explicit knowledge just presented by developing a pool of 27 items designed to tap each of the dimensions shown in figure 1. We then submitted these items to a number of knowledge management researchers who made suggestions for removing ambiguities in the wording of the items. They also categorized the items based on similarities into each of the four constructs we formulated according to our theory. We then compared the results of our experts and our original items and their groupings. As a result of these analyses, some adjustments were made to the wording of some of the items in order to remove ambiguities and to place each item clearly into one of the dimensions. The instrument uses a semantic differential presentation, which was converted into an electronic format that could be administered via the Internet. The instrument asks each subject to what extent each subject considered his or her actions taken during a specific assignment to be based on those things thought to reflect each dimension of tacit or explicit knowledge. The software then computes a score ranging from 1 to 5 depending upon where the subject places an electronic slider between the two anchors. Lower scores indicate a greater reliance on tacit knowledge; higher scores indicate a greater reliance on explicit knowledge. Some items are reverse scored since wording of those items elicited responses in the reverse direction.

The resulting instrument was then pilot tested using students in an advanced MIS course upon completion of a semester long project. Results were then tested for internal consistency and dimensionality using exploratory techniques. Further refinement of the precise wording of each item and the delivery protocol was made after analyzing these preliminary results. The resulting survey is presented in the appendix.

We next submitted the instrument to another class of advanced MIS students in computer networking fundamentals. These students were assigned a number of laboratory activities and wrote a report for each activity, which detailed their findings. The report included a synopsis of the work performed and a description of any variance from expected results. The activities chosen were ones for which the students had no prior experience, such as creating a web server, an e-mail server, imaging, setting up a Windows domain controller with DHCP and DNS services, public key encryption, packet sniffing and others; but for which each student was required to have a substantial knowledge base in order to complete. For example, in order to complete a lab on packet sniffing, the student must know what a packet is and what operations are performed on the packet when it is transmitted from one computer to another, including the structure and use of the TCP/IP protocol suite.

The sample consisted of 23 junior and senior level information systems students with varying degrees of prior experience. Although the laboratory activities were chosen so that the students had no prior experience, the group of students had been using computers in such activities as programming, system analysis and design and database design and querying. The students therefore brought with them approximately the same level of educational experience and had approximately similar knowledge bases. The average age was 21 and the group consisted of 20 men and 3 women.

A total of 10 lab experiments were performed by each subject and our survey instrument was administered after each experiment. Thus, a total of 201 observations were collected (accounting for some students who did not complete all the surveys). The results were analyzed both as a pooled group and as 10 sets of independent groups (accounting for each lab activity) for internal consistency and were factor analyzed. Factor analysis was performed to analyze the measurement model depicted in figure 1. Our premise is that if this model is supported by the data in terms of reliability and convergent and discriminant validity, then the resulting instrument can be used in subsequent tests in order to investigate the nature of the structural model. Our analysis therefore does not test any hypotheses related to the underlying structural model, as would be performed in a confirmatory analysis [3, 14], but merely evaluates the "nature of the latent factors that are

responsible for covariation in the data set…" [14, p. 69] This sort of restricted analysis, in which we have restricted some of parametric values to zero based on the underlying theory allows us to re-specify our model and re-estimate it in order to obtain an acceptable fit [3]. To do so, we eliminated those items that cross load or do not load on any one factor following accepted factor analytic techniques.

The results of our analysis are that a 16 item instrument demonstrates the best fit to our model. These items are marked with an asterisk in the appendix. Although one factor, demonstrability, had no significant loadings, it was stressed earlier that this dimension of tacit knowledge may not manifest itself in all cases. Because our subjects had no way of visualizing the final results of their projects, nor were the steps easily observed, we feel that the absence of this factor does not negate the theory. This dimension is very likely to appear in other situations where a clear picture of the final result is possible.

Reliability estimates range from a minimum of 0.73 in lab 3 when the data are analyzed as separate groups, to 0.83 when analyzed as pooled data. The factor loadings are shown in table 1. Factors are labeled as CA (conscious awareness), EX (expressibility) and F/I (formal or informal processes based on prior learning). Short descriptions are provided in table 1 for each item and item numbers correspond to those listed in the appendix. Tests for convergent and discriminant validity compare favorably with the expected result and our data exhibit a reasonable fit to the model (AGFI = 0.86). The theorized relationships appear to hold, with some interpretation [6], and the fitted model seems to accurately reflect the hypothesized one.

