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Research paper

Communication Tools for Geographically Distributed Work

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Abstract

In the current globalized business environment, companies face increasing collaboration challenges at different levels of operation. Economic factors, as well as advancements in technology, have led to the globalization of design and production, which are organized into distributed projects. Information management and communication system issues are highlighted in collaboration within global companies with different branch offices and between organizations in business networks. In this paper, we tackle these communication and collaboration challenges by studying how different communication technologies can support geographically distributed work. We address this question by identifying from the literature the key categories of collaboration challenges and by conducting an empirical, multiple-case study of three companies from 2009 to 2011. The companies consisted of a small consulting company, a medium-sized software company, and a company-driven large R&D project. In this paper, we present our findings concerning the suitability of different communication tools in various working contexts.

Key words: *collaboration, communication tools, geographically distributed work,*

1. INTRODUCTION

The increasing globalization of markets, business, and production has led to growing pressure to geographically distribute work in business, production, and other related development projects. As such, research is evolving towards larger globally distributed projects, and international online courses are becoming more and more common in education organizations. This development has led to the reality that most knowledge workers will face the need to participate in distributed virtual teams.

Distributed work among virtual teams provides an effective structural mechanism for handling increased travel, time, coordination, and costs associated with bringing together geographically, temporally, and functionally dispersed members in order to work on a common task. However, geographically distributed teams still face challenges that may be absent from traditional, co-located teams. In many cases, participants do not meet prior to starting the collaborative work, they may have different levels of experience, and even their motivating factors can conflict with common goals. All these factors make it increasingly difficult to coordinate across teams, manage evolution, and monitor progress [1, 2]. New technology provides advanced tools for distributed work, but we need to learn and gain experience with them in order to utilize the new tools efficiently.

There exists a broad array of technologies for supplementing or replacing traditional face-to-face interaction. Commonly used technologies for supporting the functioning of virtual teams include telephones, videoconferencing, e-mail, web sites, instant messaging, file and application sharing, electronic bulletin boards, group decision support systems, wikis, and real-time calendar/scheduling systems. The extent to which a team uses these technologies affects the extent of its “virtualness” [3, 4].

In this paper, we present a study on the use of communication technologies for supporting geographically distributed work. We address this problem by identifying the key categories of collaboration challenges based on a literature review and by conducting an empirical, multiple-case study of three companies. Results of this paper are based on company interviews carried out from May to December 2009 as well as a multiple-case study of three company cases carried out from 2009 to 2011.The interviews are reported on more extensively in [5]. In each of the cases, different technological solutions were used for addressing geographic dispersion. These included teleconferencing, videoconferencing, and a web conferencing tool.

The paper is structured in the following way. Chapter 2 gives an overview of the theories that guide communication-tool selection, and chapter 3 presents the research setting and methods used. In chapter 4,

the results obtained from the analysis are summarized, and section 5 concludes the paper with a discussion about the research and implications for future research areas.

2. BACKGROUND

In the global context, collaboration challenges tend to produce higher operating costs for companies due to language and cultural barriers and other issues. The transfer of knowledge over time and distance requires considerably more effort compared to development done under one roof, where tacit and explicit knowledge is exchanged on a regular basis.

In this chapter, we discuss, based on the literature review, collaboration challenges and some potential collaboration solutions. Afterwards, we briefly present media choice theories that are commonly used in a company environment when new communication tools are purchased.

2.1 Collaboration challenges

To classify the findings of our literature review, this paper uses the categories presented by Carmel [6]: loss of communication richness, coordination breakdown, geographical dispersion, loss of teamness, and cultural differences.

Loss of communication richness

Collaboration is always based on communication. It is the most fundamental aspect of successful collaboration. In distributed knowledge work, shared meanings and understanding are built on communication. It is "a mutual knowledge of all team members on what they are doing, why, and how they are doing it" [7]. As expressed by Nonaka [8], it is created through "continuous dialogue between tacit and explicit knowledge."

