IDRAK: A WEB-BASED APPLICATION TO SUPPORT CROSS-FIRM SOCIALIZATION IN CONSTRUCTION PROJECTS

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ABSTRACT

Construction projects are typically delivered by temporary organizations that bring together from the early design stages a group of firms, including the client, design consultants, contractors, and product suppliers. Socialization, i.e., the conversion of individual tacit into group tacit knowledge through informal processes such as conversations and meetings, across firms' boundaries matters to ensure effective delivery processes and product design quality. Physical and phone meetings unarguably facilitate cross-firm socialization when project participants not only have different occupational backgrounds, experiences, and working languages, but also work together occasionally. However, project participants have limited opportunities to meet face-to-face because they often stay geographically dispersed, and the problem-solving capabilities of conference calls are limited because they lack visual support. Here, we investigate how to facilitate cross-firm socialization by exploiting the capabilities of digital networks, such as project extranets, that increasingly connect firms over project time. Hence, we first review the principles underpinning recent tools in the field of Computer Supported Cooperative Work (CSCW). We then employ theoretical constructs from CSCW and knowledge management to examine empirical findings from an exploratory case study on how project participants socialize across firm's boundaries. The case study sheds light on project participants' preferences for cross-firm socializing through physical meetings and phone conversations. In contrast, findings suggest that available digital media are ill-suited to support cross-firm socialization, albeit the frequent use of e-mail due to the lack of better digital alternatives. These findings inform the conceptual framework underscoring IDRAK, a proof-of-concept of a web-based application to enhance cross-firm socialization over project time currently under development.

KEY WORDS

Project Management, Computer Supported Collaborative Work, Knowledge Management, Tacit Knowledge, Socialization.

INTRODUCTION

The management of knowledge has long been recognized an important source of learning and innovation for a firm (Nonaka et al. 2000). A simplistic dichotomy differentiates tacit from explicit knowledge: tacit knowledge is intuitive, experimental, and based on heuristics,

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whereas explicit knowledge is structured and coded in some formal way. The dynamic interaction between tacit and explicit knowledge is the basis of Nonaka et al.'s (2000) knowledge creation theory, which terms socialization to the process of converting individual tacit into group tacit knowledge without attempting a priori to codify, i.e. externalize, that knowledge. Socialization includes conversations, apprenticeships, and storytelling through which individuals develop 'common ground', i.e. mutual knowledge, beliefs and assumptions between two or more conversants (Clark and Schaefer 1989), and build a sense of community of practice (Brown and Duguid 1991).

To make socialization happen in project-based organizations is however not trivial since a group of firms engaged in one project rarely stays together in subsequent projects because of variability in product design, procurement practices, and project location. To enhance cross-firm socialization, innovative project clients promote interdisciplinary physical meetings (Larson 1997), informal partnering practices (Barlow 2000), and co-location (Gil et al. 2001). However, opportunities for project participants to physically attend get-together events are limited because they often end up staying geographically dispersed over project time, and these events are time-consuming and hard to timetable. On the other hand, conference calls have limited capabilities to solve engineering and construction problems because they lack a shared visual support. Further, both channels have limited capabilities to disseminate tacit knowledge to people outside the conversation loop (Erickson and Kellogg 2000).

In contrast, project participants increasingly stay digitally networked through project extranets, i.e. web-based systems linking a number of different firms for facilitating the exchange and storage of technical and commercial documents over project time (CICA 2002). Extranets offer functionalities to support project work, including ability to red line drawings, calendar facilities, auditable paper trail, and digital security. They also enable project participants to post, retrieve, and store documents, including specifications and drawings, requests for information, meeting minutes, and schedules and budgets.

This research examines the extent to which project extranets can be leveraged to facilitate digital cross-firm 'socialization' through addition of functionalities to facilitate cooperative work. Thus, we first review the theoretical underpinnings of recent digital prototypes for enhancing informal communication and impromptu conversations – the building blocks of socialization (Erickson and Kellogg 2000, Isaacs et al. 2002). We then draw from theoretical constructs in computer-supported cooperative work and knowledge management to examine the empirical findings of an exploratory case study of cross-firm socialization in a project organization supported by an extranet. Finally, we discuss how we are building upon the principles of Computer Supported Cooperative Work (CSCW) to develop a proof-of-concept of a web-based application for supporting cross-firm socialization in project organizations.