Table 1: Factor Loadings, Standard Errors and t-values

		CA			EX			F/I		
Item	**Description**	**Loading**	**Std. Err.**	**t-value**	**Loading**	**Std. Err.**	**t-value**	**Loading**	**Std. Err.**	**t-value**
3	Outside Knowledge	0.56	-0.06	8.78						
16	Knowing	0.81	-0.06	13.01						
17	Instinctive	0.73	-0.06	12.53						
18	Familiar	0.96	-0.07	13.03						
21	Doing	0.74	-0.06	11.88						
26	Intuition	0.66	-0.06	11.04						
4	Written by self				0.55	-0.06	9.55			
5	Explaining				0.34	-0.06	5.47			
11	Written for others				0.62	-0.05	12.22			
12	Explained				0.68	-0.05	13.37			
14	Writing				0.53	-0.06	8.12			
22	Repetition				0.40	-0.07	5.89			
24	Clear about success				0.40	-0.06	7.03			
25	Success compared to others				0.45	-0.06	7.36			
10	Previously learned steps							0.72	-0.07	10.62
20	Prior learning							0.72	-0.07	10.99

4. Discussion

One of the major goals of knowledge management in the organization is currently to codify knowledge so that more people in the firm have access to it [15]. There are a number of valid reasons for this, and a number of ways employees can be motivated to do this [20], but when the knowledge held by workers is of such strategic importance that competitiveness may suffer if certain components are made public, then the current goal of codification may be inappropriate. If managers are able to identify those portions of organizational projects that require tacit knowledge components, then a decision can be made to attempt to extract the knowledge and make it explicit for others in the organization or to protect it to help maintain competitiveness.

We are unaware of any scales that seek to classify activity components into either tacit or explicit, and so the development of our scale proceeded from scratch and was guided only by our knowledge of the theory. The resulting 16 item scale provides superior reliability and validity both from a statistical standpoint and from a theoretical one. Identification of tacit knowledge components is necessary to inform and train additional workers in these skills on the one hand and to protect competitiveness on the other. Let us now consider an example where the use of this scale might be appropriate within the information technology field. We use as a basis for our example a firm engaged in custom software development—a firm that is contracted by other firms to develop end user

applications. We will assume that this firm is a market leader which enjoys a competitive position because it can expeditiously turn out products that are of the highest quality and of great use to end users. In short, the firm creates end user applications quickly that perform to the users' specifications. We will call this firm, firm "A" and its competitor as firm "B". We begin our example by looking at firm A's discovery and use of tacit knowledge made explicit and extend this scenario to illustrate why this is not always an optimal choice.

Firm A has recently had difficulty in training newer systems analysts and therefore software quality and time to production has suffered. The firm's leading analysts are overworked and the newer analysts don't seem to be performing as well as they should. A manager has asked his senior analysts to complete our survey upon completion of a major project and discovers that much of what these analysts do cannot be explained easily—they just sort of know how to do it. Employing some knowledge workers, the manager slowly extracts this tacit knowledge from the senior analysts and codifies it so that more junior personnel can be trained in the techniques. Once this is done, productivity seems to increase and the time to produce high quality software has been shortened. The firm is able to retain its market position.

Now consider the worker who is hired away from firm A into firm B. This worker carries with him or her large amounts of explicit knowledge regarding the original firm's ability to extract end user requirements used in the analysis phase of the systems development life cycle. The ability to do so is what gives firm A its competitive advantage because it is able to develop the applications more quickly. These techniques were once tacit, but the decision was made to make them explicit so that more systems analysts could be used. This worker may now use these techniques in his new job at firm B and train others in its use as well. The impact on the firm A is the reduction in its position as a market leader, because its competitor is now able to implement its methods!

Next, consider the codified knowledge (training material) that is floating around Firm A. In its newly explicit form, the knowledge is more at risk of being intentionally or inadvertently leaked to Firm B. Firm A employees may discuss or transfer their explicit knowledge within their personal or professional networks causing the explicit knowledge to flow through the network and end up at Firm B. Alternatively, documents, either electronic or otherwise, may be emailed or distributed throughout the firm and some stakeholders. This distribution can increase the chance that the knowledge will be obtained by Firm B.

Although this is a contrived example, it merely serves to illustrate the value and the nature of tacit and explicit knowledge. The general feeling currently is to exploit tacit knowledge so that all may benefit, yet this may not be the most desirable outcome where competitive advantage might be compromised. In any event, the identification of those components of tacit knowledge is important and the scale presented herein is a first step towards achieving that goal.

