ISSN: 2167-1435
v31 n3085

Using Work System Theory to Explain Enterprise Search Dissatisfaction

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Abstract

Even with all of the technological advances intended to improve the tools, enterprise search continues to dissatisfy the majority of users. This paper proposes that Alter's Work System Theory (WST) may provide a new lens with which we can view this problem and eliminate much of that dissatisfaction. WST deemphasizes the technology in the analysis of a work system and emphasizes the customer, products and services, activities and processes, information, and participants elements. We believe that this last element, the participant, and in particular the participants' information domain knowledge may be the cause of the remaining chunk of dissatisfaction users have with enterprise search systems. We briefly discuss the literature with regards to these elements and then present a model for the analysis of the participant element along with ideas for research into this element and its impact on the enterprise search dissatisfaction problem.

Keywords: Enterprise Search, Context, Information Behavior, Work System Theory, Work System.

1. IMPORTANT INFORMATION

With the prodigious growth of information technology, computer and information scientists have been confronted with a key divisive question: Do you change the interface to make it more user-friendly, or do you change the user to make him more interface-friendly? For a time, the most common response was to train the user, but more recent developments in information systems have prompted tailoring the system to the user through means such as simplifying options and stylizing interfaces to resemble sleek, familiar designs like the iPhone (Arnold, 2014, p. 19). We propose that the shift towards changing the interface might need to be at least partially reversed and rely on a new theoretical lens to explain why the reversal may be necessary for at least one specific class of information systems.

These interface simplifications do not always help in complex, innovative products such as enterprise search solutions (ESS), where user satisfaction continues to suffer. The 2012 Enterprise Search and Findability Survey reported 44% were very or mostly dissatisfied while only 20% of respondents were very or mostly satisfied with their ESS (Findwise, 2012, p. 9). The 2013 Enterprise Search and Findability Survey found 40% were very or mostly dissatisfied with their ESS and just 19% were very or mostly satisfied with their ESS (Findwise, 2013, pp. 27-29). White (2014)

notes that the 2014 The Workplace in the Connected Organization report found 11% of respondents had very high satisfaction, in line with previous surveys. In all, user dissatisfaction with ESS has remained consistently high and failed enterprise searches, the cause of this dissatisfaction, have been estimated to cost firms millions of dollars each year (Shell, 2013, p. 13).

Given the prominence of low user satisfaction, study of ESS users should have an important role in addressing this trend. However, research regarding ESS user information behavior tends to be limited to data derived from Transaction Log Analysis (TLA) (Lewis, 2010, p. 3). TLA provides valuable insight into the actions users take to retrieve information, but the inferences made via TLA cannot fully explain why they search a given way and why there is a gap between ESS users' expectations and ESS performance. We argue that filling this gap requires study of user information behavior. Wilson (2000) defines information behavior as human behavior that relates to the active or passive pursuit or use of information sources (p. 49). Gaining insight into how ESS users developed their information behavior may offer an opportunity to address the satisfaction gap by rounding out our understanding of ESS users' information behavior.

This paper examines enterprise search through the lens of Alter's Work system Theory (Alter, 2013). It first defines enterprise search, and then presents Work System Theory (WST) and how enterprise search fits into this model. Next, it reviews how key elements of WST's Work System Framework (WSF) have shaped enterprise search research and products, introduces the concept of a Participant Information Behavior Profile (PIBP), and discusses what insight about user information behavior could be gained about improving ESSs through reviewing these profiles. It concludes with a discussion of future research directions and the implications of the PIBP to academia and the practitioner environments.

2. ENTERPRISE SEARCH AS A WORK SYSTEM

Enterprise search can be very simply defined as search inside the firewall. For the purpose of this paper, we ask the reader to focus on the process of document retrieval inside the firewall. This is an often-discussed problem in both academic (Fagin, et al., 2003) and practitioner (Murphy, 2014) literature. Both define a common challenge to be the search for an artifact that is thought or known to exist and has often been seen by the searcher in the recent past.

The problems with ESSs

ESSs fundamentally differ from web search solutions in many key areas including the nature of the content (homogeneous, html-based, document content on the web versus the heterogeneous nature and file types of documents created in an enterprise) and the purpose behind the creation of the documents and pages (web pages are designed to be found while documents produced in an enterprise are produced to communicate information, not necessarily to be found by a search engine). These two factors define the primary challenge faced when searching an enterprise document collection.

