Cultural Influences on Temporal Separation and Coordination in Globally Distributed Software Development

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CULTURAL INFLUENCES ON TEMPORAL SEPARATION AND COORDINATION IN GLOBALLY DISTRIBUTED SOFTWARE DEVELOPMENT

Influences culturelles sur la distance temporelle et la coordination dans une situation de développement de logiciels mondialement distribué

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Abstract

Globally distributed software development is facing challenges brought by geographic distance, temporal separation, and cultural diversity. Yet research regarding the impact of temporal separation and cultural differences is limited. This paper draws on an interpretive case study to examine the influence of culture on temporal separation and coordination of globally distributed software development. Our findings reveal that temporal separation is a culturally bounded concept. Cultural differences in time perception, hierarchical structure, relationship orientation, and social obligation at the societal level are found to be relevant to temporal separation. We identify multiple ways that link culture differences to the temporal separation: language issues, time estimation and commitment, adherence to a schedule, availability/unavailability for synchronous interaction, and the mediating effect of organizational culture. A research framework is developed based on theoretical considerations and then refined based on empirical findings. This paper concludes with a set of implications for both practice and theory.

Keywords: Cross-cultural issues/cultural differences, coordination theory, interpretive methods, software project management, virtual teams/geographically dispersed teams

Résumé

Cet article examine l'influence de la culture sur la distance temporelle et la coordination dans une situation de développement de logiciels mondialement distribué. Cette influence se manifeste de multiples façons : langue, estimation du temps et engagement, respect des agendas, disponibilité / indisponibilité pour communiquer en mode synchrone, et l'effet médiateur de la culture organisationnelle.

Introduction

More and more software development projects are conducted in a distributed fashion across multiple locations using global virtual teams (Carmel and Agarwal 2001; Dibbern et al. 2004; Herbsleb and Moitra 2001; Sahay et al. 2003). Global virtual team members in different locations are not only geographically dispersed; most often they are temporally separated and culturally diverse as well. There are many potential benefits of arranging software development projects in such a distributed mode. It may speed up the projects because team members in different locations can continue the work "around the clock". It could also take advantage of the diverse human capital that is available at different locations.

However, without proper plans, organization and management, these potential benefits can turn into major challenges that cause failures in globally distributed software development projects. Three of the major challenges are geographic distance, temporal separation, and cultural diversity (Carmel 1999; Carmel and Agarwal 2001; Herbsleb and Moitra 2001; Maznevski and Chudoba 2000; O'Leary and Cummings 2007; Sarker and Sahay 2004). Because of the geographic distance, face-to-face interaction among globally distributed team members is limited. Team members primarily rely on a variety of information and communication technologies (ICTs) to exchange information and coordinate activities. The lack of informal communication channels makes it difficult for ad hoc sharing of information, seeking and providing instant support, and establishing and maintaining mutual awareness among dispersed team members. The study by Cramton and Webber (2005) demonstrates a negative relationship between geographic dispersion and perceived team performance with respect to complex and interdependent tasks of software development.

Due to time zone differences, there may be limited or no overlap of working hours across different locations, which restricts the opportunities for synchronous communication, and leads to increasing waiting time for obtaining responses (Qureshi et al. 2006). Sometimes the development work at one location is delayed when it needs some critical information from the other site but cannot get it. In addition, the members of global virtual teams have diverse cultural backgrounds, which can result in differences in values, perceptions, and work behaviors. Carmel (1999), Herbsleb and Moitra (2001) pointed out that while cultural diversity can be seen as an enriching factor by bringing together divergent bodies of knowledge, it could also lead to serious misunderstandings and conflicts.

Since the work of globally distributed software development projects can be configured in many different ways, the effects of these challenges are complex (Dubé and Paré 2004; Espinosa et al. 2003; O'Leary and Cummings 2007; Watson-Manheim et al. 2002). In the published literature on global virtual teams and global software development, there is extensive research acknowledging the relevance and impacts of geographic distance, temporal separation, and cultural diversity on globally distributed projects. But many of these studies focus on analyzing the challenges of geographic distance. Several scholars and practitioners have pointed out the importance of understanding the impacts of temporal separations and cultural differences, and agued that additional research is needed to focus on examining the combined effects of these two factors (Carmel 2006; Egan et al. 2006; Espinosa and Carmel 2003; Krishna et al., 2004; Sarker and Sahay 2004; Saunders et al. 2004).

The purpose of our paper is, hence, to examine the influence of culture on temporal separation, and the impact on the temporal coordination of globally distributed software development projects. Drawing on an interpretive case study of a multinational information technology company, we find that time zone difference is only part of temporal separation, and the differences in time-based behaviors resulting from cultural differences also contribute to the temporal separation. In our study, the cultural influences on temporal separation are manifested in different ways: *language issues*, *time estimation and commitment*, *adherence to a schedule*, *availability/unavailability for synchronous interaction*, and *the mediating effect of organizational culture*. Some of these influences add difficulties to the temporal coordination of globally distributed software development, resulting in schedule conflict and delay. But at the same time, some of these influences can facilitate temporal coordination.

This paper is organized as follows. In the next section, we review the relevant literature and provide an introduction to some theoretical concepts about time, cultural diversity and coordination. Then we introduce the research questions and describe our research method. The paper proceeds by presenting and discussing the research findings, articulating the implications, and concludes by highlighting contributions of the research.

Literature Review

Temporal Separation in Globally Distributed Software Development

Time is a pervasive and complex concept (Orlikowski and Yates 2002; Sarker and Sahay 2004; Saunders et al. 2004). Scholars in organizational studies argue that members' communication and everyday work practices are structured temporally and guided by shared temporal norms and expectations (Bluedorn and Denhardt 1988; Im et al. 2005; Orlikowski and Yates 2002). While each project of global software development is framed by the objective time in the form of schedules, deadlines, and routine meetings, etc., the processes of the projects are situated in a matrix of objective time and subjective time (i.e. multiplicity of temporal perceptions and different work patterns) (Espinosa and Carmel 2003; Sarker and Sahay 2004; Saunders et al. 2004).

