Towards a better understanding of system analysts' tacit knowledge

A mixed method approach

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Abstract

Purpose – The purpose of this paper is to elicit tacit knowledge exhibited in expert information system (IS) professionals in a form that can be shared with others; and to develop categorical framework suggesting key content areas of tacit knowledge in the requirements analysis domain.

Design/methodology/approach – Requirements analysis is selected as the main focus of this study due to the importance of this phase to the success of IS development and the nature of requirements analysis tasks requiring extensive amount of tacit knowledge. The authors used the "storytelling" approach, a semi-structured interview technique for knowledge elicitation.

Findings – The study resulted in 132 knowledge items using a qualitative method and categorized them into 14 categories using cluster analysis. The study found that experienced, successful analysts see systems analysis in behavioral, managerial, and political terms and focus heavily on interpersonal, project management, and organizational issues.

Research limitations/implications – The limitations in the research sample, or in the recollection capability of the research subjects could compromise the comprehensiveness of the tacit knowledge in the requirements analysis domain; however, the elicited knowledge at least represents important dimensions one might reasonably find in this domain.

Originality/value – Very little research has attempted to capture this tacit dimension of system analysts' knowledge. Thus, capturing and transferring the tacit knowledge from experts should help in the evolution of novice to expert system analysts thereby improving both their effectiveness and the quality of the information systems developed.

Keywords Skills, Knowledge transfer, Information systems development (ISD), IS professionals

Paper type Research paper

Introduction

The state of the art of information system (IS) development is far from perfect in terms of implementing systems that fully meet user requirements. In spite of recent advances in system development tools (e.g. work flow models, diagrams, requirements engineering tools), the real issue is that no such tool can completely replace the systems analysts' cognitive skills and abilities, as well as the tacit knowledge gained from on-the-job experience (Burgetz, 1991; Schenk *et al.*, 1998). The importance of these skills and tacit knowledge is illustrated in ever-increasing popularity of the agile software development approach where skills and tacit knowledge of people are emphasized over structured processes in dealing with the heuristic nature of uncertain business requirements (Ryan and O'Connor, 2013). Thus, to better meet user requirements, it is imperative that

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systems analysts use their "how-to" knowledge that they have tacitly learned through years of on-the-job experience.

In the IS development literature, it has been recognized that a performance gap exists between expert and novice IS professionals, mainly due to the tacit dimension of their knowledge (Ryan and O'Connor, 2009). Knowledge acquired through accumulated on-the-job experience sets the expert apart from the novice, and similarly, distinguishes a successful IS professional from a less successful one (Vitalari, 1985). From knowledge management and human communication perspectives, knowledge increases the capacity to take effective action (Nonaka, 1994) and thus knowledge needs to be disseminated from experts to novices in order that all analysts can take more effective action. Yet, capturing and sharing expert knowledge in organizations is consistently considered a challenge in information systems and knowledge management literature (Wegner, 1998; Zappavigna and Patrick, 2010). Interestingly, very little research has attempted to capture the tacit dimension of system analysts' knowledge, i.e., what system analysts know about how to perform systems analysis tasks and how to put general knowledge into practice in order to succeed as a professional in real-world situations.

Capturing the tacit dimension of the system analysts' knowledge becomes even more critical as organizations adopt agile methods to software development. Agile methods focus on rapid and repeatable delivery of software in short periods of time, i.e., "timeboxes." The analyst in an agile team works closely with a customer to reprioritize requirements on a continual basis in response to changing circumstances. Waiting for a novice analyst to learn the systems analysis task while the project is in motion may slow down the development team's overall velocity or the team's self-organization processes. Making expert tacit knowledge available to novice analysts helps the latter to come up to speed with the analysis task faster and more effectively thereby increasing team velocity.

The knowledge engineering discipline has faced similar challenges as knowledge engineers attempt to acquire knowledge from inside experts to build knowledge-based systems (Mohammad and Al Saiyd, 2012). Such challenges are especially common in acquiring tacit knowledge related to experiential know-how, know-why, practical insights, intuitive judgment, and work experience. Consequently, such knowledge is difficult to harness and put into professional practice (Wagner and Sternberg, 1985; Shadbolt and Milton, 1999). The ability to articulate these kinds of tacit knowledge would assist novice professionals by imparting experiential and practical insights into what solutions will work, why they will work, and how to make them work (Abidi *et al.*, 2005). In the psychology literature, this tacit knowledge is one important aspect of what is referred as practical intelligence which accounts for individual differences in job performance (Sternberg, 1985; Sternberg *et al.*, 2000).

The research presented here seeks to provide an essential understanding of the experience-based knowledge possessed by expert systems analysts and identify such knowledge in a form that can be shared with others, thus allowing a less experienced analyst to learn more rapidly and effectively from a more experienced analyst. This sharing of tacit knowledge from expert to novice should also accelerate the evolution from novice to expert as well as improve the effectiveness of the systems analyst and ultimately the quality of information systems developed. In light of the above discussion, the major research objectives for this study are: to elicit tacit knowledge exhibited in expert systems analyst, and to develop a categorical knowledge base suggesting key content areas of tacit knowledge in the requirements analysis domain.

Several studies have investigated the skill and knowledge requirements of systems analysts (e.g. Benbasat *et al.*, 1980; Cheney and Lyons, 1980; Lee *et al.*, 1995;

Todd *et al.*, 1995; Tesch *et al.*, 2003). A common facet of these studies is a search for a relationship between successful job performance and traits of individual analysts like identified skills or knowledge clusters. The studies seek to provide knowledge/skill categories that are significant for the information systems domain and have suggested the relative importance of those categories.

This research departs from the previous studies in two major aspects. First, although past studies concerning the skill and knowledge requirements of IS practitioners provide valuable information, major limitations lie in the generality of the skill/knowledge definition and knowledge categories as well as a lack of detail about knowledge content that would be helpful in knowledge sharing. This study focusses on the underlying knowledge believed to contribute to differential behaviors between expert and novice IS practitioners and is aimed at identifying content and categories (content areas) of the knowledge acquired through on-the-job exposure that is continually evolving. Second, unlike previous studies that rely on opinion or perception of IS practitioners or CIOs (Ashenhurst, 1972; Benbasat *et al.*, 1980; Cheney and Lyons, 1980; Hunter and Palvia, 1996; Nelson, 1991; Nord and Nord, 1997), this study applies a knowledge content-based approach where knowledge categories are derived from actual elicited, action-oriented knowledge used by expert IS professionals to successfully perform their job in real-world situations. This hopes to address inconsistency between what one says or believes and what one actually does (Schön, 1983).

Requirements analysis: a tacit, knowledge-intensive domain

Requirements analysis (a.k.a. requirements engineering) refers to such activities as eliciting, analyzing, and validating what the user requires from a system and the constraints under which it operates and is developed (Paetsch *et al.*, 2003; Lucia and Qusef, 2010). These requirements analysis activities are important in all development approaches, including agile development.

Requirements analysis – the core element of IS development – is selected as the main focus of this study for two reasons: the importance of this phase to the success of IS development, and the nature of requirements analysis tasks are such that they require an extensive amount of tacit knowledge. It is widely accepted that an accurate and complete set of requirements is difficult to obtain (Appan and Browne, 2012; Davis, 1982), mainly because of the complexity of information requirements, complex patterns of interaction among users and analysts in defining requirements, as well as political and behavioral obstacles (Appan and Browne, 2012; Browne and Ramesh, 2002; Davis, 1982; Pitts and Browne, 2004). Given the challenges in defining information requirements, novice analysts tend to make more mistakes than expert analysts due to their lack of experience and context-specific knowledge (Chi *et al.*, 1982; Schenk *et al.*, 1998). These mistakes could lead to incomplete or faulty requirements analysis with subsequent adverse impacts on the success of entire development projects.

The most common application of tacit knowledge is in problem-solving tasks (Leonard and Sensiper, 1998; Simon, 1976) like that of requirements analysis. Tacit knowledge consists of heuristics or rules of thumb used to identify problems and solutions (Kogut and Zander 1992; Von Krogh *et al.*, 2000). In terms of requirements analysis, novice analysts tend to have limited episodic knowledge and apply fewer heuristics than experienced analysts (Schenk *et al.*, 1998). The expert can solve problems more easily and effectively than the novice, since the expert can recognize the situation and identify appropriate actions for dealing with it through their accumulated context-specific experiences (Simon, 1976). Previous research has shown that problem

solving in knowledge-intensive domains depend largely on procedural skills, which may operate beyond focal awareness (Chi *et al.*, 1982). A point worth emphasizing is that procedural structure is one of the key characteristics of tacit knowledge (Sternberg *et al.*, 2000). Solutions to ill-structured, ill-defined, or highly complex problems require procedural knowledge, i.e., tacit knowledge – knowing "how" rather than knowing "what." Clearly, to successfully perform the complex and ill-defined tasks required in information requirements determination, systems analysts must have a highly personalized set of cognitive abilities with extensive tacit knowledge.