DIGITAL SOCIALIZATION

Researchers in the field of Computer Supported Cooperative Work (CSCW) have long expressed concerns that many digital collaboration systems take for granted that participants interact simply because the environment makes it technologically possible, thereby neglecting the social dimension of interaction. In particular, researchers critique the design functionalities of commercial packages to support digital work, such as e-mail, chat rooms,

bulletin boards, and discussion forums, for failing to help users to keep conversations on track, get timely replies, and know who (or whether anyone) is listening: "in the digital world we are socially blind" (Erickson and Kellogg 2000). These critiques underscore the efforts incurred by researchers to develop proof-of-concepts for new digital systems that can better mimic the following set of principles of physical socialization:

VISIBILITY

Visibility describes a major building block of social interaction. Visible or socially translucent systems enable users to draw upon their social experience and expertise to structure their interactions with one another, i.e., they make visible socially significant information (Erickson and Kellogg 2000). Recent prototypes to support digital socialization seek to provide users with visibility of other users' activities and knowledge (Erickson and Kellogg 2000, Girgensohn and Lee 2002). There is a vital tension, however, between privacy and visibility because excessive visibility can be detrimental to user participation (Erickson and Kellogg 2000).

REPUTATION

One of the conditions for online communities to succeed is the ability of individuals to identify each other as well as have information about how others have behaved in the past (Kollock 1996). Knowing the identity and history of a person, in a successful community, promotes ongoing interactions because it makes it more likely that two individuals will meet again in the future (Kollock 1996). Thus, digital reputation systems aim to hold information about individuals and their actions, and to make this information available to the members of an online community. These systems are motivated by the reluctance of users in digital environments to cooperate and interact unless they have information about how others have behaved (Kollock 1996, Connel and Mendelsohn 2001, Girgensohn and Lee 2002, Jarret and Denis 2003).

SOCIAL AWARENESS

Social awareness means understanding how others' activities provide a context to one's own activity (Dourish and Bellotti 1992). Social awareness can assess physical availability as well as emotional state and group members' knowledge (Tollmar et al. 1996). Thus, social awareness can include cues about availability (whether an individual is actively involved in any discussion or not), situation (whether an individual is set to be busy, away, or at lunch), and knowledge (whether an individual has specific knowledge or knows someone with specific knowledge). Social awareness cues can be conveyed to digital users using sound and graphics or a mixture of both (Isaacs et al. 2002, Tollmar et al. 1996). They can be 'passive' or 'active' (Tollmar et al. 1996): passive cues can be pulled by the user when he/she searches for those cues, whereas active cues automatically notify the user. Active cues may not however be controlled or changed by users, e.g., information on whether a user is logged in or not. 'Social proxies' are the digital features that implement social awareness by portraying salient aspects of social information (Erickson and Kellogg 2000).

SYNCHRONICITY AND PERSISTENCE

Synchronous media have capabilities to deliver immediate feedback like chat or video-audio links, whereas asynchronous media have capability to deliver delayed feedback like e-mail or bulletin boards (Daft and Lengel 1986). Synchronous systems facilitate the creation of 'common grounding' (Clark and Schaefer 1989) because they allow clarifying, in real-time, possible misunderstandings and misinterpretation of ideas. On the other hand, asynchronous systems provide history and represent contexts. Semi-synchronous systems appear to encourage a greater range of responses than synchronous or asynchronous mechanisms (Hollan and Stornetta 1992). In turn, persistence means that social systems exist beyond the immediate here and now so individuals can construct and develop interdependence relationships beyond the immediate interaction (Karsten 2003). Unlike synchronous systems, asynchronous and semi- synchronous systems can provide persistence.

Research on computer-supported cooperative work has examined how mutual relationships or interdependencies between individuals are constructed and established as social processes, and the role that digital media can play in this process (Connell and Mendelsohn 2001, Carotenuto et al. 1999, Merali and Davies 2001, Karsten 2003, Kreijns et al. 2003). Cross-firm cooperative work clearly matters to improve the performance of the project delivery process and the quality of product design in project organizations (e.g., Tsao et al. 2004). We next draw from theoretical constructs on computer-supported cooperative work and knowledge management to examine our findings from an exploratory case study on cross-firm socialization in a project organization.