One component of temporal separation is the time zone difference. Depending on where the project is distributed, the time zone difference between two development sites can be one hour (e.g. between New York and Rio, Brazil), twelve hours (e.g. between New York and Shanghai, China), or even further. Espinosa et al. (2007a) conducted a laboratory experiment to quantitatively measure how different conditions of time zone difference affect the team performance (quality in terms of accuracy in the execution of tasks and speed of production). Their results reveal four major findings. First, a small amount of time difference has no major effect on quality. Second, quality decreases as the time difference increases. Third, speed decreases, at first, along with increasing time difference when the time difference is small. Finally, the speed eventually increases when further increasing the time difference, resulting in a "U" shape effect of time difference on speed (Espinosa et al. 2007a).

However, temporal separations are more than just time zone differences (Espinosa and Carmel 2003; Sarker and Sahay 2004). Saunders et al. (2004) argued that time is a culturally bounded concept and different ethnic and national orientations have different perceptions of time (Bluedorn et al. 1992; Brislin and Kim 2003; Hall and Hall 1990, 2003). As global software development projects are distributed across different nations, cultural differences in temporal perceptions also add to temporal separations (Egan et al. 2006; Saunders et al. 2004).

Cultural Diversity in Globally Distributed Software Development

Cultural diversity is inherent in globally distributed software development, given that global virtual team members have diverse national, organizational, and professional cultural backgrounds (Huang and Trauth 2006, 2007; Prikladnicki et al. 2003; Walsham 2002). Studies have shown that cultural diversity may be beneficial for promoting creativity and innovation, which are important for knowledge intensive work of software development (Miroshnik 2002; Trauth et al. 2006). However, at the same time, cultural diversity can become a barrier to communication, coordination, and knowledge sharing and transference, thus adding difficulties to the management of globally distributed software development (Barrett and Oborn 2007; Carmel 1999; Herbsleb and Moitra 2001)

Scholars in information systems research suggest that it is important to view culture as a multi-level construct, in that culture at various levels (national, organizational, professional, etc.) can influence the values and practices of people (Gallivan and Srite, 2005; Huang and Trauth 2006; Karahanna et al. 2005; Leidner and Kayworth 2006; Straub et al. 2002). Culture can be defined as shared values and beliefs that are historically situated and emergent, and are constantly interpreted and negotiated in social relations and interactions by a group of people within a particular socio-cultural context (Brannen et al. 2004; Goodall 2002; Huang and Trauth 2006). The relative influences of culture from different levels on globally distributed software development are dynamic and may vary depending on the specific context of the problem under investigation (Karahanna et al. 2005; Straub et al. 2002).

The Effects of Culture on Temporal Separation

Research on relationships between culture and time usually focuses on analyzing the patterns and differences of time perceptions in the society, at the national level (Brislin and Kim 2003; Hall and Hall 2003). Accordingly, individuals' time versions are usually shaped by the society they grow up and live in, but at the same time they will be "refined by the organization in which they work" (Saunders et al. 2004, p. 22).

According to international business literature, there are two major kinds of time perceptions, *monochronic* time and *polychronic* time (Bluedorn et al. 1992; Hall and Hall 1990, 2003). People who adopt *monochronic* time prefer

doing one thing at a time, taking time commitment seriously, and adhering to preset schedules (Hall and Hall 2003). People with *polychromic* time orientation tend to do many things at a given time, view time commitment only as an objective to achieve when possible, and make changes to plans easily when needed (Hall and Hall 2003). Brislin and Kim (2003) pointed out that even though different cultures fall into these two categories with varying degrees, variations exist because of professional, organizational, or even individual differences within the same culture.

Acknowledging time as a complex and multi-dimensional concept, Saunders et al. (2004) elicited four typical types of time versions, namely *clock*, *event*, *timeless*, and *harmonic* time, and discussed their characteristics along eight dimensions associated with time. The *clock* time version, which is dominant in American business environments, views time as a monochronic and definite entity that can be divided into different units and designated to given tasks. Based on the clock time version, time is a resource that can be allocated to increase work efficiency and productivity. The *event* time version, which is held by the Japanese culture, depicts time as a cyclical and recurrent entity that is event-driven and unfolds one event at a time. In this time version, procedures are important and long-term orientation is usually taken in planning. The *timeless* time version, which is usually adopted by Hinduism in India, views time as a polychronic and continuous phenomenon that has no clear boundary or ending. Multiple activities can occur at the same time. The *harmonic* time version, which is taken by the Confucian philosophy in China, views time as something intersubjective that takes into account others' perceptions and always seeks a harmony between people. Under this version, time, whether it is yours, mine, or others', is valuable and should be respected accordingly. Punctuality is considered to be an important and basic part of social manners. According to Saunders et al. (2004), when global virtual team members hold different time versions, they may have different views about timelines, deadlines, work rhythms, or punctuality, which may impose challenges to the temporal coordination of globally distributed information systems development.

The effect of culture on temporal separation is also manifested in the availability of global virtual team members during the projects (Ocker et al. 2007). Different countries have different holiday schedules. For example, in the U.S., holidays are usually one day or two days in length. In China, important traditional holidays such as the Spring Festival, can last for a week. India is a very diverse and multicultural country. Both national holidays and many religious holidays are observed in India, many of which are not very well known to people from other nations. Even how weekends are observed also varies among countries. While many countries take Saturday and Sunday as the weekend, the weekend in Israel is on Friday and Saturday (Espinosa and Carmel 2003). In their case study of distributed software development across England and India, Nicholson and Sahay (2004) found that a 9 to 5 routine and a separation of work life from personal life are encouraged in England, while in India, the boundaries are unclear. Therefore, it is very important to take these variations into account when planning activities and scheduling meetings in globally distributed software development projects.

The Impacts of Temporal Separation on Temporal Coordination

Studies have shown that temporal separation have significant impacts on globally distributed software development projects, especially on temporal coordination (Cummings et al. 2007; Espinosa and Carmel 2003; Espinosa and Pickering 2006; Massey et al. 2003; Maznevski and Chudoba 2000). Malone and Crowston (1994) defined coordination as the management of dependencies between activities. The process of software development, especially large scale systems development, is usually characterized as highly ambiguous, uncertain, and interdependent (Curtis et al. 1988; Herbsleb and Grinter 1999; Kraut and Streeter 1995; Mathiassen and Stage 1990). Therefore, effective communication and coordination are critical to the success of software development projects, especially when they are globally distributed (Carmel 1999; Herbsleb 2007; Herbsleb and Mockus 2003).