While, the literature provides guidelines, general rules, and basic understanding concerning methods to elicit requirements (e.g. Browne and Rogich, 2001; Byrd *et al.*, 1992; Marakas and Elam, 1998; Moody *et al.*, 1998), representation tools to overcome human cognitive limitation (e.g. Kim and March, 1995; Lohse *et al.*, 1995), and influences of social, cognitive, and political processes on quality of requirements analysis (e.g. Davidson, 2002; Ives and Olson, 1984; Keen and Gerson, 1977; Robey and Farrow, 1982; Robey *et al.*, 1993), no research to our knowledge has investigated what systems analysts know about how to perform requirements analysis tasks and how to put the knowledge or general rules exhibited in the literature or doctrine into practice in order to succeed in their profession's real-world tasks. Given the significance of requirement analysis and its complex and ill-defined nature discussed above, a study of tacit knowledge of IS professionals within the requirements analysis domain should prove valuable to both researchers and practitioners alike. It should be noted that IS professionals is the general term for individuals – particularly in this study's context – involved in the requirements analysis activities for system or software development. In practice, the titles may vary including systems analysts, business analysts, requirements engineers, software/system developers, etc.

Theoretical foundation

Polanyi (1966) introduced the term "tacit knowledge" and identified this knowledge as personal and generally difficult to articulate. Polanyi's notion of tacit knowledge lies in an interpretive perspective, and primarily emphasizes a process of knowing (i.e. tacit knowing), instead of what is in our heads (i.e. knowledge content). Polanyi (1969) stated that, "knowledge is an activity which would better be described as a process of knowing" (p. 132). Stated in this way, it may follow that Polanyi viewed all knowledge as tacit. Regardless, it is clear that, to Polanyi, it seemed impossible to articulate tacit knowledge and make it independent of human actions.

Within the knowledge management literature, another view of tacit knowledge has been presented. Based on the foundations of positivist epistemology, knowledge distinction between tacit and explicit knowledge was made (e.g. Nonaka and Takeuchi, 1995; Steward, 1997; Davenport and Prusak, 1998). Tacit knowledge is defined as personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspective, and value system (Nonaka and Takeuchi, 1995). Tacit knowledge is hard to articulate with formal language, whereas explicit knowledge can be articulated with formal language and communicated or transmitted relatively easily (e.g. Nonaka *et al.*, 2000; Kikoski and Kikoski, 2004). Tacit knowledge is connected directly with skills and performance as it refers to non-codified, disembodied know-how which is acquired via the informal take-up of learned behavior and procedure (Howells, 1996). Busch *et al.* (2003) view tacit knowledge as being able to make accessible to conscious awareness, make explicit, and pass on. This articulable aspect of tacit knowledge is the component on which experts and non-experts differ.

In psychology research, Sternberg (1985) adapted the term tacit knowledge, which is a result of implicit learning, to account for individual differences in professional success in real-world job performance. Similarly, Sternberg *et al.* (2000) viewed tacit knowledge is an important aspect of practical intelligence which account for success in real-world practical situations. Marchant and Robinson (1999) thought tacit knowledge a critical element of success in several professions including management, sales, and software design. Thus, almost by definition, a novice cannot be regarded as possessing considerable tacit knowledge, whereas the competent individual, regarded as an expert due to the long practical experience in his field, may possess considerable tacit knowledge.

Based on positivist assumptions, Sternberg *et al.* (2000) viewed tacit knowledge as psychological reality and proposed a set of operationalized definitions and methodology to articulate tacit knowledge. To Sternberg, tacit knowledge is perceived as any other psychological construct which can be empirically captured through conceptions of operationalization. Similarly, knowledge is distinguished into two perspectives: knowledge-as-process and knowledge-as-thing which, under knowledge-as-thing perspective, tacit knowledge is converted into explicit knowledge through articulation by means of narration and rationalization of one's own or others' behavior (Gasson and Shelfer, 2007).

Both the positivist view and interpretivist view have their own grounds as they both capture aspects of reality (Tsoukas, 1994). It is important that we make clear both the epistemological and theoretical assumptions of knowledge on which the present study is grounded, and what it means to manage it, understand the implications of each research perspective, and act in a way that reflects that knowledge (Orlikowski and Baroudi, 1991; Schultze and Leidner, 2002). As suggested by Castillo (2002), whether tacit knowledge is articulable – and how to articulate if possible – rests mainly on how tacit knowledge is defined by researchers. Additionally, while the concept of practical intelligence (Sternberg *et al.*, 2000) has been challenged that it is not a new form of intelligence but is simply the application of situational judgment of academic intelligence ones individually possess (Gottfredson, 2003), the notion of tacit knowledge defined is still relevant to the main characteristics of the study's knowledge of interest: experience-based knowledge relevant to solving practical problems and highly context-specific procedural knowledge.

Therefore, this study adopts the positivist view of tacit knowledge since the notion of tacit knowledge proposed by Sternberg *et al.* (2000) and others (e.g. Howells, 1996; Lawson and Lorenzi, 1999) matches the current study's research objectives, and nature of the phenomenon of interest (Deetz, 1996). This research seeks to identify practical knowledge in form of best practices that system analysts have learned from on-the-job experience. Such knowledge has a tacit quality and sets apart expert from novice system analysts with respect to job performance. It should be noted that this study makes no attempt to criticize Polanyi's (1966) work, nor does it offer a view of tacit knowledge in competition with, or in opposition to the interpretivist view of tacit knowledge. Instead, Polanyi's notion of tacit knowledge is considered another view of tacit knowledge with a different set of underlying philosophical assumptions and, thus, requires different conceptions and methods for empirical research activities.

Operationalization of tacit knowledge

Following from Sternberg, we view tacit knowledge as practical, informal knowledge acquired through actual performance of a task. Much of the knowledge required to complete job tasks and to be successful in a profession is tacit in nature (Sternberg *et al.*, 1995; Wagner and Sternberg, 1985, 1987). It is worth emphasizing that the notion

of tacit here refers to "not openly expressed or stated […] directly taught or spoken about to most of us." However, adoption of this view does not imply that tacit knowledge is "inaccessible to conscious awareness, unspeakable, or unteachable" (Wagner and Sternberg, 1985).

The possession of tacit knowledge reflects practical ability to learn from experience as well as to apply such knowledge to achieve personally valued goals (Wagner and Sternberg, 1985). People implicitly learn as they pursue goals on the job. This action-oriented tacit knowledge is a result of learning from experience, often without conscious intention to learn or conscious awareness of having learned, i.e., learning by doing and learning by osmosis (Howells, 1996). Therefore, people may be unaware of what they know and may have difficulty articulating it. It should be noted that length of experience is less important to the concept of tacit knowledge than the ability to learn from experience; in particular, the ability to acquire knowledge from on-the-job exposure and appropriately apply such knowledge to job problems or situations. Therefore, the true value of experience to performance is not how much experience (i.e. on-the-job exposure) an individual has, but how well an individual employs the experience to acquire and use tacit knowledge (Hedlund *et al.*, 1998). As a result, an expert in a particular field is a highly experienced professional with long practical exposure in his field and exhibits superior performance. An expert thus tends to possess considerable tacit knowledge and performs better than a novice (Tschetter and Tschetter, 2010).

Operationalized definitions of tacit knowledge

Tacit knowledge consists of three main characteristics: first, it is procedural in nature (e.g. Sternberg *et al.*, 2000; Colonia-Willner, 2004); second, it is generally acquired on one's own through personal experience with little help from others (e.g. Nonaka and Takeuchi, 1995; Howells, 1996; Sternberg *et al.*, 2000); and third, it is relevant to the attainment of goals people value because it is generally acquired through one's own experiences (e.g. Sternberg *et al.*, 2000; Ambrosini and Bowman, 2001). Each of these three operationalized definitions, respectively, addresses different aspects of tacit knowledge: the cognitive structure of tacit knowledge; the conditions under which it is acquired; and the conditions of its use. Below we discuss each characteristic of tacit knowledge; emphasizing how tacit knowledge can be distinguished from more explicit, formal knowledge (Hedlund *et al.*, 1998).

