An Ontology for Contextual Information System Design

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ABSTRACT

Collaborative teamwork is becoming more common in several domains including healthcare and disaster management. While collaborative teamwork can benefit from information system (IS) support, designing IS models to support collaboration is a significant challenge owing to the variations in tasks and people that must be supported, and the different contexts within which collaboration takes place. Collaborative teamwork can vary greatly because of context, which is the integration of diverse, dynamic, and heterogeneous needs for groups to achieve a specific goal. However in the literature there has been limited emphasis on how contextual underpinnings can be incorporated into IS design. This paper uses a case study of the design of a user-driven prototype disaster management IS. We used the think aloud method to capture participant thoughts while interacting with the IS prototype. The think aloud data was analyzed and used to develop an ontology of contextual considerations to support IS design.

Keywords

Context, information system design, think aloud, collaboration, community engagement

INTRODUCTION

Collaborative teamwork is common in a number of domains, including healthcare, manufacturing and disaster management (Reddy and Spence, 2008; Ansell, Boin and Keller, 2010). However, our ability to design information systems (ISs) to support collaboration is limited by our inability to incorporate context into systems design. To date researchers have made good progress at designing IS models such as interface or database models but less progress has been made in specifying the contextual fit of these models. Contextual fit refers to the specific situation where an IS is used. An IS to support collaboration that is designed with disregard for contextual fit leads very often to unintended interactions for the end-users such as workflow or communication issues (Ash, Berg and Coiera, 2004). Research on collaborative IS design needs to focus on the interactions between people, processes and data to account for the *context* of a system's use (Coiera, 2003). While we cannot design ISs for every context, we can identify how context can provide an important contribution to shape systems design for better fit between the end-user needs and the resulting IS. While the importance of context mediated design is well described there are few studies that have actually developed approaches for doing it.

ISs to support disaster management should be designed around the needs and contexts of the community where they will be used (Kuziemsky, O`Sullivan, and Corneil, 2012). Contextual fit is particularly important when the community members have functional or other limitations that will impact IS design. To date much of the effort in IS design for collaboration has focused on hardware and software design (Ranauk and Osterweill, 2013) or specific tasks such as information exchange or decision-making. Little research exists on identifying and designing ISs to support different contexts of community based teamwork. While existing models of collaboration provide the *structure* for systems design we need to unpack and ensure contextual considerations are in the forefront so systems will support collaborative teams in different circumstances. IS modeling approaches such as the i* social modeling approach suggest we need to go beyond traditional systems engineering activities and focus on understanding how IS will advance the collaborative relationships that different system users have (Yu, Giorgini, Maiden, and Mylopoulos, 2011). Context is what determines the scope of the specific 'rules of engagement' for how an IS needs to be designed to support collaborative teamwork (Martínez-Carreras, and Muñoz, Botía, 2013).

To date there is little research that has identified the rules of engagement for contextual IS design for a community based IS to support disaster management. In this paper we use a variation of the think aloud protocol as a way of understanding contextual needs to support IS design for disaster management. We analyze think aloud data to develop an ontology of contextual considerations and discuss how they can enhance IS design to support contextual fit.

DATA SOURCES

The EnRiCH Community Intervention (O'Sullivan et al., 2013) was implemented in four communities in Canada between January 2012 and March 2013. Participants from diverse sectors of the community (e.g. emergency management and community associations that provide support for people with functional limitations) were recruited to participate in two focus groups, a collaborative asset-mapping task, and 4 interviews. The intervention was structured around 3 phases which included 1) an orientation to the EnRiCH Functional Capabilities Framework (Kuziemsky, O'Sullivan and Corneil, 2012) and lesson on how to use Google Docs as a collaborative tool called the EHRIT; 2) an 8-10 week online collaborative asset-mapping task; and 3) testing the asset database in a table top exercise. The format of each session was discussion and hands-on learning, where the participants were provided laptops to work together on the various functions of google docs while inputting information about various community assets into the online spreadsheet. The think aloud methodology was used to capture participant experiences of taking part in each of the face-to-face consultations (Kushniruk and Patel, 2004). Data recorders were placed at each table to collect the think aloud thoughts and conversations among the participants as they learned about the tool and then actively used it online. For this ontology, we used think aloud data from communities in two different Canadian Provinces.