Espinosa et al. (2007b) identified three major types of coordination needs in distributed software development, technical coordination, temporal coordination, and software process coordination. Temporal coordination refers to the mechanisms to schedule software development tasks, synchronize activities, and allocate resources in order to optimally utilize distributed resources and adhere to scheduled timelines (Espinosa et al. 2007b; Massey et al. 2003; McGrath 1990, 1991). Herbsleb (2007) pointed out that the absence or disruption of many mechanisms (such as formal and informal communication) used to coordinate the work in co-located settings is the fundamental problem of globally distributed software development (Sangwan et al. 2007). With respect to temporal coordination mechanisms, temporal separation restrains the likelihood of synchronous communication, immediate information exchange, on-demand support, and real-time problem solving (Cumming et al. 2007). Temporal separation may cause problems in the workflow of globally distributed projects, lead to longer issue resolution time, and thus cause coordination delay (Espinosa and Carmel 2003). The study by Komi-Sirviö and Tihinen (2005) shows that in some

cases, temporal separation also reduces the team members' willingness to have meetings and exchange information, which leads to redundant work or no work at all due to lack of awareness and false assumptions.

There are some tactics that global virtual teams can follow to minimize the effects of time separation and facilitate coordination. For example, Ocker et al. (1996) proposed to sequence or structure problem-solving activities. Herbsleb and Grinter (1999) suggested using modular design to assign work to different sites, in order to reduce the task dependencies and ease cross-site coordination needs (Carmel and Agarwal 2001). Another tactic is to flexibly arrange the working hours to create or expand the overlap window to facilitate synchronous communication (Espinosa and Carmel 2003). Similarly the distributed team members can rearrange their daily workflow, allocate the non-overlapping time to independent tasks and set aside the overlapping time for dependent tasks (Espinosa and Carmel 2003).

Summary of Literature Review

Based on the existing literature on cultural diversity, cultural differences in time perception, and temporal coordination, we constructed an initial research framework to guide the research. The research framework is shown in Figure 1. It shows that temporal separation in the workplace is comprised of both time zone differences and the time-based behaviors of global virtual team members (Espinosa and Carmel 2003; Sarker and Sahay 2004; Saunders et al. 2004). The behavioral differences of team members regarding time may arise from the differences in time perception influenced by their cultural backgrounds at the societal level, such as *clock*, *event*, *timeless*, and *harmonic* time (Saunders et al. 2004). Temporal separation has impacts on temporal coordination with respect to how project deliverables are scheduled and whether the deadlines can be met as scheduled (Espinosa et al. 2007b).
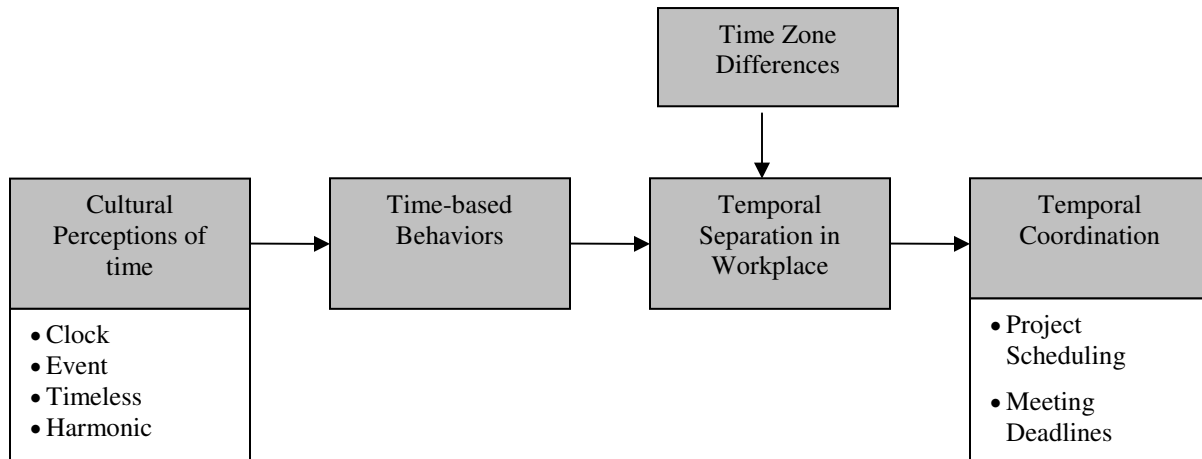
Figure 1: Initial Research Framework

Research Questions

Globally distributed software development is different from other forms of global work such as manufacturing in that the software development process is highly interdependent, uncertain, and iterative in nature (Curtis et al 1988; Mathiassen and Stage 1990; Sahay et al. 2003). These characteristics of software development processes entail great demands and challenges for communication and coordination, even more so when the projects are distributed globally with geographic distance, time zone differences, and cultural diversity. The review of relevant literature has shown that globally distributed software development is facing a number of challenges arising from temporal separation, such as how to mange the task dependencies given time-zone differences and different working schedules, and how to facilitate communication by increasing the overlap working hours and utilizing various communication technologies. The literature review also indicates that temporal separation is a multi-faceted construct, consisting of not only time zone differences, but also different perceptions of time and different patterns of time management that result from cultural differences. Therefore, it is important to take into account of the

combined effects of culture and temporal separation on globally distributed software development projects, which is not well established in the published literature (Egan et al. 2006; Espinosa and Carmel 2003; Sarker and Sahay 2004; Saunders et al. 2004). In an effort to shed light on cultural influences on temporal separation and coordination, we seek to address the following questions in this paper:

> *(1). What are the influences of culture on temporal separation?*

> *(2). How do these influences affect the temporal coordination of globally distributed software development?*

Research Methodology

Research Approach

In order to address these research questions, we draw on data from an interpretive case study at a multinational information technology company, SerTech[1]. This case study focuses on examining how cultural issues affect globally distributed software development with respect to communication and coordination. Interpretative epistemology assumes that knowledge of reality is socially constructed by human actors (Walsham 1995, 2006). In order to understand the subtleties of cultural influences on globally distributed software development, it is important to draw on the subjective experiences and understandings of the participants, i.e. the global virtual team members who are engaged in the work. Therefore, an interpretative epistemology was employed in this research to develop a better understanding of the context of globally distributed software development, particularly with respect to cultural diversity and temporal separation (Klein and Myers 1999, Walsham 1995, 2006). A case study approach was chosen because we sought to anchor the investigation in a real setting, drawing on multiple data resources (Yin, 2002).