Rich methods of communication, such as face-to-face contact, are needed for learning to communicate and building trust between parties. However, this takes time and resources. In a distributed environment, it is not always possible, so other means of communication may be necessary. This usually causes a loss of communication richness, which hinders communication. This is because a distributed communication environment usually limits the sharing of artifacts—such as flip charts, whiteboards, and tack boards—that are typically used either to show work in progress or as reference material [9]. Distribution also hinders informal or unplanned communication; instead, all this has to be managed and supported through groupware tools or the like [10].

Loss of communication richness also implies the necessity to concentrate on the quality of documentation. Poor and inadequate documentation is likely to cause inefficiency in collaborative development [1]. It has been noted that an asynchronous exchange of information via shared documentation increases the need for synchronous communication by means of face-to-face meetings or videoconferencing [11].

Coordination breakdown

Collaboration sets high requirements for planning distributed work. Often in planning collaborative projects, not enough attention is paid to ensuring coordination between teams and setting up procedures for working with partners [12, 13, 14]. The need to have specific practices and processes for collaboration is often underestimated, even though conflicting practices and processes between different teams are likely causes of problems. Difficulties identifying distant colleagues and solving problems without knowledge of whom to contact across sites have been reported [14], as have a number of software integration problems. These issues are all due to large numbers of independent teams in globally distributed development projects [15].

Geographical dispersion

Geographic distribution is an additional source of challenges. Such challenges result, for example, from a lack of overlapping working hours due to time zone differences [12]. Geographic distribution also causes challenges for requirements development [14, 15]. For example, a major problem for a remote stakeholder is a difficulty understanding requirements [12]. Dividing work across different development sites can also be difficult due to a lack of available resources, of a high level of expertise, and of infrastructure. [1]. There can be also significant differences in governance between distributed team members, which makes the management of inter-site work dependencies as well as the coordination and controlling of distributed work more difficult [15].

Loss of teamness

A loss of informal communication between parties has a negative impact on many issues, such as knowledge management and trust [15, 16]. The role of trust is significant in collaboration and contracting because it is not possible to make contracts that cover all aspects of a job. Thus, a lack of communication and trust may lead to unclear agreements; for example, expectations regarding end results may diverge. This will complicate the effectiveness of collaboration [17]. As well, conflicting processes and practices tend to diminish teamness [15].

Cultural differences

Cultural differences are a well-known source of potential collaboration problems. If distribution crosses cultural boundaries, even simply across different organizations, the implications for development, project, and quality management as well as legal issues and knowledge transfer may be amplified. Language, time, and infrastructure issues can make the process even more challenging [12, 18]. This is especially true in the case of current high-tech, multi-site, and over-the-technology-border type of R&D projects.

2.2 Potential collaboration solutions

Based on our literature review, various solutions have been presented for addressing the collaboration

challenges identified in the previous section. Those solutions are summarized here.

Management practices

Management practices are recognized as having a key role in solving collaboration problems. Properly planned development strategies and visible goals should be defined [19], as well as work distribution between the teams involved [20]. Synchronization of the main milestones with clear entry and exit criteria is needed as well [16]. In addition, decision-making practices and project-level coordination should be used as structural supports [21]. Commitments should also exist in written and controllable form [20].

It has also been recommended that work be separated across sites so that teams can work as independently as possible [18] and so that each is fully accountable for its own results [20]. The project should be led by one responsible person [20]. The importance of relationship management should be understood [22], and several relationship-building practices are suggested in order to support it, such as face-to-face meetings, organizational charts for recognizing persons, and a common kick-off meeting [21, 23]. Informing and monitoring should be followed up in all directions [23]. Good information and monitoring methods include practices such as weekly meetings and progress reports. Also, key risk factors should be identified and monitored continuously, and a mitigation approach should be prepared [15, 20].

Support practices

The literature also identifies several good practices for supporting distributed work. Configuration management with the transmission of critical data and multisite production must be well planned and executed in order to succeed in collaborative work [16]. A common software-configuration management tool with multi-site replication and a centralized bug repository is suggested [15]. Synchronizing the main milestones as well as iteration cycles of similar length is suggested with frequent builds. Collaborating companies being able to use their own development processes allows a project to start faster while also making it easier for several companies to collaborate [15, 21, 23]. Therefore, if collaborating companies have good enough processes of their own, switching to a single process is not needed. However, the decision regarding a single or separate development processes should be made at the beginning of collaboration. An interactive process model that is based on accepted best practices and that allows the development process to be tailored to the specific needs of a project or team is suggested [20].

