ABSTRACT
There has been a growing interest within the information sciences and HCI communities to understand the role of collaboration in facilitating information seeking. This focus had led to the emergence of the research area of collaborative information seeking (CIS). Although researchers are starting to identify various activities and mechanisms that underlie CIS, we know very little about the barriers to CIS. In this study, we used Mechanical Turk (MTurk) to gather data from 307 participants to understand the barriers to CIS in organizations. Through our data analysis, we identified a variety of barriers that hinder CIS. These barriers fell under four broad categories – organizational, technical, individual, and team. These barriers also had a strong temporal component which we highlight in the discussion. From these findings, we discuss some design implications for information retrieval systems.

Keywords
Collaborative Information Seeking, Barriers, Mechanical Turk, Temporality, Organizations, Qualitative.

INTRODUCTION
Traditionally, the research areas of information seeking and collaboration were studied separately within different disciplines - the former, under Information Sciences and Organizational Behavior, and the latter, under HCI (human-computer interaction) and CSCW (Computer-supported cooperative work) (Ellis, 1993; Galbraith, 1974; Kraut, Miller, & Siegel, 1996; Kuhlthau, 1991; Salancik & Pfeffer, 1978). However, more recently, there is a growing interest among researchers about phenomena at the nexus of collaboration and information (Erickson & Kellogg, 2000; Golovchinsky, Morris, & Pickens, 2010; Hyldegård, 2006; Reddy & Spence, 2008; Reddy & Dourish, 2002; Reddy & Jansen, 2008; Shah, 2010; Sonnenwald & Pierce, 2000). This interest is due to the widespread recognition that collaboration and information are entangled with each other. Information aids in facilitating collaboration, and collaboration is often required to find the information needed to accomplish tasks [30]. As a consequence of this recognition, researchers are now increasingly investigating the dynamics between ‘collaboration’ and ‘information behavior’. This focus, as reflected by the increasing number of workshops conducted and research studies published in leading journals and conferences (Golovchinsky et al., 2010; Hyldegård, 2006; Karunakaran & Reddy, 2012; Reddy & Spence, 2008; Reddy & Dourish, 2002) has led to the emergence of the research area of collaborative information seeking (CIS).

CIS researchers have conducted a number of field and technical studies in trying to understand what the concept really mean, and the various activities that underlie CIS (Hyldegård, 2006; Reddy & Dourish, 2002; Reddy & Jansen, 2008). Yet, there are still a number of unanswered questions (Shah, 2010). For instance, although we now know more about what triggers CIS (Reddy & Jansen, 2008), we still do not know much about what the barriers are to CIS activities. Therefore, in this study, we are interested in identifying these barriers. By understanding these barriers to CIS, we can start to design better tools and processes to facilitate CIS.

In order to examine these issues, we used a critical-incident self report of employees working in various organizations (Flanagan, 1954). Participants were pooled from the micro-task market platform, Mechanical Turk (Capra, Velasco-Martin, & Sams, 2011; Evans & Chi, 2008; Kittur, Chi, & Suh, 2008). We collected the CIS related practices of 307 participants from different organizations. We asked them how they went about looking for work-related information – the steps they took, the mediums they used, the people they talked to, and the issues they faced in the process. We used a mixture of close-ended and open-ended questions to capture their answers. Through this method, we identified a set of barriers that fell into four broad categories - organizational barriers, technological barriers, individual-level barriers, and team-level barriers. We also found that these barriers had a strong temporal component to it which impacted the ability of individuals to collaborate during information seeking activities. These findings also highlight some design implications for information retrieval (IR) systems.
The paper is organized as follows. In the next section, we provide background about collaborative information seeking. We then present our research methods – the platform we used to pool our participants, the steps we took for data collection, and the procedures we followed for data analysis. In the subsequent section, we present our findings about the CIS communication mediums and practices. We also present four categories of barriers to CIS. We then discuss the temporal aspects pertaining to these barriers, and derive design implications for IR systems. Finally, we conclude with some final thoughts about barriers to CIS.

**COLLABORATIVE INFORMATION SEEKING IN ORGANIZATIONAL WORK**

Work in modern organizations is becoming more collaborative (Karsten, 1999). With the increasing level of interdependence among actors, activities, and artifacts, the lines between individual and collaborative tasks are becoming more blurry. Furthermore, organizations are becoming more information-intensive but at the same time information is becoming more fragmented across multiple actors, artifacts, and systems (Hansen & Jarvelin, 2005). Consequently, collaborative information seeking (CIS), in practice, has become an increasingly important part of organizational work (Reddy & Dourish, 2002). However, as a research area, CIS, in general, has not been a particular focus of interest for IR researchers (for exceptions, see Golovchinsky, Adcock, Pickens, Qvarfortd, & Back, 2008; Shah, 2010).