Case Description

The case company, SerTech, is a Fortune 500 multinational information technology company that is headquartered in the United Stats. The business focus of SerTech ranges from hardware and software, to global IT services. SerTech operates in more than 100 countries. An important part of SerTech's global strategy is to develop and utilize different offshore delivery centers world wide, including India and China. This strategy has contributed tremendously to the growth of SerTech's global business through reducing costs, utilizing diverse global talent and increasing business flexibility. To date, the non-U.S. operations of SerTech contribute to more than 50% of its business revenue. Therefore, SerTech was an appropriate case for study in this research because of its active global IT business activities.

Data Collection

Interview data and observation data were collected by the first author during visits to three sites of the company. The first site visit was carried out in May 2006, at the company's site in India, where 14 face-to-face interviews and one phone interview were conducted. The second site visit was carried out in June 2006, at the company's site in China, where 10 face-to-face interviews were conducted. The third site visit was carried out in March 2007, at the company's site in the U.S., where seven face-to-face interviews and six phone interviews were conducted. In total, 38 interviews were conducted (Table 1).

The interviews (both face-to-face and phone) were semi-structured and typically lasted 45 to 60 minutes. An interview protocol (attached as Appendix A) was applied to ensure the specific research interests were brought into focus, and to allow some flexibility for exploring and probing themes emerging from the interviews at the same time. A criterion sampling strategy was followed to recruit interviewees who had been working on globally distributed software development projects, and with diverse roles such as developer, team lead, project manager, and director (Patton 2002). All the interviews were recorded and transcribed.

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[1] All the names used in the paper are aliases to protect the confidentiality of the participating company and interviewees.

Three sources of observational data were collected in this research. The first source was the participant observation during the interviews. The second source was the participant observation of the work activities and settings. During the site visits, the first author had the opportunity to engage in informal conversations with the local employees of the company, observe the work settings and activities that took place at each site, and have lunches and coffee breaks at the company's cafeterias. Field notes were kept to document these participant observations and some reflections on these experiences. The third source was the participant observation of the local cultural context, generated from exploring the local context from various perspectives. These included watching local TV channels, reading local newspapers, and talking to the local people such as taxi drivers. These observations and experiences provide the researchers an emic perspective for understanding the local cultural contexts (Trauth 2000).

In addition, the wealth of information on the company's websites was the major source of documentation. They included data such as strategic plans, news releases, white papers, business reports, and product show cases, etc.

Table 1: Summary of Interview Data

	Face-to-face Interview	Phone Interview
India	14	1
China	10	0
U.S.	7	6
Total		38

Data Analysis

The objective of this research is not testing the relationships between the variables outlined in the research framework (Figure 1). Instead, we utilized this framework as a "sensitizing device" to guide our interpretive analysis, ensuring that we took into account those relevant factors and their associations discussed in previous studies (Eisenhardt 1989; Klein and Myers 1999). Through this interpretive case study, we seek to identify some new concepts to refine the initial framework, to provide rich, empirical insights, and to draw some implications (Walsham 1995, 2006).

Interpretive reading and reflexive reading techniques were employed to review the data and generate meaning from the data (Mason 2002; Schultz 2001; Trauth 2000; Trauth and Jessup 2000). The interpretive reading technique requires researchers to construct an account of what they think the data present or reveal (Mason 2002). A reflexive reading technique requires researchers to locate themselves as part of data generation and explore their own role and perspectives (Mason 2002; Schultz 2001; Trauth 2000).

The preliminary analysis of the interview data was focused on searching all the transcripts for key words and themes suggested by the initial research framework and research questions. Then, through multiple interpretative and reflexive readings of data, we employed an open coding technique to identify, sort, and refine emerging themes that are related to different perspectives about cultural influence, the manifestations of cultural influence, and the ways in which the temporal coordination might be affected during the development process (Strauss and Corbin 1998). These emerging themes were then analyzed, compared, and grouped into constructs and sub-constructs to be included into the coding schema.

When a breakdown or an anomaly in understanding was encountered during the analysis, the coding schema was modified by either adding a new code or adjust the meaning of the existing codes (Agar 1986; Trauth 2000; Trauth and Jessup 2000). Then the corresponding areas of text of the transcripts that were coded previously were revisited to make sure that the interpretation was consistent (Trauth 2000). The coding process was inductive and iterative until no further codes or relationships among the codes emerged from the data.

Field notes from observations served as an instrument to facilitate the reflexive reading of the interview data (Patton 2002). Both the field notes and documentation also served as data sources for triangulation during the data analysis process (Trauth and Jessup 2000).

Findings

Our findings concurred that temporal separation is a culturally bounded concept, and that the temporal coordination of globally distributed software development is affected by temporal separation. This is in agreement with our initial research framework based on the previous studies (Espinosa and Carmel 2003; Sarker and Sahay 2004; Saunders et al. 2004). Moreover, we found that the influence of culture (at the societal level) on team members' time-based behaviors can be manifested in four ways: 1) language issues; 2) time estimation and commitment; 3) adherence to a schedule; and 4) availability/unavailability for synchronous communication. Our findings suggest that in addition to the cultural differences in time perception, the cultural differences in hierarchical structure, relationship orientation and social obligation have effects on team members' time behaviors as well. Furthermore, the organizational culture of the company was found to have mediating effects on its members' time-based behaviors. In this section, we present and discuss these findings in detail.