Tacit knowledge is procedural in nature. Knowledge can be classified as procedural knowledge and declarative knowledge (Anderson, 1983; Best, 1989). Procedural knowledge is represented in such a way that it is related to a particular use or a set of uses. It is the knowledge that dictates "how to" perform an activity. It is the knowledge for specific condition-action pairing that guides an individual's action in a given situation. People who possess procedural knowledge may find it difficult to articulate it. In contrast, declarative knowledge consists of related facts and is non-specific with respect to use. It should be noted that tacit knowledge is viewed as a subset of procedural knowledge. Hence, all tacit knowledge is procedural knowledge, but not all procedural knowledge is tacit knowledge (Sternberg, 1988).

Tacit knowledge typically is acquired with little or no help from others or other environmental support. Tacit knowledge is usually acquired on one's own – with little or no direct help from others or from the environment (neither people nor media). It is acquired through personal experience, rather than direct instruction. Sternberg (1988) contended that when an individual is given support from people or media,

the knowledge acquisition is facilitated in three aspects: the individual is helped to differentiate more important from less important information; integrate pieces of knowledge in a useful way; and identify knowledge in memory that may be relevant or helpful in the present situation. To the extent that this help is absent, an individual has not received environmental support.

Tacit knowledge is practically useful to the individual. Tacit knowledge has practical value to the individual so as to allow the achievement of personally valued goals. It is believed that the more highly valued the goal is, and the more directly the knowledge supports the attainment of the goal, the more useful is the knowledge (Sternberg *et al.*, 1995). Hence, tacit knowledge is different from the "how-to" knowledge irrelevant to personally valued goals. Knowledge is perceived as practically useful when it is relevant to individually valued goals, regardless of how the knowledge is acquired. It is possible that practically useful knowledge can be acquired in a classroom, through personal experience, through formal training, or through self-study.

The above three facets of tacit knowledge are not independent but instead are interrelated. That is, procedural knowledge tends to be practically useful in that it embodies the condition of how it is used. Knowledge acquired under low environmental support tends to have practical value since some individuals probably fail to acquire it and those who are successful in acquiring such knowledge gain a competitive advantage (Wagner and Sternberg, 1987). Further, as procedural knowledge is often difficult to articulate, it is supposedly gained through experiential learning. Similarly, knowledge gained through personal experience tends to be action oriented. Hence, procedural knowledge is expected to be acquired under conditions of low environmental support.

This research presumes that all knowledge has tacit dimension, as suggested by Leonard and Sensiper (1998). Tacit knowledge and explicit knowledge exist along a continuum, rather than mutually exclusive discrete categories where knowledge is predominantly explicit at one extreme and predominantly tacit at the other (e.g. Leonard and Sensiper, 1998; Crofts and Swatman, 2002; Edmondson *et al.*, 2003; Hall and Andriani, 2003; Jasimuddin *et al.*, 2005). It follows then, that each of the three facets of tacit knowledge is viewed as a continuous, rather than discrete, dimension of tacit knowledge. A knowledge item is not evaluated on a basis of either possessing or not possessing these three features, but rather on a basis of the degree to which it possesses the three facets as shown in Figure 1.

Tacit knowledge in this study is believed to have a continuous attribute and hence it is positioned along a continuum with explicit knowledge at one extreme and tacit knowledge at the other extreme (see Figure 1). This research attempts to explicate the tacit knowledge of systems analysts in order to make it less tacit and more readily transferable to others. It is believed that professional systems analysts' tacit knowledge usually resides in systems analysts' heads and is inherently attached to systems analysts' actions (Shadbolt and Milton, 1999; Mohammad and Al Saiyd, 2012). We also believe that this knowledge can be encoded and made less tacit to allow for transfer or sharing to others.

Research methodology

As discussed previously, tacit knowledge is grounded in personal experience and has a great impact on individuals' performance. One element of personal experience is on-the-job exposure. Therefore, the research subjects for this study were successful systems

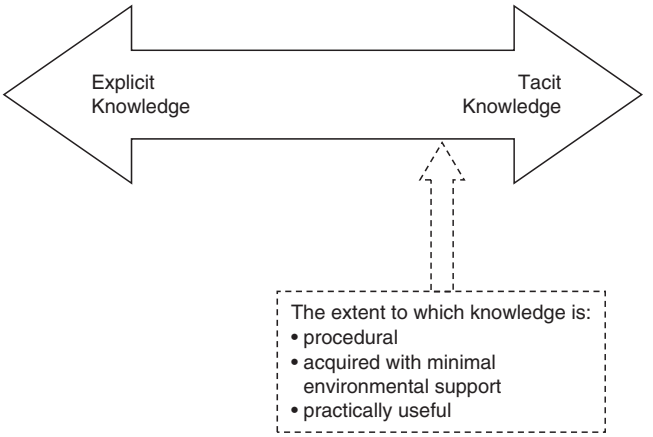

Figure 1.
Knowledge spectrum and operationalized characteristics of tacit knowledge

analysts with a great deal of on-the-job exposure identified by their senior managers. We selected systems analysts who presumably possess a substantial level of tacit knowledge, i.e., those who have spent significant time in their systems analysis position as well as having exhibited success on their job. Figure 2 depicts the research procedures undertaken. We used the "storytelling" approach, a semi-structured interview technique

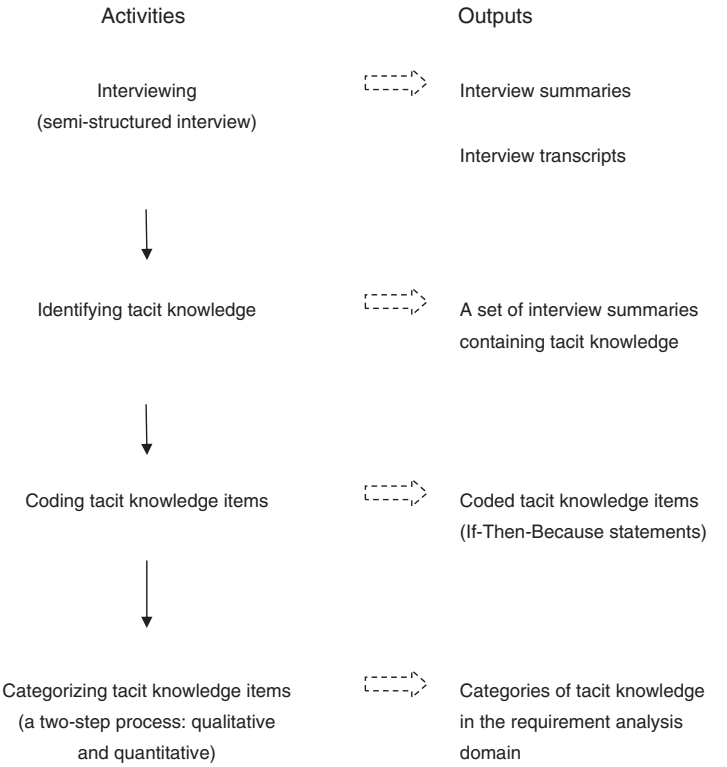

Figure 2.
Research procedures

suggested by Sternberg *et al.* (2000) to articulate tacit knowledge. Built on Flanagan's (1954) "Critical incident technique" which seeks to identify workplace situations associated with effective and ineffective behaviors, the interview encourages subjects to reflect on their knowledge by being asked to recount stories or incidents in which the subjects learned important lessons about their jobs. Focussing on stories or incidents should be helpful as a way to direct subjects toward their personal experience and away from theory or formal learning where tacit knowledge has taken place. Individual interviews of the participating systems analysts were conducted at the participants' place of work and at times convenient to them. The interviews focussed on lessons relating to systems analysis that are not written in books or taught in classes.

With the semi-structured interviews, the interviewer attempted to focus on the stories and probe for more details about the situations especially with respect to objectives, actions taken, some alternative courses of actions considered, and lessons learned from those situations. The probing questions were intended to acquire stories containing knowledge which possessed the three operational characteristics of tacit knowledge: procedural structure (i.e. probing for actions taken), low environmental support for acquisition (i.e. asking for stories or incidents from their personal job experience), and high practical usefulness (i.e. probing for objectives). To ensure validity of the data as suggested by the critical incident technique, interviewees were encouraged to tell a variety of stories to assure that each subject expressed both positive (i.e. successes) and negative (i.e. failures) aspects of the work, as well as recent as well as older work events.

A pilot study of three MBA students was conducted to: assess the effectiveness of the interview protocol; identify potential problems that might occur during interviewing, rating, and coding activities; and estimate the time requirements for each activity. Four major activities – interviewing, summarizing interview stories and lessons, rating, and coding – were conducted for the pilot study. An appropriate strategy was then developed to address those problems and issues arising from the pilot activities and resulting data to ensure reliability and validity of the research. Such strategies included revising the introduction statements to put the interviewees at ease, the addition of probing questions directed to uncover the three main aspects of tacit knowledge, and some follow-up questions to effectively identify practical knowledge in the interviewee's own words.