One reason for this is that these phenomena were studied within different disciplinary silos. On the one hand, most of the research on information seeking was conducted by researchers in the information sciences and the organizational behavior disciplines (Ellis, 1993; Galbraith, 1974; Salancik & Pfeffer, 1978; Wilson, 1981). On the other hand, a significant portion of conceptual as well as technical studies on collaboration was conducted by HCI and CSCW researchers (Kraut, et al., 1996; Olson & Olson, 2000). Therefore, CIS - although very prevalent in practice - had often been overlooked in both communities. Furthermore, researchers have viewed information seeking as an intrinsically individual activity (Ellis, 1993; Kuhlthau, 1991; Wilson, 1981). For example, Wilson (1981) viewed ‘information seeking’ as “the purposive seeking for information which arises as a consequence of the recognition of some need perceived by the user” (p.4, italics added). Such a conceptualization not only has an underlying bias towards traditional interaction patterns between an ‘individual user’ and a ‘technology’, but also places an implicit assumption on viewing ‘organizational work’ as a set (or series) of individual activities (Reddy & Jansen, 2008).

All of these issues have led to the design of technologies and processes that primarily support individual information seeking (Reddy & Dourish, 2002; Twidale & Nichols, 1998).

However, researchers have now started to recognize how collaboration and information are mutually entangled with each other (Reddy & Jansen, 2008; Shah, 2010; Sonnenwald & Pierce, 2000). They have also recognized the need to move beyond traditional interaction patterns between an individual user and a technology (Erickson & Kellogg, 2000; Golovchinsky, et al., 2008; Twidale & Nichols, 1998). These changes have led to a greater focus on CIS - “an activity in which two or more individuals work together to seek needed information in order to satisfy a goal” (Reddy & Spence, 2008). CIS may involve a variety of systems, people, and channels in order to address the information need.

**Past Research on CIS**

Early CIS researchers conducted field studies to understand the context within which CIS happens. For example, Gorman et al. (2000) looked at how team members in an intensive care unit worked together to seek and share the needed information. One of the key findings from their study suggested the importance of binding different sources of information together, in order to address a specific request or question from a team member. Sonnenwald and Pierce (2000) conducted a study in a hierarchical work environment (military command & control). Their findings suggested that information seeking is a dynamic activity, which involved working together to “seek, synthesize and disseminate information” (p.462). Reddy and Dourish (2002) conducted a study in the medical domain, where they described the role ‘work rhythms’ plays during the collaborative information seeking practices of team members. Team members who understood the work rhythm of the unit could collaborate and seek information in a “just in time” fashion.

Reddy and Jansen’s (2008) empirical study of two healthcare teams have provided important initial insights about CIS. They identified seven categories of team information needs, and observed that there was a large percentage of organizational-related information sought by team members, in addition to the majority medical-related information. More importantly, they identified four triggers (information fragmentation, lack of immediately accessible information and complexity of information needs) that act as transition points from individual to collaborative information seeking.

Similarly, researchers have also developed technologies to support CIS activities. Twidale and Nichols (1998) designed one of the first interfaces to support CIS activities. They emphasized that information seeking and retrieval systems should acknowledge the presence of collaboration within various activities. They developed a system called ARIADNE which has features for saving, sharing and visualizing the seeking and search processes. Erickson and Kellogg (2000) studied BABBLE, which supports social processes during collaborative information seeking activities. They term this “social translucence”, since the tool supports awareness amongst the users during various
collaborative acts. Similarly, Morris & Horvitz (2007) developed “SearchTogether” that facilitated synchronous or asynchronous collaboration and information seeking among a group of remote users.

These initial CIS tools and prototypes were designed to enable UI-mediated collaborative information seeking. More recently, researchers have developed advanced tools, such as like Cerchiamo (Golovchinsky et al., 2008) and Cogmento (Shah, 2010) that could facilitate algorithmically-mediated collaborative information seeking and searching.

**Research Questions**

Although both the field research and technical systems have increased our understanding of CIS, there are still a number of unanswered questions. For instance, although we now know more about what triggers CIS (Reddy & Spence, 2008; Reddy & Jansen, 2008), we still do not know much about what hinders CIS (i.e. what are the barriers).