Language Issues

There are two major effects that language was found to have on temporal coordination. First, the language about time and the interpretation of it are related to the local cultural contexts. Sometimes instead of using a precise description about time, a deadline is specified using expressions that are known to people at the local site but might be misinterpreted by team members at the remote sites. Below is an example about how the concept of "business hours" means different things in India and the U.S. In the U.S., "business hours" usually means 9 to 5. But in India, "business hours" is an elastic concept with no clear boundary (Nicholson and Sahay 2004). The misinterpretations about time and schedule, in turn, will affect the project timelines. An example was given by Sunil, who was a senior software architect working in the U.S. who has an Indian ethnic background:

> *Certain words in the U.S. mean something. But they[2] don't take that exactly over there because that is not the proper wording they use. [One time][3], we said that we needed the information by the "end of Friday, end of business day Friday." In the U.S., "end of business day Friday" is 5 o'clock eastern time or 2 o'clock at the western coast. So the information had to be collected by then. In India, when they say "end of Friday," it is not 5 o'clock. It is midnight. They work longer hours there. Their 'business hours' does not mean the same as our business hours. So we ended up not getting the information. [Sunil in the U.S.]*

Second, for those team members whose native language is not English, their choice of communication technologies to coordinate activities may be affected by their language skills. This is particularly relevant to the distributed team members in China. The Chinese participants pointed out that among Chinese IT professionals in general, the reading capability is better than listening comprehension and the listening comprehension capability is better than speaking. Therefore, some communication technologies, such as email which is concerned with reading and writing capabilities, may be more preferred than other communication technologies such as a teleconference which is concerned with listening comprehension and speaking capabilities (Huang and Trauth 2007). However, sometimes the delay of email responses may affect the progress of the projects, especially when there is a certain degree of interdependency among tasks that need inputs from dispersed team members (Herbsleb and Mockus 2003).

Time Estimation and Commitment

In order to make the software development projects run smoothly and according to schedule, project managers need to evaluate and allocate resources based on the coordination needs of task dependencies and timelines. The evaluation is based on the inputs of time estimation and commitment from the project team members. Our findings suggest that culture has an impact on the estimation and commitment to the schedule. Several participants noted that the interpretation of "commitment" is culturally different in India. When an Indian software developer says "yes" to a certain deadline, it generally means that "yes I will try it" instead of "yes I can do it" (Carmel and Tjia 2005; Winkler et al. 2008). For example, Susan, a program director working in the U.S., mentioned that:

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[2] "They" refers to the distributed team members in India.

[3] Texts within the brackets are edited by the authors to fix the syntax or clarify the ambiguity of the original quotes.

> *Between the U.S. and India, I see quite a bit of cultural difference in terms of understanding the time commitment and deadline. If you make the date and ask if they can make it, they would say there is no problem. Even if there is a problem, they would want to fix it on their own. But it is important to make only an accomplishable commitment. [Susan in the U.S.]*

This finding is consistent with characteristics of the "polychronic" time vision suggested by Hall and Hall (1990), and the "timeless" time vision suggested by Saunders et al. (2004). Saunders et al. (2004) argued that under the influence of Hinduism and Buddhism, time in Indian culture is viewed as continuous and recurrent. Therefore, in Indian culture, people tend to be very flexible and optimistic in estimating time and making time commitments (Carmel and Tjia 2005). One indication of the "polychronic" time vision is that the commitment is only viewed as an objective to achieve if possible, rather than taken literally (Hall and Hall 1990).

Furthermore, the participants in India acknowledged that the relationship-oriented and hierarchy-structured characteristics of Indian culture are also reasons that Indian team members are unwilling to say "no" to a deadline requested by their managers or team members. Nazar, a participant working in India, emphasized that:

> *The whole hierarchical thinking is deeply ingrained in the way we grow up, in the social structures that we have. This is difficult to change. [Nazar in India]*

Hierarchical structuring is deeply rooted in India (Das 2002; Hofstede 1984; Nicholson and Sahay 2001; Panda and Gupta 2004; Sinha 2004). Nicholson and Sahay (2001) pointed out that the traditional caste system has contributed to the value system of India with respect to power and relationships. This value system is often drawn upon by fellow Indians and is manifested in their social behaviors, such as a desire to please and a sense of obligation to one's superiors. Sinha (2004) suggested that the spiritual traditions of India impart the beliefs in goodness, helping others and giving. He also noted that Indians usually adapt to the contextual demands as a result of living in a highly pluralistic society. Therefore, when facing a request from others, they will say "yes" as a sign of being accommodating and cooperative.

However, such a "yes" may be taken as a firm commitment by the remote team members or the project manager. The failure to fulfill such a commitment will not only cause schedule delays, but also generate tensions and mistrust among the distributed team members.

Adherence to a Schedule

Adherence to a schedule is closely associated with time commitment in that a realistic estimation about time and seriousness about commitment to it will lead to being on schedule and punctual. Our findings suggest that in both China and the U.S., adherence to a schedule is highly valued in the business culture, and is practiced in everyday work activities. For example, Jack, a manager in the U.S., articulated the importance of adherence to a schedule from the perspective of the development process:

> *We are very process orientated. In order to deliver on time and ensure the delivery quality, it is important to follow the process step by step according to the planning and schedule. [Jack in the U.S.]*

Hong, a team lead in China, pointed out that adherence to a schedule is an important part of accountability:

> *You have the ownership of the task. You are responsible for it. If you can not deliver it, even though it may not be your direct fault, you are still accountable for it. So you have to push things forward and make it happen. The rhythm is tense. [Hong in China]*

For the punctuality aspect, Ling, a developer working in China, stressed that:

> *In our line of business, punctuality is one of the fundamental behavioral norms. We are serious about our work. But we are laid back when we are off work. [Ling in China]*

Sunil, a senior software architect in the U.S. with Indian ethnic background, made a comparison of the behavioral differences in punctuality between India and U.S.:

> *If there is a meeting at 9 o'clock, people may come at 9 o'clock, ten minutes after, or even twenty minutes after. That is OK in their culture. Here, if we have a meeting at 9 o'clock, people start to*

> *come five minutes before the meeting. The punctuality is very important to us. Not on time may be accepted there, but it is not acceptable here. [Sunil in the U.S.]*

Our fieldwork experiences in China and India illustrate the differences in the way that adherence to a schedule is viewed in India and China. The interviews at SerTech, India, were pre-scheduled by the local contact person. However, we soon found out that these schedules could not be taken for granted. The majority of interviews either did not start on time or needed to be rescheduled to a different time because the participants were busily involved with other business matters and could not meet us as planned. Usually we were unaware of the changes until the participants did not show up at a pre-scheduled time. Therefore, it took a considerable amount of effort to coordinate and reschedule the interviews. While the interviews at SerTech, China, were also pre-scheduled by the local contact person, all the interviews that we conducted there were on time as scheduled.