A total of 45 practicing analysts representing a wide variety of industries as well as firm sizes were selected for participation. Interviews were typically one to two hours in length. After each interview, written interview summaries containing potential examples of tacit knowledge were prepared. After each interview, the researcher evaluated whether the interviewee was a target subject and whether his or her stories should be included in the study. Since the goal of the study is to share tacit knowledge with novice analysts and expedite the transition from novice to expert, a screening process was employed to assure that the articulated tacit knowledge from this study would serve as good material for learning. As a result, 20 of the participants were dropped from the study for failing to meet two major research criteria. In total, 14 of the 20 dropped participants were considered too inexperienced in systems analysis, but were instead more experienced in the area of programming, design, and/or development. The remaining six of the dropped participants were not certain what outcomes would result from their actions since the actions involved ongoing projects and they did not know whether their actions would produce good or bad outcomes. Ultimately, the study sample consisted of 25 experienced and highly successful systems analysts from several different industries. The demographic statistics of the participants are provided in Appendix 1.

All interviews were transcribed. An interview summary was prepared which included either a subject's story, along with any lessons learned from the story, or a lesson learned that was not associated with a particular story. According to the three key characteristics of tacit knowledge discussed in the previous section and the focus of the study on systems analysis domain, knowledge was identified as tacit if the knowledge met the following criteria:

- knowledge was related to actions;
- knowledge was acquired with minimal environmental support;
- knowledge was grounded in personal experience and thus relevant to the goals that individual valued; and
- knowledge was relevant to job performance in the systems analysis domain.

Two raters with knowledge of the systems analysis domain and the tacit knowledge construct reviewed the interview summaries and identified tacit knowledge according to the above criteria. Both raters had access to the interview transcripts to verify any issues or questions they might have had about the story summaries. Each rater independently evaluated interview summaries. The degree of inter-rater agreement was evaluated using coefficient κ, taking into account and correcting for chance agreement. The inter-rater agreement of the overall sample (25 interviews with 118 interview summaries) was 0.71 for κ coefficient and 94.1 percent for simple percent agreement. κ coefficients between 0.40 and 0.75 represent fair to good agreement beyond chance (Fleiss, 1981), so the raters' reviews represented good agreement and high consistency of judgment.

Formatting procedural knowledge

Each example of knowledge was then transformed into a procedural form where each example of identified knowledge was mapped into a set of one or more antecedent condition or "IF" statements, by one or more consequent action or "THEN" statements, and by a brief explanation or "BECAUSE" statement. For a complex procedure, the logical operators "AND" and "OR" were used to represent relationships of conjunction and disjunction, respectively. This coding made the contents of the tacit knowledge more comprehensible, and hence facilitated subsequent analysis for the purpose of identifying knowledge categories. The result of this procedure was a set of coded tacit knowledge items. For each story summary, it was possible to have multiple examples of knowledge or multiple pairs of IF-THEN-BECAUSE statements, if distinct knowledge content was revealed. The coding was conducted independently by the same two raters who have backgrounds in systems analysis. The coding by the two coders subsequently was compared, discussed for consensus, and modified to reflect the agreement.

Two sequential approaches were adopted to identify major categories of tacit knowledge in the systems analysis domain, following from Sternberg *et al.* (2000). First, two experts with extensive systems analysis experience and considered successful in their profession independently categorized the coded tacit knowledge items without constraints in terms of the number of categories as long as the categories did not overlap. The two experts had 15 and eight years of system analysis experience and their current positions were independent contractor and project manager, respectively. Second, the results of the independent categorizing were used to create a dissimilarity matrix such that the elements of the matrix were the number of experts who categorized a particular pair of items into the same category. Having two experts, the possible value for each of the matrix elements ranged from zero to two. This matrix

was used to cluster the data to reveal natural groupings of tacit knowledge as a reflection of the experts' independent categorization. A hierarchical clustering technique, with each case starting as a separate cluster and then combining them successively until all cases fell into one cluster, was used to reveal clusters of coded tacit knowledge items. Subsequently, the experts were asked to select the appropriate number of clusters based on their overall impression of the commonality among coded tacit knowledge items and were then asked to provide labels that best describe the commonality for each of the emerged categories. The resulting cluster analysis is shown in Appendix 2.

Results

A total of 132 tacit knowledge items were generated from the interviews of 25 subjects. As previously discussed, two of the key characteristics of tacit knowledge are a procedural structure (i.e. "how to") and relevancy to individually valued goal attainment. Thus, it is clear that the tacit knowledge categories derived from the interview data were organized around particular goals that analysts pursue during systems analysis, and in the form of how to achieve such goals. The knowledge items represent effective practices and rules of thumb the expert analysts applied to overcome challenges related to requirements analysis tasks.

Below is an example of an interview summary (a lesson learned) that was considered not to be representative of tacit knowledge:

> […] The most common mistake I have seen new analysts make is they don't take into account life-time costs of the system that has been proposing. For example, they decided to use a certain programming language for a system. When we looked at the number of programming experts who knew this language it was very few; therefore, the rate of paying those people to do this would be costly. The analysts who recommended this language didn't consider this issue. Every time we made changes in the program, we had to call them in and pay them to do (the rate was high due to high demand but few people knowing this particular language). The novice analysts tend to come up with a proposed solution to the problem without looking at the bigger long-term picture what happen when you go from static to dynamic (i.e. what happen if we make some changes in the next year). They should have considered the back-end cost or maintenance costs.

This lesson seemingly met the criteria of minimal environmental support for knowledge acquisition, and also appeared to have practical value, but the knowledge is more related to "knowing that" or "know-what," rather than "knowing how." The subject primarily explained his/her observation on what happened and what the problem was, but did not specifically suggest how to handle or avoid such problems.

An example of story summary representative of tacit knowledge and the knowledge items extracted is shown below:

> […] In some occasions, the requirements from end users and the issue of end user satisfaction are not as important as usual and thus don't play a key role in systems development. For example, the owner of a company wanted to make changes in the current sales system. There were conflicting perspectives between the sales staffs, who actually used and interacted with the system, and the owner of the company. The owner of the company perceived things in profit perspective, while sales people viewed things in sales perspective. The owner noticed that with the current system, costs were not properly identified to determine the profit and as a result, the owner came with a new formula that could identify costs more accurate. However, sales staffs, as end users, felt the changes were unreasonable because they had to make the same level of performance with less resource. With the new system, for sales it was difficult to understand in terms of sales perspective.

> The owner was very confident in his way and he believed the change was the right way to do. In this situation that the change was dictated down or delivered in the top-down manner, needs from the end users and any attempt to satisfy the end users would not be an issue here. The only thing I, as a systems analyst, could do was to take concerns from the sales staffs and explain or suggest to the owner, but I was not going to change according to the end users' requests. I was not going to risk my job by satisfying the users, while not conforming to the owner's needs. At the end, it seemed the owner's approach was right. Although the sales decreased, the profits did increase.

From the excerpt above, the following coded knowledge item was generated:

> **IF** the needs and requirements for the new systems development are dictated in a top-down manner
>
> **AND**
>
> **IF** there are conflicting perspectives and requirements between end-users and management
>
> **AND**
>
> **IF** you perceived a threat to your job by not conforming to management's requirements
>
> **THEN** follow management's requirements and do not attempt to challenge management in an attempt to satisfy end-users. Take the users' concerns to management in order to make them aware of the users' perspectives and potential for resistance as well as to show the users your acknowledgement of their needs.
>
> **BECAUSE** you might be risking your job by satisfying end-users' requirements and challenging management's requirements. There are some occasions like this where user satisfaction is not always the most important concern for systems development and the acknowledgement of the users' needs could help maintain good relationships.

According to the result of the cluster analysis, the two expert reviewers agreed that 14 clusters appeared to be the best solution. The categorization was based on identifying a dominant aspect in an item and the greatest meaningfulness of the categories in the view of the expert reviewers.

Category names, along with a brief description explaining each category are shown in Table I. The 14 dimensions of functionally related tacit knowledge items were organized around particular goals that analysts pursue during requirements analysis, and how to achieve such goals. Figure 3 shows the categories of tacit knowledge along with the proportion of items contained in each category. The predominant categories – communicating (14.39 percent), eliciting cooperation (13.64 percent), selecting/administrating elicitation techniques (12.88 percent), and confirming requirements (11.36 percent) – accounted for 52.27 percent of all items.