CASE STUDY: CROSS-FIRM SOCIALIZATION IN A PROJECT ORGANIZATION

This case study investigates practices employed by different firms engaged in the delivery of a set of projects to socialize across boundaries through various media, including face-to-face, telephone, e-mail, and project extranets. We gathered data through a series of nine interviews with representatives of four participating firms, each interview lasting between one and two hours. We adopted a strict interview protocol: all interviews were semi-structured and tape recorded, and subsequently transcribed; some interviews involved multiple respondents and two interviewers. We triangulated interview data against archival documents and observations, including a detailed walk-through of the extranet supporting the project organization. The purpose of the case study was to explore and build foundational understanding on cross-firm socialization in a project organization, rather than trying to build or test theory from empirical findings (Yin 2003).

The research setting was a programme to deliver an Asset Management Plan of a major British utility company, which manages water treatment works, wastewater treatment plants, and thousands of kilometers of water mains. This programme involved capital investment on water and wastewater projects and was more than half way through when we started our data collection process. The utility company had appointed a consultant to act as overall project manager and engineering service provider. It had also signed three framework agreements (called alliances, each worth around £250M) with three joint venture companies for detail design, construction, and commissioning of the new water and wastewater capital projects up to March 2005. Each joint venture managed the subcontractors who, in turn, had to work

with around 50 novated key equipment suppliers (e.g., for valves, pumps, actuators, switchboards, and process kits). The three joint ventures were supported by three distinct but similar instantiations of the same project extranet platform (Figure 1). Our study was undertaken with some of the firms involved within one of the joint ventures.

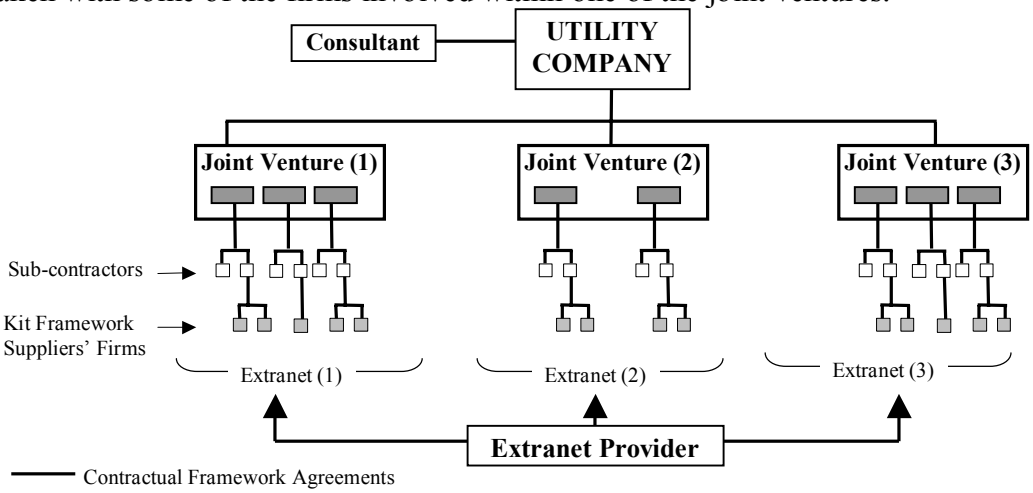

Figure 1. High-level Contractual Structure for the Capital Investment Programme

SOCIALISATION THROUGH PHYSICAL MEETINGS

Respondents generally perceived regular one-on-one or group meetings as the most frequent practice through each project participants sought to work collaboratively and exchange tacit knowledge. While the need for project participants to regularly get together was actually spelled out as a contractual requirement, project participants were free to set up the format, frequency, and location of the meetings. Project participants felt that there were several advantages in having regular meetings: First, meetings helped them to speed up decision-making. Second, physical meetings provided a rich environment (Daft and Lengel 1986) to exchange information and communicate to which they could bring drawings and audio-video presentations. Third, meetings enabled participants to be friendlier and more personal with their colleagues from other firms. A design coordinator explained the importance of the face-to-face interaction in physical design review meetings to create common grounding (Clark and Schaefer 1989): "You can never replace the face-to-face design review meetings because a lot of the times the design engineer would be sketching things on paper and asking if this would solve the problem, and you cannot include this neither in the meeting minutes nor substitute it with e-mail or project extranet."

On the downside, respondents pointed that meetings could be time consuming, difficult to arrange, and not necessarily effective. They also felt that the knowledge that would be exchanged and created in the meetings was hard to disseminate to people not attending the meetings because the documented minutes were too restrictive. A site manager for a first tier subcontractor explained this point: "Although the revised drawings and minutes that result from the meetings include a lot of information, they do not include any of the underlying knowledge and experiences needed to reach such decisions."