The punctuality issue was commonly mentioned in the interviews with Indian IT professionals. They suggested that although not being on time is still somehow accepted and even expected in some occasions, the business culture in India has been undergoing changes as a result of the continuous increase in international business interactions. In addition, they argued that while the global IT business is growing at a very fast speed in India, the local infrastructure development has been lagging behind and is unable to support the growth, especially in those major IT hub cities, such as Mumbai, New Delhi, and Bangalore (Kobayashi-Hillary 2005). Because of the under-developed physical infrastructure, many IT employees have to battle their way to commute to work everyday. Yet, tele-work or mobile work is still not feasible. These infrastructure issues add additional challenges to coordinating globally distributed software development temporarily. Shilpa, an executive in India, described such a challenge:

> *You can plan to leave home one hour earlier. But you still cannot be on time for the meeting and for the call because you have these problems [of traffic jam]. We don't have 1-800 facility here so we cannot kind of call in for a conference call using a mobile phone. There are confidentiality issues and regulation issues. It is not that flexible. [Shilpa in India]*

Availability/Unavailability for Synchronous Interaction

Due to the restrictions of regular working hours and time zone differences, global virtual team members might be unavailable to work on some development tasks or unavailable to interact synchronously with their remote team members. We define this as *time-zone-difference unavailability*, which arises because of the time zone differences among remote sites. In addition, there are two types of unavailability that are specifically related to the local cultural contexts: *holiday unavailability* and *social unavailability*.

As we have discussed in the literature review, different countries have different holiday schedules. Of the countries in this case study, India appears to have the most complex holiday system. Since India is a very diverse country, people observe not only the national holidays (New Year, Republic Day, Labor Day, Independence Day, etc.), but also holidays related to different religions, such as Hindu (e.g. Pongal, Maha Shivratri, Ganesh Chaturthi, Diwali), Islam (e.g. Muharram, Ramadan, Milad-Un-Nabi), Christian (e.g. Easter, Christmas), Sikhism (e.g. Guru Nanak Jayanti), and Jainism (e.g. Mahavir Jayanti). Adding more complexity to the issue of holiday unavailability is that a project might be distributed across multiple sites. It is challenging for global virtual team members to keep track of all the variations regarding *holiday unavailability*. Eric, a developer in the U.S., pointed out:

> *Different countries, different religions, they all have different holidays……Whatever the holiday is, you actually have to take that into consideration when you do things, like scheduling meetings and understanding the availability. A lot of times, the word does not get out that tomorrow is such and such holiday and [someone] will be off for a week……There are some huge variations in holiday schedules. It sounds like a simple problem. But that is actually one of the issues causing a lot of headache. [Eric in the U.S.]*

Social unavailability is concerned with being unavailable as a result of family needs and social obligations. Examples of *social unavailability* include jury duties, childcare, etc. *Social unavailability* is a culturally embedded concept because some of these family needs and social obligations are unique in some cultures. For instance, both China and India are relationship-oriented countries (Hofstede 1984; Sinha 2004). Taking care of one's elders at home and being attentive to one's extended family is a cultural norm in China and India (Trauth et al. 2008). Therefore, they may have additional family needs that make them unavailable. Raj, an executive in India, pointed out that:

> *For example, somebody will not understand, culturally we still have to take care of parents because there is no social security system here for the elderly. Everything is taken care by the family. We have to be with them. All of these add up to the cost. [Raj in India]*

Along with these two types of unavailability, we also found two types of availability in this research, *flexible availability* and *accommodating availability*. Both *flexible availability* and *accommodating availability* function as enabling mechanisms to facilitate the temporal coordination of globally distributed software development.

We define *flexible availability* as being available outside the normal working hours. In Indian culture, under the influence of polychronic time perception, there is no clear boundary between work and life, and plans may be altered flexibly to satisfy different demands (Hall and Hall 2003; Nicholson and Sahay 2004). This indicates that people might be unavailable when expected to be available, but will also be available when expected to be unavailable. Rohit was a program director in India who had previously worked in the U.S. for ten years. He drew on his personal experience to make a comparison with respect to work-life balance between India and the U.S.:

> *There is a cultural difference between US and India with respect to how long can somebody be expected to stay at work. In the U.S., the work-life balance is a very significant thing……. Here in India, I think the culture is very different in a sense that work never ends. People expect you to be at work all the time. [Rohit in India]*

The participants noted that software developers in India will work extra hours to make up the time of holiday or other leaves, and will be willing work overtime when needed. Such *flexible availability* was also seen by the Indian participants as a means of gaining advantage in a competitive environment. For example, Arul, a developer working in India, pointed out:

> *In the U.S., they make a big fuss about 9-5 work hours or work overtime. But here we are willing to adjust. We grew up in a competitive environment. We know that we have to make extra effort to compete, and to gain advantages. [Arul in India]*

Accommodating availability refers to the willingness to shift the working hours to create a larger overlap window for the synchronous activities. Our research findings show that such accommodations are mutual. Global virtual team members either take turns to shift their working hours, or they meet at a middle ground. For instance, one participant in China mentioned that their project team used to schedule to meet at 8:00 AM American Central time, which corresponded to 9:00 PM Beijing time on the same day. Usually after the team members in China finished the meeting and wrapped up the work, it would be close to 11:00 PM and they had to catch a bus or train to return home. Safety was also a concern for retuning home late. They then switched the meeting time to 7:00 PM American Central time, which corresponded to 8:00 AM Beijing time plus one day. This illustrates the accommodations that are negotiated based on the contextual needs.

The Mediating Effect of Organizational Culture

Saunders et al. (2004) acknowledged that organizational culture also contributes to shaping individuals' time versions. Our findings agree with this assertion. Participants in each site made comments about the effect of organizational culture in SerTech, in terms of values and norms, on bridging some of the cultural differences in time estimation and commitment, and adherence to schedule. For example, a protocol of responding to any email requests within 24 hours was implemented in the company. It was noted that SerTech was establishing and promoting a global value system to leverage its diverse talents to produce greater synergy among different sites of the company. This is reflected in the narratives of individuals from all three countries.