The categorical knowledge base provides a better understanding of the relative distribution of the various significant aspects of tacit knowledge relating to requirements analysis. The study made no attempt to generate mutually exclusive categories, but was intended to suggest the broad significant areas of the development and use of tacit knowledge in systems analysis.

Discussion

The role of tacit, experiential knowledge

Using examples, we explain two primary ways by which the results of our study have advanced the current understanding of requirements analysis.

Category	Description
1. Establishing trust	Building trust to reduce job-related fears that other team members may have because of the task or project
2. Establishing credibility	Building one's professional credibility in order to facilitate project work and respect
3. Controlling scope	Limiting requirements based on the project charter or management guidance
4. Managing constraints	Identifying and controlling external or internal limits that will impact the application requirements
5. Evaluating business value	Determining the value of proposed requirements by measuring ROI (return on investment) or by comparing them to corporate or strategic goals
6. Managing involvement	Keeping appropriate resources informed and involved to the proper extent throughout the project duration
7. Managing expectations	Ensuring that all parties clearly understand scope and constraints and the reasons behind them and thus have realistic expectation of the end results
8. Selecting user representatives	Identifying and gaining access to the appropriate end users to identify requirements for the project or task
9. Selecting internal team members	Identifying and gaining access to the appropriate internal resources to assist on analysis and design tasks
10. Resolving conflicts	Addressing conflicting requirements or positions so that the project can proceed
11. Communicating	Tasks/responsibilities where the appropriate means of communications is key to achieving the desired results
12. Selecting/administering elicitation techniques	Selecting and applying appropriate elicitation techniques or methods for initially obtaining requirements
13. Confirming requirements	Reviewing and validating previously gathered requirements before sending them to design and development
14. Eliciting cooperation	Gaining cooperation and support from appropriate parties or individuals in order to accomplish a task or responsibility

Table I.
Tacit knowledge categories

Instantiating the requirements analysis literature. The tacit knowledge instantiates the literature when it puts the very general and formal knowledge discussed in the literature into use. The explicit knowledge within literature is broadly identified and applicable. The tacit knowledge items in this study suggest that through experience, system analysts put the broad applicable knowledge into practice and made it usable in a contextually appropriate situation. The instantiating function of tacit knowledge reflects specific use of formal knowledge in the real-world problems. Thus, the tacit knowledge helps in explicating formal knowledge already in the literature.

A substantial body of research literature on the effects of user expectations on system success suggests a positive relationship between realism of user expectations and users' perception of their performance with the IS (e.g. DeSanctis, 1983; Ginzberg, 1981; Szajna and Scamell, 1993), thus suggesting that users' expectations need to be managed and kept realistic. One particular technique suggested is not to promise more than can be delivered (Szajna and Scamell, 1993). The following example will help elaborate on this technique:

IF the project is about application development for customers

AND

IF salespeople are the ones who have direct contact with the customers

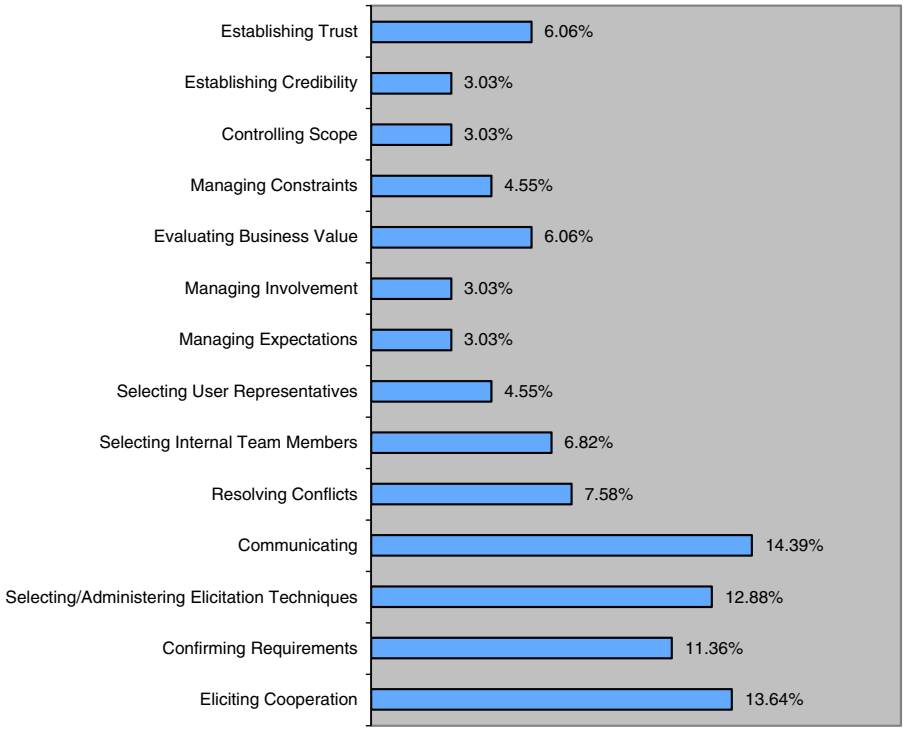

Figure 3.
Proportion of tacit knowledge items obtained from each category

THEN have IS people work directly with salespeople to gather requirements. Don't wait until the requirements are done before you make marketing people aware of technical limitations. Reconcile these issues up front before making promises to the customers

BECAUSE sales and marketing people tend to promise customers things that developers can't deliver. When not informed, marketers are not aware of developer capabilities. Sales people are motivated by commission and will sell products to make the customer happy.

Managing user involvement is another area of focus in system analysis (e.g. McKeen and Guimaraes, 1997; Petter, 2008; Paetsch *et al.*, 2003). Managing involvement focusses primarily on staffing issues for the purpose of getting the appropriate degree of involvement from the appropriate individuals. For example, Petter (2008) provides general suggestions to keep users involved and updated throughout the project and creating small groups to allow all to be heard. The current study extends these ideas further by providing real-world problems and a "how-to" aspect of implementing, especially when facing organizational challenges related to power structures. The following item well depicts this situation:

IF you have to get requirements from a business sponsor and people who are working for that business sponsor

AND

IF the business sponsor has more authority in the chain of command than others

THEN involve the business sponsor at the beginning to set direction and goals/objectives. Don't involve the business sponsor in all of the requirement gathering meetings. Invite the business sponsor back again later if there is an important issue that needs to be solved. Keep the business owner updated on the requirements via documentation or one-one-one conversations throughout the project.

BECAUSE having a business sponsor in the same room with his/her staff could impact the way his staff (users) talk and think, thus changing the dynamics of the discussion. Requirements discussions without the sponsor avoid influence of the sponsor on users' opinions. However, you always have to constantly keep the sponsor informed on the requirements.

Augmenting requirements analysis literature. A number of tacit knowledge items identified in the study augment the requirements analysis literature by filling gaps. Some items address important exceptions and appear to set boundary conditions for the application of rules identified in literature. For instance, conditional utilization of the formal interview approach as a requirement gathering technique is rarely mentioned in the literature, but evident in the study. The following item reflects knowledge about when and when not to adopt a formal interview approach and about how the formality of requirements gathering is related to trust and credibility:

IF you are well recognized in your organization as having experience and a good performance record

AND

IF you want to have a one-on-one interview with a user

THEN use an informal, conversational approach when interacting with the user and avoid taking notes or tape recording

BECAUSE using an informal approach is likely to make the user feel at ease and prevent him from feeling intimidated, possibly resulting in the user talking more and telling you something confidential but important to the project.

BUT

IF you are inexperienced and your reputation with the company is questionable

THEN adopt a formal approach when interacting with the user and be aware of this issue

BECAUSE a lack of formality (e.g. not taking notes, dressing informally) could negatively affect users' impression of you while more formality could help build trust and credibility for you.

Utilization of articulated tacit knowledge

The goal of tacit knowledge acquisition is to optimize or accelerate the process of experiential learning in a given domain. To achieve the learning goal, the study seeks to identify a subset of domain knowledge that is important to practical success. The tacit knowledge is articulated in order to share with others, helping them to develop their own knowledge, and thus accelerate the transition from novice to expert in a given domain.