Our research team has been interested in the issues of CIS for a number of years (Karunakaran & Reddy, 2012; Reddy & Spence, 2008; Reddy & Jansen, 2008). We are currently focused on understanding what those barriers are, what their causes are, and how one could design systems and processes to overcome those barriers. Consequently, we had the following research questions for this study:

What hinders people from collaborating while looking for work-related information? [i.e. What are the barriers to CIS?]

a) What steps do people take when they are not able to fully find the information they are looking for?

b) What issues people face in the process, and why?

c) How do they overcome these issues and what could we learn from them in order to design better CIS tools?

**METHODS**

We have been investigating CIS ethnographically for a number of years, primarily within the Healthcare and the Education domains (Karunakaran & Reddy, 2012; Reddy & Jansen, 2008; Reddy & Spence, 2008; Spence, Reddy, & Hall, 2005). In this study, we wanted to “step back” from a particular organizational context, and instead, identify the perspectives of a broad range of participants from different organizational settings about how people encounter CIS barriers, the causes of those barriers, and the practices that led to those barriers.

Using a survey-based methodology would enable us to reach a large population. At the same time, we also wanted to gather some descriptive, experiential data. To achieve this balance, we used a critical-incident self report (Flanagan, 1954) - with a mixture of open-ended and close-ended questions – and putting incentives in places for elaborate descriptive answers. Although a critical-incident self report (Capra, et al., 2011; Evans & Chi, 2008) would not be able to match the in-depth experiential insights derived from ethnographic field work, we could capture descriptions concerning the practices that acted as a barrier to CIS. Through collecting, comparing and analyzing hundreds of these descriptions using the ‘constant comparative method’ (Glaser, 1965), we identified some overarching categories of barriers to CIS.

**Participant and Data Collection**

Following Capra et al. (2011) and Evan and Chi (2008), we recruited participants through Mechanical Turk (henceforth, MTurk), a crowd sourcing platform and micro-task marketplace that enables people to perform tasks at low-cost and high-speed. As Capra et al. (2011) suggest, one of the main reasons for using the MTurk was to reach a set of participants outside the traditional student populations. MTurk’s usefulness has been demonstrated in a number of research domains (Ipeirotis, 2010; Sorokin & Forsyth, 2008), including Information Sciences and HCI (Capra, et al., 2011; Evans & Chi, 2008; Kittur, et al., 2008).

Our data collection strategy was in the form of a critical-incident self report, in which participants share incidents, events, and activities of certain genres that occurred relatively recently. Critical-incident self-reports are most accurate when it comes to recounting participants’ very recent experiences (Evans & Chi, 2008; Flanagan, 1954). We asked questions about participants’ latest information seeking act. Specifically, we used the statement below to prompt participants to recollect their recent experience -

“Recall the most recent experience you had when you were NOT able to find some work-related information that you were looking for”

We formulated our subsequent questions based on the above statement. Questions were close-ended (yes/no questions, multiple choices, and rating), as well as open-ended (free-forms, comments). We asked how participants went about looking for work-related information – the steps they took, the mediums they used, the people they talked to, and the issues they faced in the process. Therefore, we had a large proportion of open-ended questions – which captured free-form responses from participants – as compared to close-ended questions. For open-ended questions, we had incentives set in place to ensure that participants share their experiences in a relatively detailed manner. This included a special bonus payment ($5) for selected detailed answers.

**Quality Control.** Following Kittur, Chi & Suh (2008) and Evans and Chi (2008), we took special steps to formulate our survey in such a manner to reduce invalid responses. We deployed several levels of ‘control’ to ensure that the responses we get are valid and reliable. First, we followed certain heuristics to screen participants. We recruited only those participants who had a) ‘acceptance rate’ of at least 95% or above (i.e. at least 95% of their past work should have been accepted and approved by requesters before. This criteria strengthens the relative quality of the responses), and b) at least 24 months of full-time organizational experience. We initially obtained the information concerning the work experience of the participants, and later, re-verified them during the course of the survey to...
ensure validity of the responses. Second, we inserted control questions and probed for highly-specific questions to reduce invalid responses. We did this through repeating two verifiable questions at different places, examining the similarity in responses, and using it as a control to eliminate incoherent and invalid responses (Kittur, Chi & Suh, 2008). Third, we used CAPTCHA at the end of the survey to eliminate ‘spammers’ and ‘bots’.