SOCIALISATION THROUGH TELEPHONE AND E-MAIL

In addition to face-to-face interaction, project participants also used the telephone and e-mail to support socialization. Respondents characterized the telephone as a useful channel to engage in quick and unambiguous conversations necessary to clarify technical and managerial issues as projects unfolded over time. Respondents also noted that phone conversations were useful to allow for undocumented cross-firm discussions to avoid possible contractual implications. On the other hand, respondents praised e-mail communication for its capability to attach drawings, sketches, and documents along with the body of text of the e-mail message, but noted that e-mail exchanges could be slow in relation to the synchronicity (Daft and Lengel 1986) of phone conservations. Notwithstanding some respondents' concerns that informal e-mail messages could be contractually binding, our interviews suggested that e-mail was the practitioners' preferred digital media to interact informally; as put by a design co-coordinator: "E-mail is a lot clearer to a lot of people than other IT tools because it has been used extensively throughout the past 5 years in the construction industry." A site manager further argued that the preference of practitioners to exchange information over e-mail could hamper the use of newer technologies such as the extranet supporting the project organization: "As long as e-mail is there as an escape route, we will keep on using it."

Project participants were cognizant, however, that excessive communication through e-mail could be detrimental to cooperative work because e-mail messages could be ambiguous to the receiver and give room to misinterpretation and confusion. Hence, one respondent noted that e-mail was primarily useful for confirming and clarifying on-going issues, but less so for explaining and exchanging new ideas. This point was described by a site manager: "When you put something in writing, that doesn't mean that people will understand the content. If I am writing an e-mail I tend to describe things in my own way. If I send this e-mail to someone s/he might fail to understand what I am trying to say. This is why I tend to talk to people on the phone to explain better what I need to say."

In addition, one respondent noted that e-mail also failed to provide awareness cues (Dourish and Bellotti 1992) about the availability of the receiver to engage into a conversation: "I use phone because it has a more immediate response, unless you send an e-mail knowing that the person on the other side is definitely going to see it. Sometimes I send someone an e-mail and then pick up the phone and tell him I have just sent you this e-mail about this thing." As are result, this respondent actually clarified that often when she wanted to talk to a colleague 20 meters down in the same office, she would send her an e-mail to book an appointment for a more face-to-face conversation.

SOCIALISATION THROUGH THE PROJECT EXTRANET

The programme administrators decided to adopt a commercial extranet approximately one year after the start of the programme,[3] and the extranet started to run one year later. The functional features of the extranet would help the design consultant and the joint ventures to

[3] 'Lotus Notes', a well established platform within the consultant's organization, was initially discussed as the digital platform to implement across the project organization, but this possibility was ruled out later due to consultant's concerns about possible security breaches into its system.

formalize the processes for exchanging documentation, such as drawings, specifications, submittals, and requests for information. Administrators also reckoned that the extranet would help project teams to hold timely design reviews and turn around documents faster.

In addition, the extranet provided three features for supporting informal cooperative work: 'Team Mail', 'Project Forums' and 'Telephone Directory'. 'Team Mail' enabled the project participants to communicate via e-mail messaging within the extranet environment, and this digital correspondence would be automatically archived in one repository for future reference. 'Project Forums' worked as a virtual meeting-place where users could communicate with other users and engage in open discussions. Finally, the 'Telephone Directory' aimed to maintain a database of all users within an alliance. User data was displayed in a table that listed the names, telephone numbers, and e-mail addresses of project participants. If an extranet user clicked on an individual's name, it would display a record of the information held about that individual, and the address details of the employer.

When the extranet was first introduced, project participants started to informally use its main functionalities for exchanging documents in a non-structured way that suited their problem-solving and collaboration needs. This informal use of the extranet across the boundaries of firms bounded by contractual agreements raised concerns with the programme administrators. Programme administrators also felt that the unstructured use of the extranet was creating an information overload problem and could lead to a breakdown of communication between project participants in each alliance. As a result, administrators started advising against the use of the project extranet for informal information exchanges, instead suggesting project participants to use traditional communication channels for that purpose. Further, administrators encouraged the use of face-to-face, telephone and corporate e-mail systems to support more informal information exchanges related to the 'Post–Comment–Review–Post' cycle in design development.