Thus, practical uses of the articulated tacit knowledge are training and knowledge development of systems analysts. As mentioned earlier that learning is a goal of tacit knowledge acquisition, the articulated tacit knowledge can be used to develop training programs. The articulated knowledge could be shared with other analysts and the shared knowledge would be combined with existing tacit and/or explicit knowledge the analysts possess to develop their own knowledge or learning. The knowledge

transferred to or developed by the knowledge receivers after learning the articulated tacit knowledge materials may not correspond closely to the intention of the knowledge givers (i.e. the expert subjects). In addition, different knowledge receivers may possess varying levels of apprehension depending on their existing knowledge base, both explicit and tacit. Thus, the level of apprehension of and what individuals actually learn from transferred tacit knowledge vary among individuals depending on their existing knowledge- and prior-related experiences. As suggested by Nestor-Baker and Hoy (2001), the articulated tacit knowledge allows an individual to connect the experiences of others to his/her own experiences (i.e. their own successes and failures), and such connection stimulates the development of tacit knowledge.

The literature raises the question about whether tacit knowledge degrades as it is made explicit (Becerra-Fernandez and Sabherwal, 2001). The study attempted to articulate tacit knowledge in order to make it less tacit so that it could be shared with a number of individuals. And while we will not claim that tacit knowledge has to be made explicit before it can be shared, it is possible that some richness or part of tacitness of the knowledge the expert analysts have may be lost and not be captured in the study. That said, there is little doubt that the learning process is accelerated when some tacitness of expert knowledge can be captured and shared with others. Therefore, the articulation of tacit knowledge should serve as a complementary approach to other tacit knowledge transferring approaches such as mentoring, apprenticeship, and observation.

Requirements analysis tacit knowledge base

The 14 categories of tacit knowledge items obtained from this study represent major areas of requirements analysis in which tacit knowledge may reside. That is, the emergent knowledge areas provide a multidimensional representation of a tacit knowledge structure in the requirements analysis domain. It is apparent that the experienced and successful analysts interviewed in this study view systems analysis in managerial, political, and behavioral terms; focussing heavily on project management, organizational, and interpersonal issues. Indeed, previous research provides support to this study's findings that a focus on managerial, behavioral, and organizational aspects of systems analysis is essential to success of IS professionals, and possibly such orientations manifest more among expert than novice analysts as experts learn over time in the workplace while they advance in their careers (e.g. Lee *et al.*, 1995; Lee and Wingreen, 2010). Table II shows the knowledge orientations and relevant categories that represent each respective orientation.

The increasing popularity of agile development methods make it important to better understand human factors in the IS development process (McBride, 2008; Ryan and O'Connor, 2013; Paetsch *et al.*, 2003). Given that agile approaches focus on the importance of people, communication, coordination, and trust building between developers and users (Adkins, 2010; Ryan and O'Connor, 2013), the articulated knowledge oriented in the interpersonal and organizational issues (e.g. establishing trust, communicating, eliciting cooperation, and resolving conflict) should be helpful to enhance system quality.

It is interesting to note that approximately 15 percent of all the knowledge items reflect knowledge related to managing self-knowledge dealing with self-organizational aspects of performance, like protecting oneself from being a victim of organizational politics or being perceived as a poor performer by others, progression in career, how to gain, maintain, and enhance respect and professional credibility, and how to manage one's self to maximize personal productivity. The knowledge items manifesting this individual success orientation were distributed across establishing credibility,

Project management focus	*Interpersonal knowledge focus*
Controlling scope	Establishing trust
Managing constraints	Establishing credibility
Evaluating business value	Managing expectations
Managing involvement	Communicating
Selecting user representatives	Confirming requirements
Selecting internal team members	Eliciting cooperation
Resolving conflicts	
Selecting/administering elicitation techniques	
Organizational knowledge focus	*Self*
Establishing trust	Establishing credibility
Establishing credibility	Resolving conflicts
Resolving conflicts	Confirming requirements
Eliciting cooperation	Eliciting cooperation

Table II.
Tacit knowledge in the requirements analysis domain: integrated knowledge base

resolving conflicts, confirming requirements, and eliciting cooperation categories. An example of tacit knowledge reflecting how the analyst managed the self and simultaneously handled organizational conflict is shown below:

IF the business sponsor has a big ego

AND

IF the business sponsor is certain as to what the system should be and tries to push his ideas

AND

IF the business sponsor doesn't want you to get input from end users because it is likely that their ideas differ

THEN create specific requirements documents and ask the business sponsor to sign off on them. Try to eliminate ambiguity or anything that is open to multiple interpretations regarding the requirements. Don't push too hard for end user participation.

BECAUSE having the business sponsor sign off on very specific requirements protects you from being blamed when the project is unsuccessful due to a lack of end-user input. If the business sponsor has a big ego and wants his/her ideas implemented, pushing for end user input only serves to frustrate him/her, which may wind up hurting you. You want to deliver the best product possible, but not at the expense of alienating yourself from the business sponsor.

Interestingly, while there has been a wide array of prior research concerning required skills and knowledge for IS professionals (e.g. Lee *et al.*, 1995; Todd *et al.*, 1995; Nord and Nord, 1997; Tesch *et al.*, 2009), none of them demonstrates knowledge concerning individual success from self-perspective. Despite its significance in an analyst's career success, this self-oriented knowledge has been largely neglected or unmentioned in the literature. In practice, it is common that individual interests may conflict with organizational interest and this challenge may leave novice analysts in a difficult position. Thus, the 15 percent of tacit knowledge relating to managing self may not represent a big portion of the whole, but yet represents significant practical knowledge that has largely gone unmentioned in the literature.

Unfortunately, the importance of organizational and political issues is not emphasized in formal training. Politics involves building credibility across the organization, negotiating, attaining commitment, and building support (Keen, 1981). Requirements analysis involves ongoing sensemaking among stakeholders (Davidson, 2002).

Bergman *et al.* (2002) highlight the political nature of requirements especially for large-scale systems and thus requirements engineers must be trained to manage inherently political processes to manage evolving requirements to construct a stable solution. It is obvious that this study supports the importance of organizational behavior and political issues on systems analysis and development. The analyst must learn to live with organizational politics and see the opportunities inherent in them. For example, an expert analyst explained, "I believe we have to learn to deal with politics and capitalize on that and use it to our advantage […] not to make others look bad. Politics is everywhere at every level. We have to learn to deal with that to be successful."

Although the current research does not compare novices and experts, the user involvement issue appears very important to the process of requirements analysis in the mind of a number of expert analysts we interviewed, as evidenced in the following comments by an interviewed analyst: "My experience is that usually the end users are so glad that they are being heard even if they are not getting everything they are asking for. To me, you have to meet business goals but if you don't listen to the end user they are not going to use the system."

Limitations of research

Of course the research presented here is not without limitations. One potential limitation is that since the identified tacit knowledge of the study is based on storytelling which focusses on subjects' previous personal experience (i.e. stories or incidents the subjects encountered), the limitations of human memory may limit subjects' ability to recount their stories and thus have an impact on validity of the study results. However, a number of interview questions were used to assist the subjects' recollection process such as asking the subjects to recall extreme situations, e.g., their most recent project, their most difficult project, their best or worst project, etc. This approach has proved to improve the subjects' recollection ability significantly during the interviews (Flanagan, 1954; Sternberg *et al.*, 2000).

In this study, tacit knowledge is articulated from expert practitioners who are highly experienced and successful in their field and believed to possess considerable tacit knowledge. Success, practical experience, and ability to learning from experience define the role of tacit knowledge, as stated in the theoretical framework. We recognize that the study has not yet proceeded to validate the role of tacit knowledge in separating experts from non-experts. Thus, future studies should be conducted to strengthen the validity of the articulated tacit knowledge by comparing the groups of successful, highly experienced with not-as-successful, highly experienced individuals or with successful, inexperienced individuals regarding their judgment in articulated tacit knowledge.

Another limitation concerns the completeness of tacit knowledge in the requirements analysis domain. This study by no means provides an exhaustive knowledge base, but does represent important knowledge areas in the requirements analysis domain. Whereas it is conceivable that limitations in the research sample, or in the recollection capability of the research subjects could compromise the comprehensiveness of the tacit knowledge in this domain, the tacit knowledge elicited in the study at least represents a number of important dimensions one might reasonably find in the requirements analysis domain. Therefore, the elicited tacit knowledge items are considered reasonably good representatives of tacit knowledge in this domain.

Research implications

This study has implications for both research and practice. While previous studies have focussed primarily on behavioral differences between novice and expert in terms

of cognitive processes and knowledge structures (e.g. McKeithen *et al.*, 1981; Schenk *et al.*, 1998; Sonnentag, 1998; Vitalari and Dickson, 1983), little has been done on the underlying influences of those behaviors. The lack of understanding about systems analysts' knowledge and of captured knowledge content limits the development of systems analysis training programs (Ryan and O'Connor, 2009; Vitalari, 1985). This study seeks to address this gap by focussing on the underlying knowledge purported to influence the behaviors of systems analysts and their effectiveness in performing the job, which is believed to contribute to differential behaviors between expert and novice systems analysts and, ultimately, between successful and less successful systems analysts.