DATA ANALYSIS

The think aloud recordings were transcribed verbatim and checked for accuracy. The first two authors (CK & AH) used qualitative content analysis to analyze the transcripts and develop an initial ontology of IS contexts that included broad categories such as interfaces, information access and protocols. The other authors then reviewed the ontology and provided feedback for revising it. Once the categories were refined we also analyzed for differences across the two communities. The final version of the ontology was developed based on consensus of all authors.

RESULTS

After analyzing our data we developed an ontology of contexts for collaborative IS design (Fig.1). We identified three key contexts that emerged as hierarchical concepts for the ontology in consultations with the EnRiCH groups in these two communities. They are the technical contexts, individual contexts and collaborative contexts. Sub-concepts emerged from each of the three main concepts.

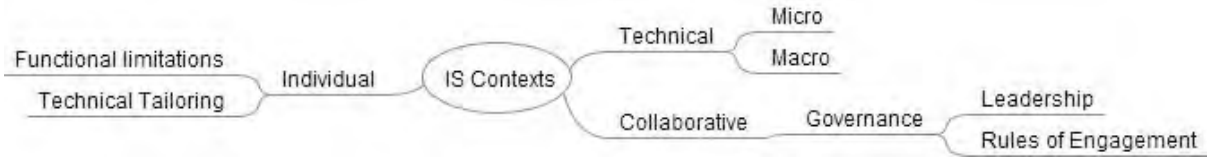

Figure 1. Ontology of Contexts for IS Design

Technical Contexts

Two categories of technical contexts were identified: micro and macro. Micro contexts refer to how individual users interact with an IS. Macro contexts refer to technical interactions at the organizational or system level. At the micro level it is essential to understand each user's technical capabilities prior to using an IS. In analyzing our data we discovered that there are two different, yet very important micro technical contexts. The first context is general technical skills, which refer to basic knowledge such as how to use a computer, create an e-mail account, and open and close a document. The two communities had different asset profiles and subsequently different types of technical skills as part of their profiles. In Community A, the participants had extensive experience with different types of technology and therefore acquired skills which supported use of more IS applications. In Community B, the asset profile varied considerably and included strong social networks, and a culture of face-to-face communication in this small community. The different profiles impacted how the training session was done. In Community A we moved directly to using the IS for the purpose of the task at hand (asset mapping). In Community B we focused on ensuring each participant could access the tool and understood the use of the tool for asset mapping, bridging the gap between participants who did not have as much experience with IS and those who were regular users of IS, prior to introducing the asset mapping exercise.

The second technical context is task related skills, which refer to technical skills specific to the task at hand. For our training sessions these skills included entering data into a spreadsheet, posting comments on a blog, and linking or uploading various documents including text, video or audio documents. The distinction between general technical and task specific skills is very important. During the training sessions the think aloud process highlighted an important lesson about transfer of technical skills. As expressed in the following quotation by a participant, while many people are familiar with the use of Facebook, it represents a different skillset than spreadsheet creation or data entry.

> *"But, no, it's this spreadsheet that's bothering me, because all I do is email and look at Facebook. I don't even have a computer."*

Macro level technical contexts are at the system or organizational level. A common issue which emerged from the data in both communities was the question of what happens in the event of a power loss, loss of cellular network, and loss of satellite, when the IS may not be accessible. In fact data from think aloud revealed that the participants were concerned that all of the collaborative effort put into designing a system may not be useful (and could actually become a vulnerability if a system) if it is not available when it is needed during a disaster.

> *"So it's a real strength when you've got power and the satellites are working and things, but once they're down, then our reliance on that kind of communication becomes a vulnerability. "*

Given that during events such as disasters, it is very possible that macro level systems may become non-functional, it is important that designers can provide solutions for the online content to be available offline. Solutions such as pre-caching can be done to ensure that information can still remain available in the event of loss of power and connection.

Another macro technical issue is the ability to access the system across different settings. In the data, it became evident that some organizations, especially government organizations, may have firewalls that prevent people from accessing the system. Some participants had to devise very innovative technological solutions to get around firewall or security issues. In the excerpt below a participant describes how someone linked two separate systems to get around corporate firewalls.