5. Limitations, Implications and Future Research

This study has some limitations. The study utilized subjects chosen on the basis of availability, which restricts its ability to generalize to the population since it represents a non-probability sample, but because it was conducted as a lab experiment, the ability to generalize the results was already limited. Future studies, which examine the structural nature of the underlying model should be randomly drawn in a field study to overcome this limitation. We have already introduced the nature of tacit knowledge and the problems that this presents when attempting to measure it. Our approach of limiting the instrument to address a recall of behaviors and not the actual knowledge used in the behavior should help to alleviate this problem.

There are several areas within the IT industry that may make use of information collected from our instrument. Here are but a few:

1) Knowledge workers who elicit tacit knowledge from domain experts can identify tacit and explicit components and decide which needs to be codified;

2) Data modeling and normalization of data structures is an enormously complex activity that contains largely tacit components. Identification of these components might make it easier to understand and model efficiently; and

3) Programmers are sometimes hired to be *ad hoc* systems analysts. For those companies who hire programmers who must figure out the business processes and convert them into systems, the use of tacit knowledge is pervasive and not easily passed along to new hires. For this group turning tacit knowledge into explicit knowledge might improve competitiveness by reducing development time.

Strategic value in information systems and therefore competitive advantage can be obtained through such things as:

1) The time to implement a new system—the quicker one firm can do it, the more likely they are to acquire first mover advantages and increase market share;

2) Software quality—the higher the quality of the product, the higher the customer loyalty and the more business the firm is likely to receive; and

3) Software capability—the more it is user friendly, the greater is its ability to withstand adverse events (viruses, locking up or other security issues), and the better its performance under load, the more likely the firm will obtain more business.

Within these strategic areas, managers need to know what to protect and how to protect it from competitors. Competitors can hire away people with such knowledge or they can engage in less than honest methods of obtaining it, but in general the more tacit the knowledge is, the more difficult it is to extract and utilize.

6. Conclusion

This study presents a theory of tacit and explicit knowledge in terms of the components that reflect the degree of tacitness of knowledge. We do so in order to present a scale that can be used to identify whether individuals rely more on tacit or explicit knowledge in the completion of a task and to identify what tasks might be more conducive to either tacit or explicit knowledge. That is, some work within organizations may require predominantly tacit or explicit knowledge by nature, and this nature may further be influenced by the individuals performing the work. If we can identify those areas in which people rely more on tacit knowledge, we can evaluate these areas in terms of competitiveness and decide whether to make this knowledge explicit or not. We may also be able to classify people as relying more on tacit or explicit knowledge in the performance of their duties and assign them accordingly. Such matching of individuals to type of knowledge work naturally would require additional research, and the instrument developed here may be helpful in that research.

7. References

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8. Appendix

In order to complete this activity, to what extent …

1. Did you rely on written instructions?
2. Did you rely on material presented in class?
3.* Did you rely on knowledge gained from outside this class?
4.* Could the knowledge you used be written down?
5.* Would you have difficulty in explaining the steps?
6. Would viewing the finished product allow you to understand the steps involved?
7. Were you conscious of the steps required?
8. Did you utilize formal procedures?
9. Did you organize the steps you used?
10.* Did you rely on steps learned previously?
11.* Could the steps be written down so that any student could be successful?
12.* Could the steps be explained in class so that any student could be successful?
13. Did the solutions come to you step by step?
14.* Would you have difficulty writing down the procedures you used?
15. Would it be easier to show other students how to do this than tell them?
16.* Did you feel you knew how to do this without thinking about it?
17.* Did your actions seem instinctive instead of reasoned (or considered)?
18.* Were you already familiar with how to do this?
19. Did you spend more time planning the necessary steps or doing them?
20.* Did you rely on what you had learned previously?
21.* Were you able to do this without thinking about it?
22.* Did you feel that you were repeating certain steps?
23. Did you have to invent new steps?
24.* Are you clear about your success on your finished project?
25.* Could you explain why you did better or worse on this project than others?
26.* Did you rely on your intuition?
27. Did you change your typical approach to solving problems?

Notes: Each item was displayed using a semantic differential format using the anchors, "Completely" and "Not at All." Scores were obtained by converting the position of an electronic slider into a 5-point scale. Scores can therefore range from 27 (indicating complete reliance on tacit knowledge) to 135 (indicating complete reliance on explicit knowledge. Items 1, 2, 4, 7, 8, 9, 11, 12, 13, 19, 23, 24, 25, and 27 were reverse scored. Items marked with an asterisk are those included in the reliability and validity estimates.