Sufficient communication equipment with adequate support is obviously required [20]. Heterogeneous tools should be integrated for system development and concrete activities (e.g., programming, unit testing, conducting workshops), and not only for abstract concerns (e.g., analysis) [24].

The need for fast data and information exchange between sites sets the requirements for a proper network infrastructure. There is also need for common rules, procedures, and practices for problem solving.. Building trust can be aided by developing strategies for internal communication and contact maintenance with all participants [19]. Furthermore, establishing peer-to-peer links is suggested, for example by establishing people who act as communication links or liaisons between companies at all organizational levels, e.g., subcontracting managers, project managers, and developers [23].

Cultural awareness should also be created, paying attention to all the cultures represented in the development teams, including organizational cultures. This can be done, for example, by circulating management personnel across sites and cultures ("cultural liaison") or by setting up mixed teams of different cultures in order to create an awareness of cultural diversity. This will also encourage ideas for coping with diversity and for instilling team spirit [20].

Finally, it should be noted that competence and experience in general are likely to improve the chances of successful collaboration [15].

2.3 Media choice theories

Media choice theories explain why certain tools should be used for certain tasks or activities [25]. There are three theories usually connected with the subject of communication tools / media choice: social presence theory (SPT), media richness theory (MRT, also known as information richness theory (IRT)), and media synchronicity theory (MST). These theories are summarized below.

Social presence theory was introduced in 1976 by Short et al. [26]. It suggests that the social effects of a medium are based on its ability to provide an awareness of the presence of the interaction partners. The more effectively the communication tool is able to provide an awareness of presence, the more that people are able to feel socially present in the communication situation. Media with low social presence (e.g., memos) are good for providing information, while media with high social presence (e.g., face-to-face communication) are better for negotiations.

Daft and Lengel [27] propose another theory, known as media richness theory (originally called information richness theory). It is based on social presence theory and the presumption that increased media richness is linked to increased social presence [28]. This has become one of the most widely applied theories of media use. According to this theory, a medium is considered richer that provides more communication channels and feedback, that contains a more targeted message, and whose language conveys shared meanings and is easily understood by all communicating parties. Face-to-face communication represents the richest medium. Media richness theory suggests that different professional tasks are completed more efficiently when task properties and media richness match. Tasks with high equivocality and uncertainty should be channeled through richer media. Tasks with unequivocality and high certainty can be channeled better through a leaner medium [25, 27].

Dennis and Valacich [28] have analyzed the capabilities of different media and have criticized Daft and Lengel's media richness theory for three reasons:

- No media could have the highest values in all dimensions, so none could be labeled "the richest."
- No media is monolithic. It is possible for a single medium to possess different levels of communication capability depending how it is configured and used.
- Ranking media in absolute terms is not practical.

Based on these criticisms, Dennis and Valacich [28] introduced media synchronicity theory, which suggests that effective media use requires a match between media capabilities and the fundamental communication processes needed to perform a given task. The theory focuses on two main communication processes: the exchange of information (conveyance) and the development of shared meaning (convergence). According to this theory, multiple communication media should be used when performing a task that involves both exchanging information and developing shared meaning for the information [28].

Common to these theories is the task technology fit (TTF) framework, which proposes that matching ICT characteristics with task characteristics is more likely to lead to the effective use of communication tools [29,30,31]. It should be noted that new media (e.g., instant messaging) may have difficulty fitting these classifications. This may result in a need for these theories to be revised [32].

3. RESEARCH SETTING AND METHODS

Our research was conducted in two phases. The first phase consisted of interviews within companies, which was carried out to understand collaboration and communication challenges from the point of view of companies. The second phase consisted of a multiple-case study in which solutions were proposed and implemented by the companies to solve the identified challenges.