Furthermore, the success of systems analysts is achieved through a combination of technical, behavioral, and managerial skills (e.g. Cheney and Lyons, 1980; Todd *et al.*, 1995). Wagner and Sternberg (1987) suggested that the ability to learn informally on the job, i.e., acquire and manage tacit knowledge, is a significant determinant of managerial success. Hence, the pressure created by the critical importance of tacit knowledge in information systems analysis, and the challenges in organizational knowledge management demand for an increased understanding of the tacit knowledge of systems analysts. This research attempts to provide the essential understanding of such experience-based knowledge (i.e. tacit knowledge) and identify such knowledge for better knowledge management and dissemination within the organization.

Sutton (2001) suggests that explicit knowledge alone is typically not sufficient to yield effective performance and further suggests that in order to effectively deploy explicit knowledge learned in formal learning environments one needs to develop relevant tacit knowledge through practice. Similarly, the study presented here also suggests that tacit knowledge interacts with and provides complementary value to formal explicit knowledge (Cook and Brown, 1999) and that the important functional roles of tacit knowledge are instantiating and filling gaps within the explicit knowledge or doctrine such as suggesting conditional use or exceptions in the doctrine. As such, it would be interesting to further investigate when and how to introduce the tacit knowledge to an individual to assure that the individual has sufficient understanding of the doctrine so that the maximum value of tacit knowledge could be gained and that the misuse of tacit knowledge could be avoided.

Although past research has identified system analysts' expertise, these knowledge categories have been too general, i.e., they do not specifically elaborate the tacit quality of the knowledge, nor do those categories convey the detailed content of the knowledge. In contrast, this research is aimed at identifying this content, along with the categories of knowledge acquired through on-the-job exposure that is continually evolving. As a result, unlike previous studies, the implications of findings from this research are primarily directed to organizations attempting to improve knowledge transfer and creation among job incumbents rather than to formal educational settings attempting to appropriately design information systems curricula to serve industry needs. Transfer of on-the-job knowledge from expert to novice would accelerate an individual's progression from novice to expert and, eventually, improve the effectiveness of systems analysts and the quality of developed information systems.

Practical implications

The elicited tacit knowledge allows novice analysts to learn more rapidly and effectively from the experiences of others as well as themselves. In particular, the elicited knowledge enables an individual to connect the experiences of others to his/her own experiences (i.e. their own successes and failures) thus stimulating the development of tacit knowledge (Nestor-Baker and Hoy, 2001). In general, the results presented here demonstrate a heavy

orientation on behavioral aspects – including interpersonal, organizational, and managerial dimensions – on systems analysis activities. An effort to improve the behavioral and managerial knowledge to systems analysts is strongly encouraged. Such knowledge areas are particularly critical in agile development environments which emphasize more on people than process (McBride, 2008; Ryan and O'Connor, 2013). Additionally, as agile approaches rely heavily on people's expertise and competence (Paetsch *et al.*, 2003), the articulated experiential knowledge would help in the learning process and thus expedite the transition from novices to experts.

The study results – along with the "interview for stories" methodology employed here – also provide insights for future management action to better utilize knowledge of the organizations' existing employee base. The stories, lessons learned, and the elicited knowledge items consisting of a set of work-related situations/problems, with actions/solutions in response to those situations, and justifications for taking the actions are a rich source of tacit knowledge in the systems analysis domain. Such materials could be garnered through the interviewing and coding techniques described here and the results could then be used to develop a scenario-based or case-based training program to share with other practicing systems analysts. The training should focus on relating the cases with trainees' own experiences (i.e. interpreting their own experience and providing feedback). This recommendation is consistent with some of the other limited empirical research attempting to elicit tacit knowledge. For example, Zappavigna and Patrick (2010) suggest uncovering tacit knowledge by applying linguistic analyses, and lends further support to the notion that the storytelling approach highlighted here appears to be another effective way to elicit tacit knowledge (e.g. Abidi *et al.*, 2005; Venkitachalam and Bush, 2012), and that such approaches should be incorporated as part of normal work processes.

In addition, the IF-THEN-BECAUSE procedural structure and the storytelling approach is also consistent with the tacit, experiential knowledge acquisition approach explored in the knowledge engineering area (Abidi *et al.*, 2005; Mohammad and Al Saiyd, 2012). To build knowledge-based systems in a particular domain, knowledge engineering area applied the storytelling approach to understand expert reasoning processes – what solutions will work, why they will work, and how to make them work – in order to derive scenario-based knowledge and construct necessary rules (Abidi *et al.*, 2005; Mohammad and Al Saiyd, 2012).

Conclusion

Expert systems analysts are distinguished from novice systems analysts based on the tacit quality of the knowledge acquired through accumulated on-the-job experience. Transferring this knowledge from expert to novice can accelerate the evolution from novice to expert and, therefore, improve the effectiveness of systems analysts and the quality of information systems developed. However, to date, transfer of knowledge between individuals in an organization continues to be a problem in organizations. Using a sample of 25 experienced systems analysts, we generated 132 tacit knowledge items that in turn generated 14 categories of functionally related tacit knowledge items in systems analysis domain. The predominant categories include communicating, eliciting cooperation, selecting/administrating elicitation techniques, and confirming requirements which together comprise over 50 percent of the tacit knowledge elicited. The study also found that the more experienced analysts see systems analysis in behavioral, managerial, and political terms and focus heavily on interpersonal, project management, and organizational issues. These results can be used to develop training programs to assist knowledge transfer to other analysts, thus accelerating the transition from novice to expert systems analysts.

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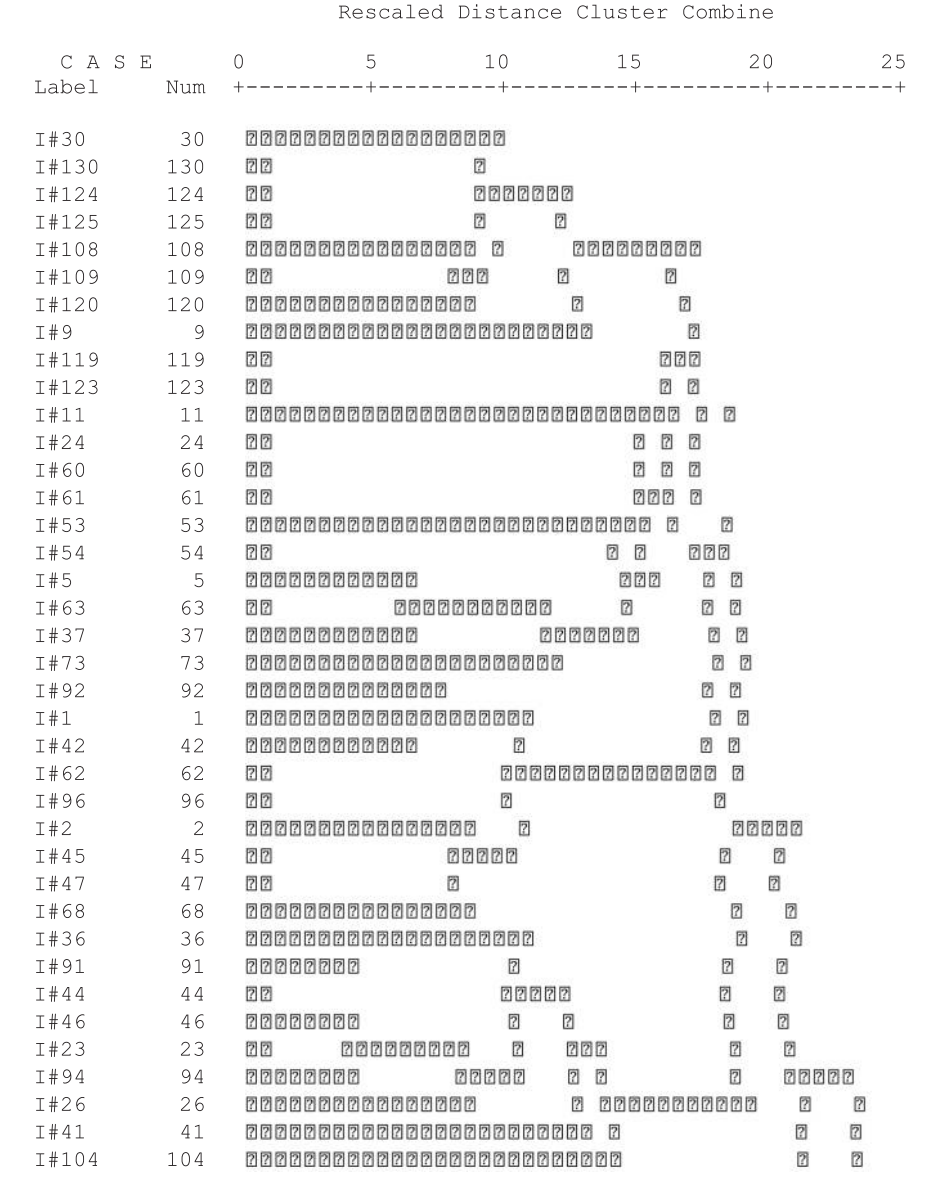
Appendix 1