> *Value in [SerTech] is not an empty statement. We want to see it is embedded in each employee's belief, behavior, and work. [Tan in China]*

> *The forms of communication and coordination are different in each culture. But there is a global [SerTech] culture that is slowly building up around each of these differences. [Ankur in India]*

> *I think it helps a lot that everyone on the team works in the same company. I think there is a lot more common culture because of that. [Jason in the U.S.]*

Furthermore, two specific values of SerTech's organizational culture, global and diverse, were constantly enacted by its employees to convey a sense of organizational identity (Smircich 1983). These two values were interconnected.

The participants acknowledged that the global presence of SerTech (operating in more than 100 countries) enabled the company to serve a wide variety of diverse customers. Working at SerTech provided a good learning opportunity of how to work with people in different cultures because the company was global and diverse as well.

> *One big advantage we have is the local presence. [SerTech] has offices in more than 100 countries. All of these people in these countries know their customers. They are local to their cultures. So they can fill the gaps if there is any. The big advantage for us is that [SerTech] is global and diverse by itself. [Shilpa in India]*

> *You cannot work in [SerTech] without constantly communicating with people in other cultures because we are always working with cross-cultural teams. [Jian in the U.S.]*

It was suggested by the participants that on the one hand, SerTech values the diversity of the local cultures, while on the other hand, it was striving to develop a global culture that can serve as a sense-making device to guide and shape behaviors of its global workforce (Smircich 1983).

> *Of course there are many different local values. What SerTech does is to rationalize it and bring it to one level, such as punctuality, responding to the customers, work process and evaluation. [Karthik in India]*

Summary of Research Findings

Based on our findings, we modified our initial research framework to incorporate the key themes that emerged from data analysis. The refined research framework is shown in Figure 2. Consistent with the initial framework, both time zone differences and time-based behavior of global virtual team members (influenced by culture) were found to contribute to time separation in the workplace, and time separation impacts on temporal coordination of globally distributed software development. In particular, our findings suggest that the influence of culture on time is manifested in multiple ways. We also found that in addition to cultural differences in time perception, there are several other cultural differences at the societal level that can have effects on the team members' time-based behaviors: hierarchical structure, relationship orientation, and social obligation. In this study, since the software development collaborations were across national boundaries but not across organizational boundaries, it was suggested the organizational culture of SerTech has mediating effects on team members' behavioral differences regarding time.

Discussion

Our analysis of the cultural influences on temporal separation and coordination in globally distributed software development has implications for both theory and practice.

Implications for Theory

This research has several implications for theory. First, our findings confirm the notion that temporal separation is a culturally bounded concept in globally distributed software development (Espinosa and Carmel 2003; Sarker and Sahay 2004; Saunders et al. 2004). Building on previous research, we developed a research framework (Figure 1) to shed light on the dynamic relationships among culture, differences in team members' time-based behavior, time zone difference, temporal separation, and temporal coordination (Espinosa and Carmel 2003; Hall and Hall 1990; Leidner and Kayworth 2006; Massey et al. 2003; Sarker and Sahay 2004; Saunders et al. 2004).

Second, we further extend the framework by eliciting four aspects in which cultural differences at the societal level may play a role in temporal separation (Figure 2): *language issues*, *time estimation and commitment*, *adherence to a schedule*, and *availability/unavailability for synchronous interaction*. Therefore, our findings provide empirical evidence and new insights into the discourse about examining the combined effects of cultural differences and temporal separation. Because this is an understudied research area, both theoretically and empirically, the research constructs and themes derived from this study can serve as inputs for future theoretical development regarding relationships among culture, temporal separation, and temporal coordination.

The third implication for theory is the confirmation that culture is a multi-leveled construct in globally distributed software development (Gallivan and Srite 2005; Huang and Trauth 2006; Karahanna et al. 2005; Leidner and Kayworth 2006; Straub et al. 2002). Our findings suggest that culture at both the societal level and the organizational level has impacts on temporal separation. Several scholars in cross-cultural information systems research argued that most research on global information systems only focuses on the national level of cultural analysis and often treats culture as a static concept, which does not assist in providing an in-depth understanding of the complex phenomena (Myers and Tan 2002; Sahay et al. 2003; Straub et al. 2002; Walsham 2002; Weisinger and Trauth 2002). We concur that it is important to take an interpretative stance to investigate the influence of culture. For example, we initially drew upon the cultural differences in time perception to interpret different time behaviors of global virtual team members. Through the interpretive readings of the participants' narratives, we found that cultural differences in hierarchical structure, relationship orientation and social obligations also play a role in shaping different time-based behaviors of global virtual team members.
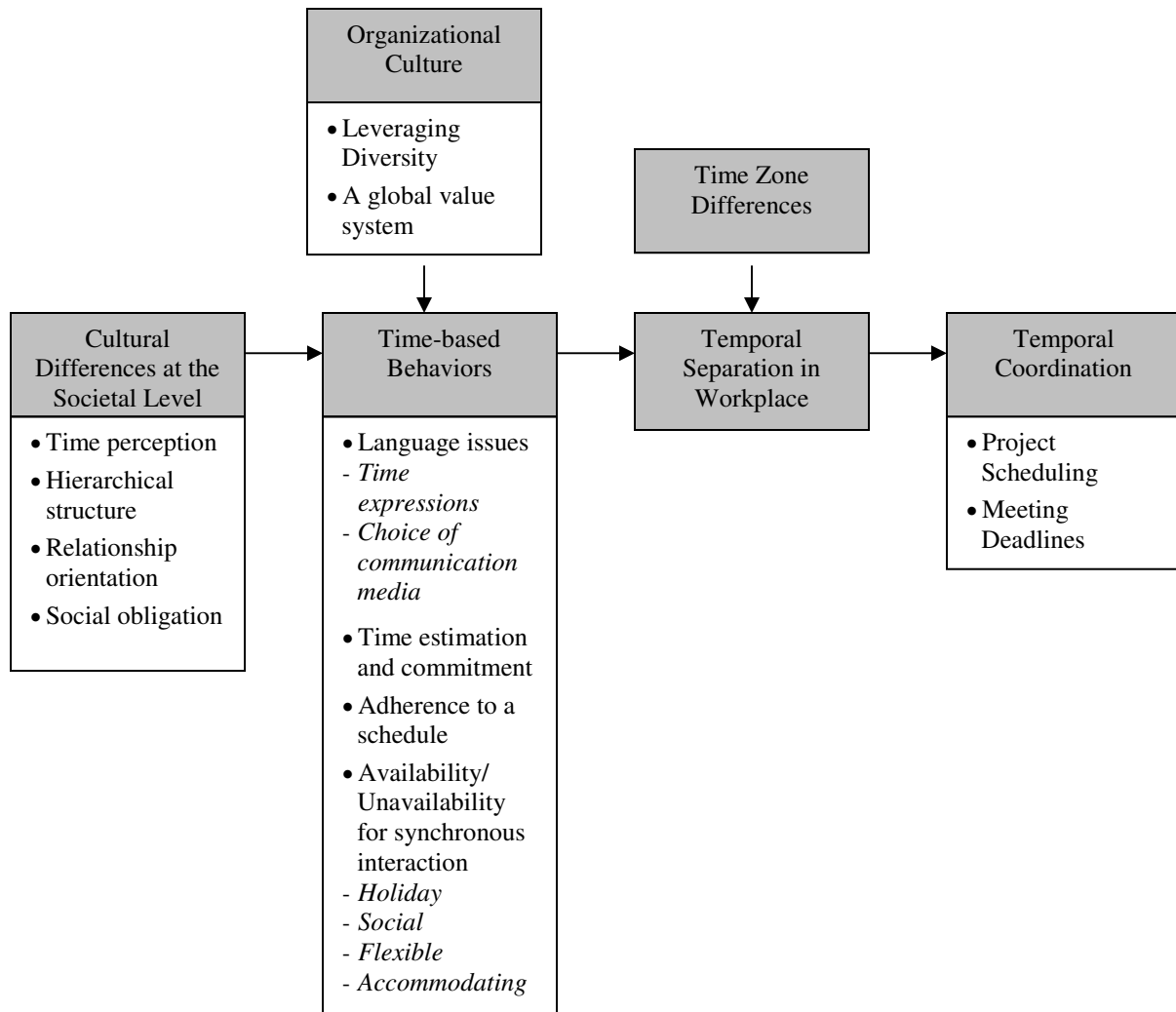