There were thirteen companies interviewed in the first research phase, of which ten were small- and medium-size enterprises (SMEs) and three were larger, international organizations. The company interviews were conducted from May to December 2009. They resulted in 30 different interviews, which were transcribed. The purpose of the interviews was to gain an initial understanding of these companies' situations and to identify their current needs, experiences, and difficulties in using communication and collaboration tools. The interviews focused on communication tools and their use. The results of the interviews are reported more extensively in [5]. In this paper, we present only the results that are connected to the following company cases.

The multiple-case study, in the second research phase, consisted of three company cases and was carried out from 2009 to 2011. The three companies involved were a small consulting company, a medium-sized software company, and a large company-driven research and development (R&D) project with several partner organizations. The goal of studying the company cases was to determine how different communication technologies can support geographically distributed work. Each of the cases used different technological solutions for addressing geographic dispersion. These technological solutions were teleconferencing, videoconferencing, and web conferencing tools.

In these three cases, the empirical data was collected primarily by observing meetings in the companies. The researcher observed the companies' internal meetings. The researcher also observed the customer meetings of the small consulting company and the medium-sized software company as well as the project management group meetings of the R&D project. The small consulting company used a web conferencing tool during the meetings, the medium-sized software company used videoconferencing, and the R&D project used teleconferencing. Interviews were also conducted to supplement the observations in order to gain a deeper understanding of each company's needs as well as collaboration and communication contexts.

4. RESEARCH RESULTS AND FINDINGS

Firstly, we present some of the findings of the initial company interviews [5] and then we present the results of the company cases. The results of the interviews provided background information and a starting point for the company cases. At first, the company cases are presented as individual cases, and then the experiments regarding communication-tool use are combined with them.

4.1 Company interviews

Use of virtual meeting tools is growing due to high travelling costs and ecological reasons. Companies have also become more aware of their lost productivity as a result of travelling time. However, there was consensus between almost all the interviewees concerning the importance of face-to-face meetings, especially at the beginning of projects. If organizing such meetings was not possible for these organizations, the importance of a communication tool using video became a necessity during the first distributed-project meetings. It was expressed that it is also possible to gain teamness and trust even without face-to-face meetings but that took much more time. Once these people got to known each other, they did not need any more rich media to support their social interactions.

We found that when using conference tools, the most important feature for the users was the quality of the voice, which, together with document sharing, was enough for most interviewees. The most popular communication solution for meetings was online conference tools. Eighty-five percent of interviewed companies used these tools. Videoconferences were not as commonly used as online conference tools; 54 percent of the interviewed companies used videoconferences. The reason for this seems to be that videoconference equipment is considered difficult to

use and more expensive. All the interviewees used the telephone, which is so familiar that it was not recognized as a special communication tool (i.e., on par with videoconferencing). The use of teleconferencing has lost much of its significance, but it still has an important role for situations in which participants are in an environment that is technologically limited or if they travel frequently.

In the company interviews, we found that the main problem in companies was the poor skill level of workers regarding their ability to use communication tools. Small companies could not hire support personnel, and application training was only organized in bigger companies. Personnel did not recognize the value of such training. Choosing the right communication tools for external communication was another issue. Using many different communication tools led to situations in which none of the tools were used properly. Especially, there were problems with open-source programs. Open-source program manufacturers or distributors did not usually have sufficient support services or help desk services.

Interviewees noted that two types of situations needed as much rich media as possible. The first situation was selling a product or service to a client and the other was one in which conflicts needed to be resolved or consensus was needed among divergent opinions.

4.2 **Company cases**

As noted earlier, to address geographic dispersion, different technological solutions were used in each case. The technological solutions used were teleconferencing, videoconferencing, and web-conferencing tools.

According to observations and interviews, teleconferencing's main positive features for the users were the following:

- It was cheap
- It was easy to use
- Participants could enter into the meeting from almost anywhere
- Good task technology fit in routine tasks.

The most common difficulties of using teleconferencing were the following:

- It needed another system (e.g., e-mail) to distribute meeting material
- It was difficult to work with shared material
- The low social presence made it difficult to build trust between participants.

Videoconferencing tools offer more media richness for users than do teleconferencing tools, leading to some attractive features:

- Good picture and voice clarity
- It shows participants' expressions and gestures
- A high social presence helps participants from different cultural background to understand each other's meanings.