Demographic variable	Number of subjects	%
Gender		
Male	19	76
Female	6	24
Age		
25 or younger	0	0
26-35	12	48
36-45	9	36
46-55	3	12
Education		
Less than high school	0	0
High school	2	4
Associates	9	8
Bachelors	13	36
Masters	0	52
Doctorate	1	0
Industry		
Transportation	5	20
Consulting/IT provider	4	16
Higher education	3	12
Entertainment	3	12
Aviation	3	12
Retail	2	8
Paper and packaging	1	4
Healthcare	2	8
Distribution	1	4
Finance and insurance	1	4
Transportation	5	20
Consulting/IT provider	4	16
Higher education	3	12
Organization size		
Less than 250	6	24
251-1,000	3	12
1,001-5,000	3	12
More than 5,000	13	52

Table AI. Demographic statistics of the participants

Appendix 2. Cluster analysis output

Dendrogram



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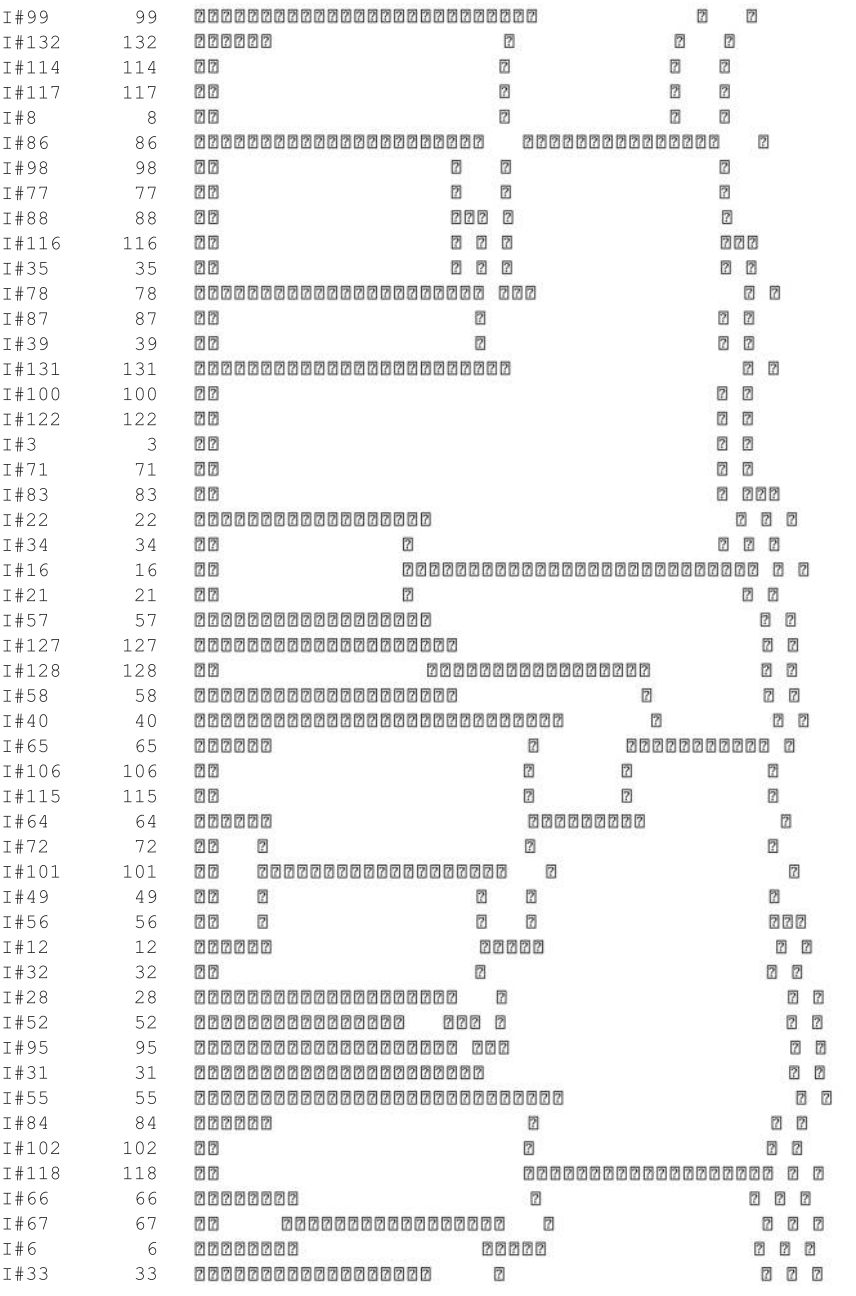

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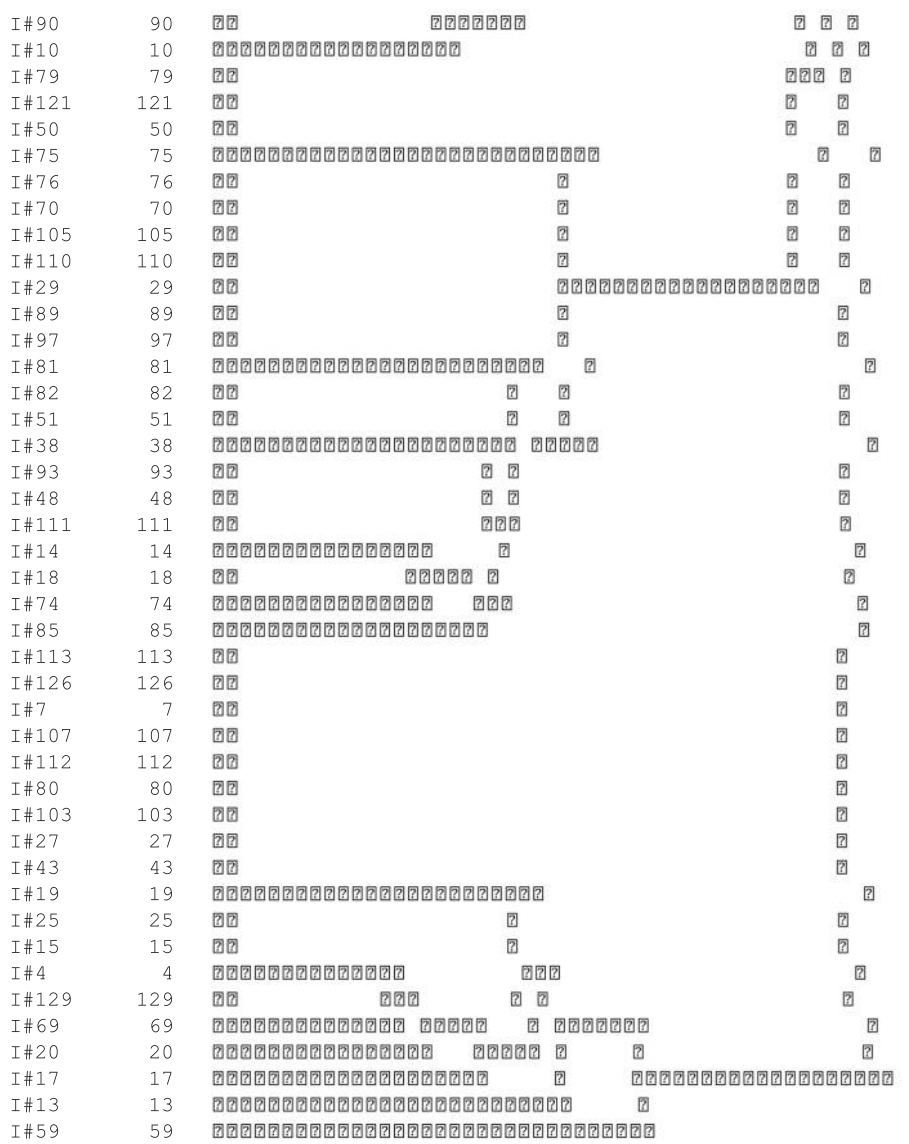

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