Data Analysis
We collected responses from 307 participants. We used a constant comparative method (Glaser, 1965) to analyze the data. Open-ended responses were coded and analyzed by two independent coders by adhering to the guidelines specified for constant comparative method. We iteratively performed the data coding and analysis.

We followed Charmaz (2006) approach to data coding and analysis. Charmaz’s approach to data coding unfolds through sequence of three major steps, namely initial coding, focused coding, and theoretical coding. The first step in the process is “initial coding”, where concepts are uncovered, named and developed. Responses were coded on the basis of “in vivo” codes – phrases and terms offered by the informants - in order to arrive at first-order categories. Data was analyzed line-by-line to arrive at initial codes, and categories. These links lead to clusters of second-order themes. The final step, theoretical coding, was used to strengthen or dismiss the emerging findings, and to tie it back to extant literature. These final steps lead to a collapse of second-order themes onto overarching aggregate dimensions.

A modified Q-Sort approach (Stephenson, 1964) was used to calculate inter-coder reliability. The two coders were assigned several participant quotes/phrases into pre-agreed initial codes. Brief definitions of the codes (what they meant, what they stood for) were discussed a priori. Then, the coders were asked to assign those codes to the phrases. Similar procedure was followed for subsequent focused codes and theoretical codes. The agreement level between the coders was found to be 82% - signifying a high level of agreement.

FINDINGS
Through our data analysis, we identified the mediums and practice of CIS. We identified who people generally approached when they are looking for missing pieces of information, how they go about doing it, and what challenges and hindrances they faced in the process. We also identified four categories of CIS barriers - organizational barriers, technological barriers, individual-level barriers, and team-level barriers. We discuss those findings in this section.

Communication mediums and Practices of CIS
Among the 307 participant, only 18.2% (56 participants) were able to find all the information they were looking for by themselves, and the rest 81.8% (251 participants) said that they were able to find only partial information by themselves. Among the ones who were able to find only partial information, when asked whether they interacted with anyone (either face-to-face, or, distantly) else to get to that information, 63.5% said ‘yes’ and 36.5% said ‘no’. More than half of the participants interacted with someone else when looking for work-related information.

People preferred to interact with colleagues who are in physically nearby locations, suggesting that even in days of virtual work and ubiquitous communication tools, (Allen, 1977) famous “30 meters rule” seems to still hold true in this regard.

“I asked the people sitting near me if they could help me find the information. If they could not, I got on the telephone and asked some other people in the organization whether they could help me find the information.” (participant #152)

“I think the fact our company has two locations that are not within walking distance makes it hard sometimes to track down information or to collaborate…. I feel like I would be interrupting their day if I asked them for help, I would not feel that way with the people in my office.”(participant #212)

<table>
<thead>
<tr>
<th>Answers</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colleagues within my team who were physically nearby</td>
<td>48.3%</td>
</tr>
<tr>
<td>Colleagues outside my team who were physically nearby</td>
<td>23.0%</td>
</tr>
<tr>
<td>Colleagues within my team, regardless of the location</td>
<td>33.7%</td>
</tr>
<tr>
<td>Colleagues outside my team, regardless of the location</td>
<td>21.3%</td>
</tr>
<tr>
<td>Manager</td>
<td>21.9%</td>
</tr>
<tr>
<td>Other</td>
<td>12.4%</td>
</tr>
</tbody>
</table>

Table 1. Whom did you talk with when you were looking for information?

Among participants who interacted with someone when looking for work-related information, a large number of them preferred to interact with “colleagues” (Table 1) Participants had particular preferences about who they collaborated with in their efforts to find the information. They preferred to interact with colleagues who were within their team as opposed to colleagues who were outside their team.

A significant number of participants talked about leveraging technology when they were looking for work-related information. Many of them preferred to use search engines to look up for information, while only very few of them used company portals and online forums. (Figure 1).

However, the use of search engines had its own share of problems, as reflected below,

“I realized that search engines are crowded with far too many results, many of which are arbitrary and have nothing to do with what I am looking for."
It feels as though I’m a detective so I needed to incorporate other methods of obtaining information. I asked co-workers and went to a library to try and avoid becoming reliant on the internet.” (emphasis added) (participant #23)

“After I realized that I was not able to initially find the information I was looking for online, I tried to go about my internet search in a roundabout way by typing in synonyms of my search term or by searching alternate phrases entirely. After I exhausted all branches and avenues of online searching, I surveyed my co-workers and friends in person, by text, by messenger and by phone to mine them for ready information and to jot down their ideas and advice. As a last resort, off I went to the music library on the second floor to browse for information the old-fashioned through the periodicals and articles available. By the end of the day, I had assembled a good collection of information to filter through and pick and choose the best bits from to compile and form the final information I needed.” (participant #301)

All of this reiterates the notion that CIS involves a wide variety of actors, activities, and artifacts. It may include colleagues that are co-located or distributed, and may utilize a variety of technologies. However, as we can see from the above examples, these CIS activities are not always smooth, and often are hindered by various barriers.