An operating protocol was subsequently institutionalized that restricted further the cross-firm usage pattern of the extranet for information exchange purposes according to the following rules (Figure 2): First, the consultant should assign a number of Project Engineers (PE) to act as gatekeepers of all communication getting in and out of the extranet with the joint ventures. Second, each joint venture should assign a number of Design Coordinators (DC) and Lead Engineers (LE) to act as gatekeepers of all communication getting in and out of the extranet respectively with the joint ventures and with subcontractors. As one Design Coordinator described: "The contract limits everyone's communication […] until contracts are built in a way that enforces the use of the extranet in a different method, you will always find that the use of the system will be restricted to a cycle of passing, commenting, and reviewing of information."

While the protocol did not apply to the two digital socialization systems built into the extranet (the 'Team Mail' and 'Project Forums'), respondents noted that these functionalities were hardly used over time. Three factors were suggested to contribute to this phenomenon: First, a design engineer working for a sub-contractor noted that she felt uncomfortable about the extent that other firms could monitor her usage of the extranet and check the content of her messages: "It is too visible as he [the consultant] can see everything on the extranet and that is not necessarily what we want […] I think it should be used with things that are already decided but not with the process of getting somewhere." These concerns for lack of privacy

manifest the importance of carefully balancing visibility and privacy features in computer-based cooperative work (Erickson and Kellogg 2000).

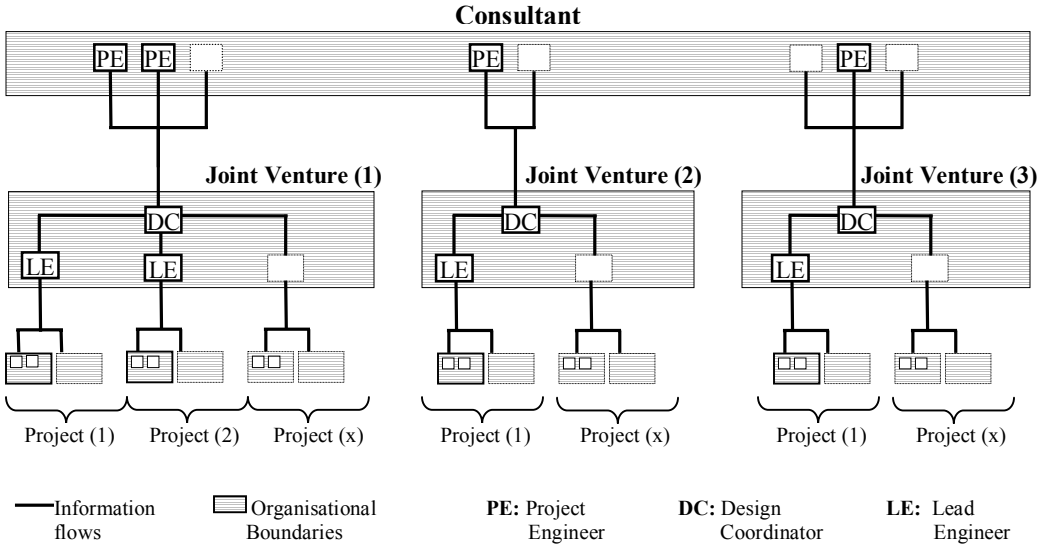

Figure 2. Cross-firm Communication over the Extranet after the Protocol

Second, two respondents suggested that people were reluctant to embrace new digital media to socialize; as one Project Engineer explained: "if it is worth being put there [on the Project Forum] then it is worth being said in a meeting or personally to somebody or recorded in some other manner […] If we have nothing else but [project extranet] then we would probably use it extensively, but [project extranet] came to us in a later date than our existing tools." This perception was corroborated by another respondent that observed: "I think this [low use of the project forum] is just because people become comfortable and familiar with a specific way of doing things. The culture is not there yet." Finally, respondents unanimously noted that they were also inevitably deterred from digital socialization by the administrators' concerns about potential liabilities incurred by the automatic documentation of informal communication.

FINAL OBSERVATIONS

Our findings suggest that project participants enthusiastically engaged into informal exchange of information over the extranet for problem-solving until administrators instructed them against those practices mainly because of the possible professional liabilities stemming from documented informal exchanges. Further, this popular but informal, early use of the extranet happened despite the rudimentary functionalities that the extranet provided to support digital socialization vis-à-vis recent prototypes of computer-support cooperative work (e.g., Erickson and Kellogg 2000, Girgensohn and Lee 2002, Tollmar et al. 1996, Isaacs et al. 2002, Jarret and Denis 2003). Without downplaying the concerns of administrators, the work we present next assumes a contractual environment which favors, or at least does not deter, digital socialization. In effect, project participants have long recurred to e-mail exchange to support problem-solving because of its convenience and ease of use,

albeit the limitations of e-mail systems and professional liabilities. Further, the benefits of digital socialization for speeding up work are so widely recognized in environments to develop software projects that researchers continuously investigate best ways to automatically document digital conversations and broaden their accessibility (Zaychik and Regli 2003).