ESSs face the difficult task of ranking documents retrieved by the search engine without the benefit of the additional information available on a web page beyond the textual content of the page. When limited to only using the word-frequency-based document ranking schemes without the benefit of ranking algorithms such as Google's evolution of their original PageRank algorithm, document ranking algorithms fall victim to the inherent ambiguity of language (words taking on many meanings) (Zipf, 1949) and therefore struggle to rank the truly relevant documents at the top of the search results. Given the searchers' tendency to think that a search box is a search box and that all search engines work as successfully as the web search engines such as Google and Bing, this ranking challenge, or deficiency, inherent in ESSs leads to many failed searches.

The continued failure of ESS vendors to provide systems that satisfy their users suggests that the problem may need to be analyzed from a different perspective. Work System Theory may provide that new perspective. Alter (2013) argues that traditional views of systems focus on the technical aspects of a system while deemphasizing the non-technical aspects (p. 74). WST offers an alternative view, which focuses on including human participants, business processes, and products or services that are produced via a work system into the description of the work system. WST is built on the concept of a work system, which is a system

in which humans and machines perform work to produce products or services for customers (Alter, 2013, p. 82). Figure 1 shows Alter's depiction of the Work System Framework.

WST's WSF, a model of WST, includes several key elements: processes and activities (actions that produce products or services for customers), participants (those who perform work within the work system), information (information artifacts that are acted upon by processes and activities), technologies ("tools that are used by work system participants and automated agents"), products/services (artifacts or actions produced by a work system for customers), and customers ("recipients of a work system's products/services for purposes other than performing work activities within the work system") (Alter, 2013, pp. 80-81). Table 1 is a work system snapshot of how enterprise search fits within the definition of a work system. A work system snapshot is a summary tool used to identify how key elements of the work system currently perform and forms the basis for determining how that performance could be improved (Alter, 2013, p. 83).

As the table illustrates, enterprise search fits the definition of a work system. The human resources employees (participants) produce information and make it available via enterprise search. The customer-cum-participant leverages enterprise search to get the information she needs about health insurance benefits (services).

This example illustrates only one series of transactions possible through enterprise search. The complexity of the enterprise search work system suggests multiple approaches to storing, searching for, and retrieving data may be necessary to meet the demands of these six differing elements. Of the elements discussed in the snapshot, Alter emphasizes that processes and activities, technologies, information, and participants are "viewed as completely in the work system" while customers and products/services can fall inside or outside of the work system (p. 79). We review how these four central, internal WSF elements appear in enterprise search research and products.

3. THE WORK SYSTEM ELEMENTS AND ENTERPRISE SEARCH

The WSF processes and activities, technologies, information, and participants elements have an interlinked relationship that has affected the direction of enterprise search research and product development. Processes and activities shape the work completed with enterprise search. Technologies provide the enterprise search tools used to complete processes and activities. Information is the raw material used to complete processes and activities. It influences the development of technologies. Finally, participants use the technologies to draw from information and complete processes and activities. We review developments in each of these areas to highlight problems with enterprise search and how participants, the least studied WSF element, are linked to these problems.

The Processes and Activities Element

Given the diversity of possible ESS clients, which can vary by industry field and many other traits, characterizing all processes and activities that can be accomplished with enterprise search is a challenge (Benghozi and Chamaret, 2010, p. 54). Five important processes and activities include the creation of, storage of, search for, retrieval of, and application of information. Researchers have shown particular interest in understanding and enhancing participant search for and application of information.

Benghozi and Chamaret (2010) have identified four general needs that trigger a participant to search for and apply information: answering a specific question, answering a client question, searching for a previously seen item, and searching for an item that is believed to exist when in reality it does not (pp. 38-39). Identifying these triggers is important because it focuses our understanding of why information is sought and how it will be applied. Developments in text mining and business intelligence have enhanced the search for and application of information by broadening what types of needs can be addressed by enterprise search (Intranet Focus Ltd, 2012, pp. 5, 8). The four general search needs that trigger a participant search as well as text mining and business intelligence are examples of how researchers have studied the search for and application of information. These factors are shaped by categories of participant context such as industry field, skills, and tasks, which we will discuss further in "The Participant Element" section.