During the observations, some reasons why videoconference meetings are not used more were found:

- The initial costs, compared to other tools
- The usability of the equipment
- It, too, needs another system (e.g., e-mail) to distribute meeting material
- It was limited in its ability to work with distributed documents and other artifacts.

The web-conference tool-use situations revealed the following features of this tool to be most important for users:

- It has the richest media (video, voice, chat, and document sharing)
- Good support for collaboration
- It is a scalable solution.

It was found that web-conference tools also have weaknesses:

- Users had a lot of difficulty with their computers' voice settings
- Firewalls and firewall port policies can be problematic
- All their features need a fast broadband connection

Based on our research results, we can argue that all of these communication tools were adequate for the purposes for which they were meant to be used. However, many times, they were used in the wrong situations. The users did not often recognize that these communication tools should be selected carefully based on each meeting's requirements.

Teleconferencing is most appropriate when participants know each other well and when the meeting deals with routine issues (e.g., weekly meetings). The effective use of teleconferencing requires that meeting rules be clear and that there be strict addressing practices. A chairman's role is important in such meetings because addressing requests is not as easy as it is when using other communication tools.

Videoconferencing's advantage is its large, clear video image. This allows it to be used for situations in which gestures are important. Videoconferencing is best used in difficult communication situations, such as for communication between different cultures or in conflict situations.

The strength of web-conferencing tools lies in its versatility. Its ideal use is for situations in which voice or video are connected to share documents. Situations like this include distance education, collaborative planning, and documentation inspection.

5. CONCLUSION

In conducting the company interviews, we found that these companies' main problems were workers' lack of skill in using communication tools as well as a lack of supporting personnel and application training. Company observations also suggested that some communication features and usage possibilities were not utilized

because of the users' limited skill levels. Limited knowledge about using the communication tools was one of the reasons why the users tended to use one tool for many different situations, even if the tool did not work properly in such situations.

Small companies could not hire support personnel and application training was only organized in bigger companies. Personnel did not also recognize the value of this training. One possible solution for this problem is to connect training to the internal use of the tool to overcome the fear and resistance, as was done in the web-conference company case. The first sign that the internal implementation process was going to succeed was the growing number of staff meetings via web-conferencing tool after the first training meetings. These meetings were one part of the actions that Roy [33] described as the first pre-requisite for developing a use culture within an organization, where managers and employees are truly motivated and committed to use ICT communication tools.

Understanding the basics of the task technology fit (TTF) framework proposed by the media choice theories could help users succeed in their tasks. TTF proposes that matching ICT characteristics with task characteristics leads to a better likelihood of using communication tools effectively [29, 30, 31]. For that purpose, a greater amount of extensive research as well as further development of practical models for supporting media choices in the context of distributed knowledge work are needed.

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Komunikacioni alati za geografski raspodeljen rad

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Rezime

U trenutnom globalizovanom poslovnom okruženju, kompanije se susreću sa sve većim izazovima saradnje na različiti nivoima poslovanja. Ekonomski faktori, kao i napredak u tehnologiji, doveli su do globalizacije projektovanja i proizvodnje, koje su organizovane u raspodeljenim projektima. Informacioni menadžment i komunikacioni sistemi se naglašavaju u saradnji između globalnih kompanija sa različitim predstavništvima i među organizacijama u poslovnoj mreži. U ovom radu, rešavamo problem ovih komunikacionih i saradničkih izazova tako što proučavamo kako različite komunikacione tehnologije mogu da podrže geografski raspodeljen rad. Problemu pristupamo tako što smo na osnovu literature identifikovali ključne kategorije izazova saradnje i izveli smo empirijsku višestruku studiju slučaja u tri kompanije u periodu između 2009. i 2011. godine. Kompanije su se satojale od male konsultantske kompanije, kompanije srednje veličine za softvere i velikog istraživačko-razvojnog projekta u okviru kompanije. U ovom radu predstavljamo naše rezultate vezane za prikladnost različitih komunikacionih alata u različitim radnim kontekstima.

Ključne reči: *saradnja, komunikacioni alati, geografski raspodeljen rad*