Categories of CIS Barriers

So, what are the barriers that hinder people from working together to find the needed information?

<table>
<thead>
<tr>
<th>Categories</th>
<th>Barriers</th>
<th>No. of Participant Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organizational Barriers</strong></td>
<td>Values and Org. Culture</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>Incentives and rewards</td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>Org. Practices</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Org. Structure</td>
<td>48</td>
</tr>
<tr>
<td><strong>Technical Barriers</strong></td>
<td>Expert-Location</td>
<td>157</td>
</tr>
<tr>
<td></td>
<td>Communication Tools</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Multiple, Un-integrated Systems</td>
<td>39</td>
</tr>
<tr>
<td><strong>Individual-Level Barriers</strong></td>
<td>Individual Personality/Person Perception</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Fear of losing face</td>
<td>86</td>
</tr>
<tr>
<td><strong>Team-Level Barriers</strong></td>
<td>Schedule Conflicts and Work Load</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td>Distance and Availability</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>Language and Communication Issues</td>
<td>32</td>
</tr>
</tbody>
</table>

Table 2. Categories of CIS Barriers

We identified four broad categories of barriers: Organizational Barriers, Technological Barriers, Individual-level barriers, and Team-level barriers (Table 2). We discuss these categories in detail below.

Organizational Barriers

Organizational barriers refer to barriers with organizational-level characteristics. These include barriers that arise due to the structure, culture, values, rewards, incentives and practices held by an organization.

For example, a number of participants stated that an organization that “values” individual expertise tend to make people behave in certain ways – in holding on tightly to the information they have, which in turn, hinders CIS.
“I think it’s the mentally of work orders here—the boss asks for a task to be done, and assigns that task to a specific person. The job/task is his or hers alone, and asking others for help just makes the worker look lazy or incapable of doing the job themselves.” (participant #62)

“We work on a SMART goals basis and if I spend time assisting someone else, I might consider the fact that I don’t “get anything” out of it myself. That is the collaborative issue that arises most frequently.” (participant #271)

In addition to the “value system”, rewards and incentives also play a crucial role. An organization with few rewards and incentives for sharing information would propagate an individual oriented behavior, which in turn, could lead to individuals holding on tightly to their information. All of these issues hinder CIS.

“Individual employees are assigned specific tasks. Their is no incentive to help coworkers as that would just create more work for the individual employee. Every minute helping another employee is a minute that one cannot dedicate to one’s own work.” (participant #8)

“Another organizational barrier that prevents people from collaborating is the lack of incentive to help people collaborate for other information. Individuals have such a large workload that they cannot spend time helping others searching for new information.” (participant #304)

Organizational structure and processes also play an important role in hindering CIS. Since information is fragmented across multiple sources, individuals must have the ability collaborate easily, in order to easily the information together from multiple places. However, hierarchy and chains of command, could pose a potential problem. As and when one “...must go through the established chain of command even if you know who can best give you the information or one of the other higher ups is incompetent.” (participant #274), CIS becomes more difficult.

“There is a hierarchy of command at my company, meaning it is taken as offensive if you do not go up the chain of command properly and often you are reprimanded if you go above your immediate supervisor, such as going to Human Resources first.” (participant #120)

If centralization and hierarchy poses a problem, decentralization poses a different kind of problem. As an organization gets increasingly decentralized, information becomes more and more fragmented, making it difficult for people to find appropriate and relevant information sources.

“The main difficulty (and strength) is that we are decentralized. Sometimes it’s necessary to ask several people to find out who to actually get the answers from.” (participant #12)

Finally, organizational policies and infrastructures can act as another barrier.

“One organizational barrier is authentication and permission rights. There are many aspects of my organization’s network that are prohibited to some departments, and allowed to others. This creates a serious barrier for information flow, mainly because any inter-department assistance would require both individuals relocating to a computer that is linked to both networks.” (participant #104)

In summary, a large number of participants believed that the barrier that most strongly affected their CIS was the organizational culture that placed a high value on “individual expertise”. Also, “reward structures” and “incentives” for sharing information were also significant barriers.