The Technologies Element
The tremendous growth of information creation has created substantial market demand for tools capable of managing the storage, search, and retrieval of a variety of structured and unstructured data (PR Newswire, 2014). A substantial body of work including journal articles, conferences such as the Text REtrieval Conference (TREC) and the Enterprise Search Summit, and blogs such as Stephen E. Arnold's *Beyond_Search* (http://arnoldit.com/wordpress/) discuss the technologies element behind enterprise search from both research and commercial perspectives. The literature contains numerous articles examining ranking algorithms, relevance feedback, and query expansion, and we can see the results of this work in the enterprise search systems on the market today (White and Nikolov, 2013, pp. 19-20). Future development points to expanding on existing technology through more widespread adoption of open source software, merging search and business intelligence functions, developing search-based applications, advancing federated search, expanding people and expertise search, and incorporating mobile and cloud-based search options (Intranet Focus Ltd, 2012, pp.5-9).

The Information Element
It is difficult to separate discussion of the information element from the technologies element when discussing enterprise search since each informs developments in the other. The information element behind enterprise search is likewise well-discussed in many of the same resources as enterprise search technologies. The information element of and ESS is very complex and most participants are not trained in the nuances of information science. This can make completion of processes and activities difficult.

The literature regarding the information element covers topics such as the formidable growth of data, the inadvertent duplication of existing data that could not be found via search, differences in structured and unstructured data, multiple heterogeneous repositories, multiple sources, and metadata (including formal sources like taxonomies and informal sources like tagging). These important issues spur development in the technologies element. But since most participants are not aware of these issues and thus are not able to use knowledge of them to improve their ESS experience, this could be a driving force behind the dissatisfaction being reported.

The Participant Element
As stated previously, study of enterprise search participants is largely based on inferences made through the analysis of search engine logs, although more recent studies such as Joseph, Debowski, and Goldschmidt's (2013) study of records managers have used interviews and information retrieval demonstrations to directly assess participant information behavior; that is, their behavior relating to the active or passive pursuit or use of information sources (Wilson, 2000, p. 49). While such direct assessments are improving our understanding, there still exist gaps in our understanding of information behavior such as how participants search for information, use information systems such as enterprise search, develop information behavior through their tasks and skills, understand information organization, and choose search strategies, among other issues (Joseph, Debowski, and Goldschmidt, 2013, pp. 4, 23-24). These gaps in our knowledge of information behavior are all related to the context associated with the search (and the searcher).

Many related studies (Ghani, Djordjevic, and Cumby, 2011; Girgensohn et al., 2010; I-Chin, 2011; Kuchmann-Beauger, Brauer, and Aufaure, 2013; Lindstaedt, Kump, and Rath, 2011; Reichhold, Kerschbaumer, and Fliedl, 2011; Solskinnsbakk and Gulla, 2009; Teevan, Morris, and Bush, 2009) have explored the concept of applying context to search through means such as user profiles. All of these studies have shared the same basic strategy: inferring an ESS participant's current traits. Traits included attributes like participant industry field, skills, and tasks. These traits are typically inferred through information behaviors such as the participant's previous searches and web browsing history. By using machine learning and other technical strategies, the researchers were able to create algorithms that enhance the searchers' queries or improve search results in some other way. An example of a search enhancement is Teevan, Morris, and Bush's (2009) use of a "groupization" algorithm to apply data gathered about a group of similar participants to rank search results. Inference of participant context has delivered some results in improving search, but we still see very high rates of dissatisfaction. We suggest that looking at the participant in terms of their understanding

of how ESSs work (and not just how to use the search box) may help reduce those dissatisfaction rates by improving the way they perform their searches.

4. PARTICIPANT INFORMATION BEHAVIOR PROFILES (PIBP)

We have pointed out that three of the four main elements of Alter's WSF have, and continue to receive plenty of attention from both researchers and commercial ESS developers. We believe that the fourth, the participant element, has not received enough attention, or at least enough attention from the appropriate perspective. We propose that researchers can begin to address this gap by focusing on the unresolved questions about participant information behavior and its impact on ESS design. This requires further study of what drives the information behavior. Participants can be characterized by an incredible variety of traits, but viewing them from the perspective of their impact on the enterprise search work system allows us to narrow our focus on three key traits: industry field, skills, and tasks. Developing participant information behavior profiles (PIBP) by describing these three traits provides a foundation to organize the study and analysis of participant information behavior and begin applying study discoveries to improving participant satisfaction with enterprise search.