We also belief that the frequent use of digital media to resolve work-related problems is inevitably bound to increase, first, as-digital savvy young blood enters into the industry, and second, as commercial competition forces engineering design practices to outsource parts of the work to other countries where qualified labor remains cheaper. Given the problem-solving capabilities of socialization, as well as the difficulties and costs associated with physical socialization when project teams are geographically dispersed, research should focus on developing platforms to support better cross-firm digital socialization in project organizations. We introduce next a proof-of-concept of an original web-based system to support cross-firm digital socialization in a project organization, underpinned on a cross-fertilization of theory in computer-supporter collaborative work and knowledge management with our empirical findings.

IDRAK: THE PROOF-OF-CONCEPT

We termed IDRAK, an acronym for Internet Dialogue and Repository for Acquired Knowledge, 4 to our instantiation into a proof-of-concept of the conceptual framework depicted in Figure 3. The words 'Dialogue' and 'Repository' reflect respectively its synchronous and asynchronous socialization features. This semi-synchronous approach ensures that IDRAK will maximize on the benefits of both synchronous and asynchronous approaches as well as encourage a greater range of responses (Hollan and Stornetta 1992). 'Acquired Knowledge' expresses the ability of project organizations to reuse acquired tacit knowledge from one project into another.

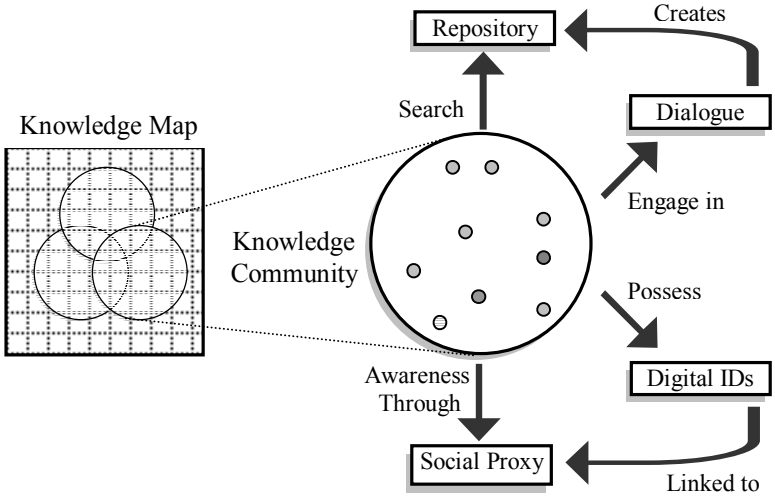

Figure 3. IDRAK Design Framework

[4] IDRAK also means "Knowing" in Arabic language

IDRAK's conceptual framework pieces together the following capabilities: 1) **Knowledge Map**: It links a set of knowledge 'communities', each aggregating groups of users with shared practices and similar interests (Girgensohn and Lee 2002). Digital communities facilitate 'interaction' by raising users' awareness to others' competences (Erickson and Kellogg 2000); 2) **Digital IDs**.: It enhances the visibility of users' digital presence. Each user holds a persistent digital identity and profile. Digital IDs help users to recognize other registered users and build a reputation on the digital space (Kollock 1996, Connel and Mendelsohn 2001, Girgensohn and Lee 2002, Jarret and Denis 2003); 3) **Social Proxy**: It aims to provide users with graphical cues that convey social awareness. This enhances user awareness and recognition for other users' knowledge, situation, availability, and activity (Issacs et al. 2002). Our approach to the social proxy conveys cues both 'passively' and 'actively' (Tollmar et al. 1996); 4) **Dialogue**: It allows users to engage in synchronous communications to facilitate the creation of common grounding (Hollan and Stornetta 1992); and 5) **Repository:** It codes and collates dialogues into a searchable repository of contextualised conversations to facilitate tacit knowledge dissemination (Erickson and Kellogg 2000). IDRAK and its validation strategy are described in-depth in El-Tayeh and Gil (2006).

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