Technological Barriers
Barriers that arose due to issues with tools and technologies – a lack of a particular technology, or missing functionality within a current technology - are referred to as “technological barriers”

Participants highlighted that a lack of communication tools often acted as a barrier for CIS -

“....barriers that prevents me from collaborating with people while looking for information is communication difficulties. When there are not proper communication routes, such as pagers, phones, and so forth, to reach doctors, respiratory therapists, occupational therapists, nutritionists, and so forth it is very difficult to provide care for a patient since I need to collaborate with them to find out treatment information.” (participant #281)

Similarly, a number of participants talked about issues pertaining to having multiple systems that does the same function, but are not integrated. They said that non-integrated systems led to more fragmentation of information, which in turn, hindered CIS.

“We use multiple systems. Various groups complete the same tasks, just for a different market segment. Systems are not united, and it is not easy to compare what others in different market segments are doing for the same product you sell. It is hard, as sometimes people from various market segments will notice the disconnect and question our sustainability” (participant #179)

In addition to those technological barriers, an overarching concern of participants was the need for “expert-location” systems. Participants said that their inability to find the appropriate person who could potentially help them was the single major barrier to CIS. In some cases, participants said that even finding simple information such as “phone numbers” and “email addresses” of contact points from other business units is difficult. As one participant said, “Limited contact means between business units. No direct phone numbers or email addresses” (participant #41)
hinder their CIS to an “extraordinary extent”. And this especially becomes a pressing issue for people working large organizations.

“I work in a 10,000 person organization. The organization chart and points of contact are constantly changing... I have no clue who could help me. We have so many employees, I don't know who does what, what department works on what or who even to begin asking to get pointed in the right direction.” (participant #118)

If locating ‘preliminary contact information’ is a fundamental issue that hinders CIS, there are also other related issues. Even after locating an initial contact point, individuals need to go through several other levels and layers and networks to get to the appropriate person who could actually be of any real help in giving relevant information.

“It also takes more time to try to find someone who can help you with the information that you need, sometimes you have to go through many people to find the one who can actually give you useful information.” (participant #176)

As a result, people stop their CIS activities, and tend to “guess” and “make do” with whatever information they have in hand.

“In the organizations where I’ve worked, the barriers have really always been relating to the difficulty in finding the right people with the answers I need, as well as the fast-pace that sometimes encourages making a "best guess" on the information readily available, rather than taking a lot more time to find the perfect answer.” (participant #120)

Also, since current expert-locator systems do not have in-built mechanisms that could help people to approach those experts (for example, features to find out when they are free, when to schedule a time to meet/consult the expert), it creates other problems that hinder their CIS.

“If an expert that you need to consult with is unapproachable, it is a barrier. I have experienced people that will use excuses that they have no time to do what is in affect their job. Also, there are some who cause such an uproar if you ask for help, that you would rather struggle with the problem and seek almost any source of information but them.” (participant #14)

Individual-level Barriers
In addition to the technical and organizational barriers, there were also “individual-level” CIS barriers. By individual-level, we refer not to the personality-traits and dispositions of individuals, but to the attitudes, perceptions, and cognitive-frames held by people about themselves and others. An example of such barrier would be the “person perception” held by employee -

“Perhaps a person's perception of himself/herself could prevent people from collaborating. Some people have a natural tendency to be self-reliant, which could hinder any type of collaborative efforts. Also if the organization was structured in a way that yielded a highly competitive atmosphere, I would be less likely to collaborate because of the every-man-for-himself work mantra.” (participant #102)

Few individuals are concerned about how CIS would affect their co-workers (i.e. the person whom they are collaborating to find the needed information).

“It's not so much that my organization doesn't encourage collaborative work, but rather, I feel that the individuals who work in my office are bothered when I ask questions. Whenever someone needs help, I am the first to offer my assistance because I know how it feels when help isn't offered.” (participant #84)

All of these, in turn, influence the perceptions of individuals about “collaborating” when it comes to information-seeking.

“It was a task assigned to me (contacting Con Edison regarding our company billing), so if I was to ask somebody else to assist me in finding the information I need, it would be ask if I was asking them to do my work for me. Also, my co-workers are assigned other tasks and were busy with them.” (participant #161)

Team-level Barriers
Team-level barriers most often arises in situations when participants of a team are unable to contact or connect with each other when looking for particular information. From our analysis, we found that these team-level barriers arise due to two overarching reasons. i) blurring work boundaries; and ii) schedule/time conflicts.