PIBP Definition

PIBP differ from inferred user profiles in that they serve as a tool to organize descriptions of information behavior gathered from direct survey of the participants. Additionally, the WST lens gives them the potential to impact the entire work system's technology, information and process design by providing tools such as work system snapshots to analyze the current descriptions of participant information behavior and determine where problems are and how they should be addressed. We propose that PIBP are comprised of two main components: subject domain knowledge and information domain knowledge, and that each component is made up of the three key participant traits.

Subject domain knowledge is skill in any subject except information science. This would be the knowledge needed by the participant to do their work (e.g. knowledge of vehicle dynamics for a chassis systems engineer). Information domain knowledge is skill in information science, which includes knowledge regarding the creation, storage, search, retrieval, and application of information. These are derived from Tucker's (2012) work regarding information behavior differences found in subject matter experts. Tucker used the more specific term generic search knowledge to describe information search skills (p. 45). We have broadened it to information domain knowledge in order to reflect that participants use ESS not only to search for information but also to create, store, retrieve, and apply information. While subject domain knowledge plays an important role in information behavior, we will focus our discussion on information domain knowledge because its role is much more direct.

The three key traits (industry field, skills, and tasks) are derived from David Hawking's (2004) assessment that the goal of an ESS is to "present search results in a form or order which is of *maximal utility to the searcher* (emphasis Hawking) (p. 16)." The definition of utility depends on "the nature of the organization, the identity of the searcher and the characteristics of the task to which the search results will contribute" (Hawking, 2004, p. 16). We define these traits within the context of our model in Table 2.

What experience a participant has in his industry field, skills, and tasks form the basis of his subject and information domain knowledge. Each participant has unique experience in these traits that affects his or her domain knowledge. For example, a lawyer has a different balance of domain knowledge than an information science professional. We define the relationship between these components in Figure 2. Note the emphasis on information domain knowledge over subject domain knowledge. Having defined the PIBP components, we propose that PIBP are measurable by two factors: first, the amount of similarity between participants and second, a participant's skill in the information domain relative to his or her peers.

First, there will likely be similarities between participants based on the number of traits shared in common. More similarities will likely yield more similar PIBP and vice versa. It may then be possible to create group PIBPs, which reflect generalizations made about participants with many similarities. We hypothesize it may be possible to create PIBP about groups of participants, which draws into question whether multiple approaches to enterprise search may be necessary to satisfy group needs. Measuring

similarities between group members and similarities between different groups could provide a basis for measuring participant skill in the information domain relative to his or her peers.

Second, measuring participant skill in the information domain allows comparison between participants with different subject domain knowledge. This may reveal similarities between different groups that could be used to identify similar information needs. Separating skill measurement from subject domain knowledge additionally allows an individual to be compared to a variety of different groups or subgroups. A participant, for example, could be compared to other participants who hold a Bachelor's degree or who are also Junior Developers. Skill measurement should be based on quantifiable measurements of information behaviors. An example would be requesting that a tested participant be able to retrieve a specific document in two minutes if given a citation. Identifying quantifiable measures of participants allows us to make some predictions about what we anticipate the typical PIBP will include as well as define the ideal PIBP.

Typical PIBP

We anticipate that many group PIBP will emerge. Similarities will likely be due to factors such as what organizations are used as survey sample bases. A university, for example, should reflect group types such as year of study or subject studied. We estimate that the average PIBP participant's information domain knowledge abilities will fall in the middle of the skill spectrum. It is likely that among different group PIBP, skills could vary greatly. However, we note that there are two points which participants in different group PIBP will likely have in common. One point is that groups of participants with similar industry fields, skills, and tasks will likely have similar information behavior and likely have developed it in a similar way. Exploring how these participant groups developed their information behavior through study such as surveying different levels of university students could yield valuable insights about how past experiences impact current information behavior. Another point is that the widespread popularity of information tools such as Google has likely had an impact on most participant information behavior. Customer inquiries about whether enterprise search will be "like Google" have been reported by enterprise search experts (Allen, 2012; Earley and Associates, 2012; Kehoe, as cited in Enterprise Search Summit Spring 2012, 2012; Mullen, as cited in Enterprise Search Summit Europe, 2012; Owen, 2012; Whysel, 2011). We expect that the average PIBP will be affected by these new information touchstones.