> *"…but do you know what he did? The tablet is his but because it's tethered to a corporate blackberry it doesn't violate the firewall. Like, I can't tie my iPhone, cause it's not corporate, into my computer and synch, right? Because it's a foreign entity inside the corporation."*

Individual Contexts

While our overarching goal was the design of a collaborative tool which could be used to support asset-mapping, we needed to build collaboration from all the individual contexts in each community. Some of our community participants had functional limitations that impacted their ability to use the tool. Many of the IS applications that are typically used can assist people with various functional limitations in accessing the technology, but these features may not be known. Visual limitations are a common issue,

particularly in an aging population. PDF is a common format for documents and indeed many of the documents that people wanted to post to the shared Google Docs site were in PDF format. People with visual limitations may find it difficult to read online despite increasing the font or highlighting text. Adobe Acrobat© reader has a feature that will read a document to you. In one session we adapted the training to demonstrate how this feature could be used to support access for some of the participants, because the group was largely unaware of this feature.

> *Yeah. I'll show you one feature really quickly—How many people know that you can actually get Adobe Acrobat—Like for a PDF document, you can actually get it read to you? On the standard downloaded Adobe formats?*
>
> *Oh really?*
>
> *You don't have to pay for it or anything like that. So open up the document ...go to View, where it says Read Out Loud*.

Another individual context is the ability to tailor an IS to suit individual tastes. However because everyone was using the same tool, people assumed that everyone has to have the same interface, alert frequency etc.

> *"You said we can tailor and configure it as much as you want. So if all of us in this room decide to change it to our own likes and dislikes, sort of thing, is that going to take away the last person that did it?"*

During the training session we identified functionalities that can be tailored such as alert frequencies when new documents were uploaded, when someone responded to a discussion post, or interface features such as font size or color. We also emphasized that those functionalities can be changed without impacting other users.

Collaborative Contexts

The context where collaboration takes place defines the collaborative governance that emerges for a particular setting. Aspects of this governance include the establishment of online leadership, which may be different from offline leadership. There also needs to be a discussion on rules around making information available to large amounts of participants as discussed in the following quotation.

> *"And that's a really important piece in this – Is that it's—You know, it's—We're in the—Say for this—For example, in the Stroke Club, well, we may not want to put all the names of the people in the Stroke Club up there. On the other hand, we might want to put two or three names of contact people. Okay?"*

Another part of collaborative governance is the 'rules of engagement' for how collaboration works. Collaborative protocols exist in offline communities too but the asynchronous nature of IS mediated communities puts greater importance on collaborative protocols to ensure respect and common ground around online postings and discussions.

> *"So I mean, it happens in non-technological settings, too, and . . . The more you collaborate, the more people you collaborate with, it puts a greater emphasis on development of common protocols and umm . . . shared understandings and things like that so that sort of puts the . . . the emphasis on—or the importance on developing those and knowing that when [Another participant's name] puts something up that . . . you know, there's a certain level of respect"*

Integrating Individual and Collaborative Contexts

Maslow's hierarchy of needs states that feeling accepted is a fundamental need but so is the need for individual tolerance and privacy. While our individual and collaborative contexts are separate we also realized that a key aspect of collaborative IS design is balancing individual and group contexts. For the most part, participants liked the idea of developing and engaging in an online community, but there was also concern about excessive information sharing and individual autonomy.

DISCUSSION

While the importance of context in IS design has been described before, there is little research that has identified specific types of context and how they can inform IS design. Further there is little research on contextual IS design in community settings where members may have functional or other limitations that impact IS usage.

Our ontology identified different types of contexts that exist and specific examples of each context. Our analysis also identified how the contexts differed across the two communities. The contexts we identified can assist IS design by reduce ambiguity between IS designers and the IS users. One significant context was the level of general technical skills. Systems design and training typically focuses on skills related to the task being automated by the IS. However the technical context highlighted the need to ensure that users have an appropriate level of general technical skills prior to initiating a collaborative task.

While the think aloud process was valuable for gleaning contextual insight on IS design, the collection and management of think aloud data was a time consuming process. However by identifying specific categories of contexts we have provided the means for other studies to use the contexts to support the design and evaluation of ISs to support collaborative activities.

CONCLUSION

Context is a very important consideration in IS design, particularly for activities that integrate individual and group needs. In this paper we used a community based IS design session and the think aloud approach to develop an ontology of IS contexts. The ontology has three hierarchical concepts (technical, individual, and collaborative) as well as sub-concepts that provide specifics about each concept. The ontology provides insight on how to incorporate context into the design and evaluation of ISs.

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