People within a team often have expertise in particular aspects of the work. Therefore, work-related information does not often completely reside within a single person, but is spread across a set of people. This makes collaboration (and consequently, CIS) essential to completing day-to-day activities. However, in spite of the need for collaboration within teams, there are tensions due to the blurring boundaries between “individual work” and “team work”. That is, if a good portion of information required for completing an individual’s task resides within his/her teammates, and if both the individual and the teammate knows that this is the case, what exactly are the boundaries between “individual work” and “team work”? At what appropriate time intervals could that person approach his/her teammate? Many participants expressed their doubts in these lines - regarding the appropriate amount of times one could approach their team-mates for getting some information. In addition to that, participant reflected that workload and schedules created additional barriers.
"It is difficult when you are assigned a task to go to others who have their own workload and tasks to fulfill". (participant #281)

"Time is always a factor..... In my organization, it is extremely (sic) hard to find time to sit down and talk to others since we do not have common planning periods" (participant #193)

Even though if an organization has a collaborative-culture, issues related to time and scheduling brings forth genuine difficulties for people to perform their CIS.

"The organization in which I am employed actively encourages collaboration so the only real barrier to collaboration is when the person that I need to collaborate with is unavailable." (participant #4)

All of these, in turn, hindered people from working together in order to find the needed information.

**DISCUSSION AND IMPLICATIONS**

It is important to note that the different categories of barriers interact with and influence each other. For example, an organization that values individual expertise would tend to not only create “experts” who are reluctant to share their expertise, but also hinder the overall collaborative climate within that organization. Therefore, in spite of the presence of adequate and appropriate technology, CIS would still be hindered due to the overriding effects of organizational practices, values and incentives.

"The last thing you want to show your superiors is that you seem to have to ask someone else for help with your own projects." (participant #237)

"Sometimes when asking for information, you can appear incompetent, especially if it's something that you should know but, for whatever reason, you don't know." (participant #133)

Similarly, an organization that encourages a collaborative culture, but does not have the necessary tools, technologies and processes to facilitate that collaboration, and leverage its benefits, would also hinder CIS. Likewise, frames and perceptions held by individuals are often influenced by the organizational context - which includes the values and practices espoused by the organization. For instance, an organization that values individual expertise would have a specific effect on an individual’s perception when it comes to collaboratively looking for information, as opposed to another organization that values collaboration. As one participant puts it,

"The greatest barrier is probably the stigma of not seeming confident in one’s ability to "get the job done". (participant #12)

Clearly, the barriers to CIS are multifaceted and occur in many different ways. As we examined why these barriers occurred, we identified a strong temporal component to them.

**Temporal aspects to CIS Barriers**

Based on our analysis, we found that CIS is driven (and hindered) by two different notions of time – a calendar-based time (“chronos”) that is determined by the larger organizational routines, and a phenomenological-based time (“kairos”) that affords people to leverage opportune moments when “the time is right” (Garud, Gehman, & Kumaraswamy, 2011; Orlikowski & Yates, 2002). Such opportune moments cannot be a priori scheduled by the clock or the calendar.

However, technologies within organizations are mostly designed to facilitate CIS based on a “calendar-based time”. For example, “scheduling systems” and “shared meeting calendars” all facilitate a priori, planned collaborative information seeking and sharing activities. Nevertheless, as increasingly seen within modern workplaces, information needs arise as a part and parcel of everyday work tasks and activities. Such information needs could not be determined in advance. Therefore, we need to think of mechanisms to resolve such information needs “then and there”. Or else, such needs fade away, and people will either give up, or “make do” with whatever they have at hand.

As highlighted in the findings, people tend to go to their immediate colleagues at nearby locations to resolve their information needs. However, with the increasing advent of distributed teams and virtual work, such practices are becoming more difficult. Although instant messenger, email and other communication tools could be of some help here, they don’t really facilitate collaborative seeking and sharing of information. As one participant said,

"Sometimes questions comes up when I'm not scheduled to work that have an immediate answer, and I'm stuck, or questions come up when I am on shift that need a quick response, which I cannot get via e-mail." (participant #204)

So, one challenge for CIS researchers is to develop mechanisms that could not only support activities centered around calendar-driven time, but also support activities centered around individual-driven perceptions of time. In short, designs that facilitates people to seek the needed information in order to seize the “opportune moment”.