Ideal PIBP

An ideal PIBP will demonstrate that a participant has high skill in information domain knowledge. This assessment should be drawn by identifying the skill test results of an information domain expert. Their results will serve as an ideal or benchmark for comparison against both individual and group PIBP. Having identified typical and ideal PIBP results for individuals and groups, it is then possible to begin applying insight from these results to improving enterprise search.

PIBP Application

Alter notes that one important advantage WST has over other system analysis tools is that it takes into account how human behavior may deviate from what software designers account for in their analysis and design process (p. 100). Humans have varying abilities, motivations, and responses to workplace tools and events. If we want to change how they behave, we must first understand what drives their behavior. Only then will we be fully prepared to put in place the right responses to change that behavior. In some cases, we may even find their behavior corresponds to other problems that we were not aware of but require attention. In the specific case of enterprise search systems, the PIBP provide a means to evaluate participant performance against the ideal PIBP and may help identify areas of the work system snapshot that need to be addressed to ensure the successful use of the system. In other words, PIBP could be used to identify the appropriate design, behavior modification (training), or other problem solving approaches.

5. FUTURE RESEARCH

Given that current research into the information behavior of enterprise searchers is fairly sparse, many opportunities exist to contribute to collective knowledge in this area. The PIBP model needs to be further elaborated, measured, and tested. Then the application of the PIBP needs to be investigated to see if it is indeed a contributor to failed enterprise search. Different system designs will need to be evaluated to see if improvements can be made

(either in the systems themselves or in the training of the participants) that will resolve the problems. All of this research, if done through the lens of WST, will help test that theory and help in its refinement.

Survey and Analysis of Current and Future Enterprise Search Participants

PIBP are intended to serve as a tool to organize descriptions of information behavior gathered from direct survey of the participants. We have defined PIBP components using broad categories and subcategories with the intent that more may be defined as details are derived from the study of participant information behavior. We submit that direct survey methods may be the best choice to begin gathering data on participant information behavior. This data can then be analyzed and applied to specify typical and ideal PIBP. We anticipate that group PIBP will emerge from this analysis.

Survey work should focus on describing past and present participant industry field, skills, and tasks. It should ask participants to rank their current ability and desired ability with general information and subject domain knowledge. To account for the influence of non-workplace factors such as personal use of Google and similar tools, it should be careful to include questions regarding both formal and informal experiences, skills, and training.

Problem Solving Participant Dissatisfaction with Enterprise Search

Once survey results are derived, analyzed, and applied to PIBP, work on analyzing enterprise search problems and opportunities can begin. Analysis of typical versus ideal PIBP may be particularly revealing in this regard. We expect that two primary approaches will emerge: systems design and participant information behavior modifications. Some participant information behavior may be in response to unidentified problems with the design. In these cases, design changes driven by issues identified in the PIBP work may be contribute to the creation of better ESS. It is also likely that some participant information behavior is better addressed through behavior modification. Training is a traditional part of integrating information system technology into the workplace. Training that focuses on improving the PIBPs of the knowledge workers may have a greater impact on reducing ESS dissatisfaction than traditional "how to use the system" training.

The Application of Work System Theory

WST has been relatively untested outside of work that Alter and his colleagues have performed. Niederman and March (2014) argue that this is simply a consequence of Alter's theory not yet being well-known (p. 355). In their review of WST, Niederman and March determined that WSM has potential value in practice and WST should be further tested and refined (p. p. 352). Future research and application in enterprise search may provide the case studies and refinements that WST needs to advance as a theory.

6. CONCLUSIONS

Participant dissatisfaction with current enterprise search is a complicated problem that likely has a complicated solution. Much work has been done, and continues today, on improving search engine technology and their user interfaces in an effort to eliminate some of this dissatisfaction without much success. We suspect that using the WSF and focusing on the participant to gain an understanding of the knowledge participants have about how a search engine actually works may lead to improvements in ESS design and user-training. We believe that such an approach can also be applied in a more general way: that understanding what users know about how the information systems they use actually work might help us design better systems and better training regimens. This should lead to better user satisfaction and more successful use of complex systems.

Researchers in academia can work to elaborate and test the basic WST-based model proposed in this paper. The fundamental idea presented here – that truly understanding the technical background of the users (participants) can be applied to any other complex information technology currently in use and other technology specific participant profiles can be developed and tested. Practitioners, the developers and installers of ESS systems, can use the ideas presented in this paper to take a different look at both systems design and user training.

The PIBP implies that users' information behavior goes much deeper than understanding how to use the software. It implies that the users' knowledge of how the software actually works (in this case: their knowledge of the basics of information science and how a search engine works) can have a dramatic impact on

ISSN: 2167-1435
v31 n3085

user satisfaction and successful use of the systems. In other words, training the users on how the systems work (not just on how to use the system) and designing systems to work with an understanding of user information behavior may have a dramatic impact on their successful use.

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Appendix

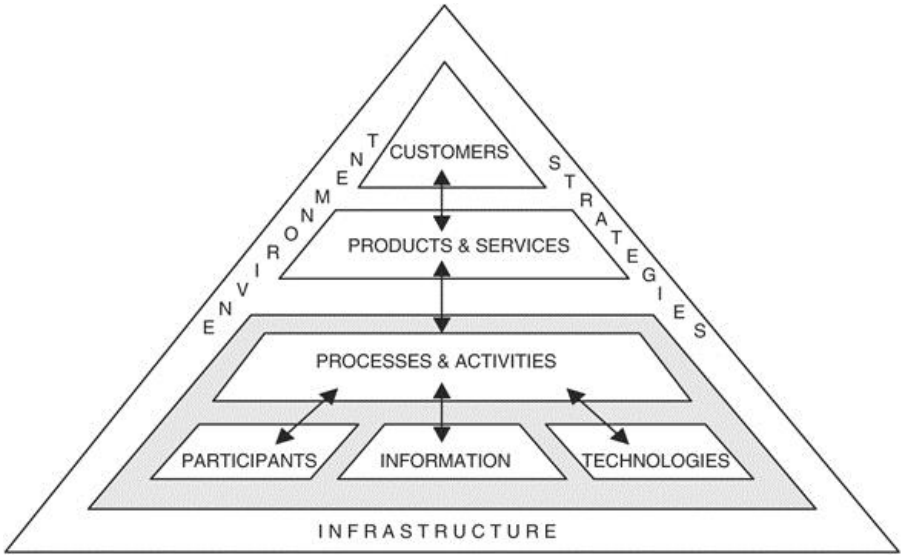

Figure 1 The Work System Framework (Alter, 2013, p. 78)

Table 1. Work System Snapshot of Enterprise Search

Customers	**Products/services**
An employee researching a personal question about their health insurance benefits.	New content about health insurance benefits. Employee decisions on using health insurance benefits.
Major activities and processes	
Human resources director receives notice of change to employee health insurance benefits. Human resources employee checks content archives to see if change is reflected in health insurance benefits yet. Human resources employee produces new content if information about change in health insurance benefits is not yet reflected. Human resources employee adds the new content to the organization's content archives. The employee who needs information about health insurance benefits searches content archives. The employee retrieves the new content about health insurance benefits.	

Participants	**Information**	**Technologies**
An employee researching a personal question about their health insurance benefits. A human resources manager tracking policy changes. A human resources employee producing health insurance content.	Human resources artifacts Other policy and regulation artifacts FAQ/Q&A repository	Enterprise Search System Databases Content Management Systems Document Management Systems Search-Enabled Applications

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Table 2. Definition of Participant Information Behavior Profile Traits	
Trait	Definition
Industry Field	1) The industry field to which a participant's organization belongs. 2) The domain in which a participant has trained. 3) The role within the participant's organization within which the participant serves.
Skill	Measurable ability in accomplishing a task or participant-selected goal.
Task	A finite, structured or unstructured goal which a participant is obligated to meet.

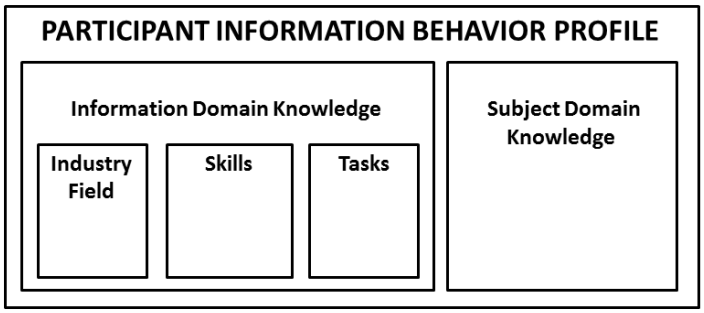

Figure 2 The Participant Information Behavior Profile