"Most of my colleagues were more than willing to help when available however, so it was usually a matter of timing in order to catch them at an opportune moment to be able to have our discussion. “Right now” wasn’t always possible, but “later on” was usually anywhere between the space of a few minutes or even hours... Time and place is everything in a workplace, so as long as I managed to coordinate and respect both, I found that I was always able to find and get the information I needed in the end from cooperative co-workers, employees and friends." (emphasis added) (participant #72)

One way to do this is to devise ‘awareness technologies’ into IR systems that would enable people to understand the
work status and availability of their immediate colleagues, and to visualize the temporal routines of their organization. This would let people to understand the larger work rhythms of their colleagues (as well as their organization), enabling them to proactively pre-adapt their collaboration in order to seek information in a “just in time” fashion (Reddy & Dourish, 2001), and to “catch them (colleagues) at an opportune moment”. Another way to do this is to incorporate mechanisms into current IR tools that could diffuse the information need into several different sources (such as discussion forums, organizational micro-blogs, project level forums etc.), record, index and rate the received responses, and devise incentive schemes for quicker and appropriate responses. Both these approaches clearly suggest the need to take the ‘social’ as well as the ‘technical’ aspects into consideration.

**Expertise Location in CIS**

As described earlier, a major barrier to CIS was finding the right people who could help them in finding the needed information. As one participant put it,

> “I was primarily hindered by two things: 1) a lack of time in being able to spend time tracking down others, asking my question, and awaiting their response (particularly if they weren’t available or online); 2) a lack of knowledge about who precisely to ask for the information (i.e., who would have the answer I needed).” (participant #262)

However, none of current CIS/CIR tools and prototypes has features which support “expert location” and “expert recommendation”. Among the various CIS tools and prototypes, such as ARIADNE (Twidale & Nichols, 1998), Cerchiamo(Golovchinsky et al., 2008) and Coagmento (Shah, 2010), we found that none of them had features that would help people to locate and connect with experts. Though we do realize that these tools are designed to support specific functions and audiences, it is still interesting that none of them had any features related to locating experts – an important aspect of CIS within the context of organizations.

We argue that there are two possible reasons for this. First, many tools use “web search” as the overarching metaphor to model and augment CIS/CIR activities (Golovchinsky et al., 2010; Morris & Horvitz, 2007). Though CIS/CIR within the context of ‘web search’ and ‘organizational work’ has some similarities, there are also substantial differences. There are differences in the way information is fragmented within organizations across multiple actors, artifacts and routines (Reddy & Jansen, 2008). There are differences in norms and incentive structures. There are also differences in the ways the “social context” could be understood and captured (Gorman, et al., 2000; Sonnenwald & Pierce, 2000). We question whether the “web search” metaphor is an appropriate one to model CIS and CIR activities within organizations. Second, many CIS/CIR tools were built based on user studies in controlled settings and not based on in-situ studies. As a result, these tools do not incorporate information concerning how people (or groups of people) within organizational settings work together to search for needed information.

Current research on “expert recommender” (Ackerman, Pipek, & Wulf, 2003) systems and “organizational memory” (Ackerman & McDonald, 2000) could be very helpful in addressing some of these issues. CIS and CIR tools and systems could incorporate functionalities that could recommend experts based on summation of an user’s immediate information need and the user’s network of preferences. Similarly, tying intra-organizational social networks into the system could facilitate better collaborative information seeking and retrieval. Finally, having an escalation procedure that could address questions concerning what to do when a particular expert is not available (or, does not answer), could facilitate better CIS.

**CONCLUSION**

Most underlying conceptualizations of information seeking are still viewed primarily from an individual user’s perspective, despite the evidence that collaborative information seeking plays an important role in organizational work. There has been a great deal of focus on individual information seeking. This has lead to the design of processes and technologies that support individual information seeking but not collaborative information seeking. This is acutely problematic in settings where teams and team work are important. Our current inability to effectively support CIS is an impediment to team success in critical domains such as healthcare. Therefore, we must not only identify but also begin to address the barriers to CIS to help improve people’s ability to collaborate during information seeking activities.

However, as we begin to design processes and tools to address these barriers, we must be careful about the context for which they are being developed. For instance, web search is one context for the use of CIS tools. Therefore, the techniques and approaches to overcome barriers for CIS during web search may not apply to CIS in organizational settings involving cross-boundary interactions across various actors, artifacts and technologies. Therefore, we need to develop approaches to overcome CIS barriers based on particular contexts.

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