Figure 2: Refined Research Framework

Practical Implications and Recommendations for Management

Given that cultural differences affect temporal separation and coordination yet cultural diversity is inherent in globally distributed software development, the key challenge is then how to address these issues from the managerial perspective. Krishna et al. (2004) suggested that the cross-cultural issues in global software outsourcing

can be managed via the following approaches: purposefully choosing the outsourced projects to minimize cross-cultural issues, selectively staffing the project teams and including roles such as cultural liaisons to bridge the cross-cultural differences, providing initial and on-the-job cross-cultural training to facilitate the mutual cultural understanding in both parties, and managing the work relationships and developing a shared "working culture" in the process. With respect to managing time zone differences in globally distributed software developement, Carmel (2006) drew upon the case study of Inforsys and proposed three mechanisms that can be employed to overcome the impacts of time zone differences: technology, development process, and organizational culture (Sangwan et al. 2007). Agreeing with Krishna et al. (2004), our research findings indicated that training, including both cultural training and language training, is important to promote cultural understanding and facilitate communication. With respect to staffing, our research findings revealed the important roles of local managers in evaluating and allocating the available local resources in order to coordinate the interdependent development tasks. We also concurred with Carmel (2006) that temporal separation (resulting from the combined effects of time zone differences and cultural differences) can be managed via organizational culture, process and technology. In summary, we identify four implications for practice from this research.

First, with respect to language issues, since time related expressions are culturally embedded, it is important to decode the meanings behind each other's language about time, develop a protocol for time communication, and specify time requirements as accurately as possible in the communication (Komi-Sirviö and Tihinen 2005). Another language related issue is that individuals' language skills may affect their preference for using asynchronous communication technologies to coordinate activities, which may cause delay in the development process. Formal and informal language training programs can provide help regarding this issue (Farrell and Grant 2005; Huang and Trauth 2007; Li and Gao 2003).

Second, cultural differences with respect to time perception, hierarchy, and relationship have effects on both time estimation and commitment, and adherence to schedule. People who adopt a polychronic or timeless time version tend to make optimistic estimations about time and may easily make changes to the plan when needed. In addition, under the influence of a hierarchical and relationship orientated culture, team members may make commitments to a timeline because they are unwilling to say "no" to the requests. However, failure to deliver the time commitment or adhere to the schedule can cause schedule conflicts and delays, and generate mistrust and conflict in the project team as well. Our findings suggest two strategies that may help to address these challenges. One strategy is to utilize the mediating effects of organizational culture, establishing and promoting norms and values systems concerning professional conduct across all the sites (Carmel 2006). In the case of SerTech, two perspectives of the organizational culture, leveraging diversity and promoting a global value system, served as sense-making devices to establish an organizational identity and guide the behaviors of the global workforce. Another strategy is to foster an open atmosphere and establish trust relationships at the team level so that team members are more willing to raise issues, express concerns, and seek and offer help.

Third, our findings show that availability/unavailability of distributed team members for synchronous interaction is a rather complex and dynamic issue. In addition to the unavailability as a result of time zone differences, we identified four types of availability/unavailability as a result of cultural differences. In general, *holiday unavailability* arises because different countries have different holiday schedules. Some of these schedules are quite complicated. Even when all the *holiday unavailability* can be captured and taken into account before the project starts, ad hoc *social unavailability* may come forward during the project. However, unavailability may sometimes turn into *flexible availability* because team members are flexible to make up the hours or put in more hours. Furthermore, shifting working hours is a common approach to accommodating the needs for synchronous interactions. And such *accommodating availability* is mutual and negotiable. Formal weekly meetings and an established reporting structure are two common strategies managing the process of globally distributed software development. Furthermore, one of the key challenges of temporal coordination is how to estimate and minimize the effects of the unavailabilities (human resources) and at the same time fully take advantage of the availabilities (human resources). Local project managers play a critical role in temporal coordination in that they are responsible for evaluating the available resources, setting realistic goals, monitoring the process, making resource and schedule adjustments when needed, and communicating and coordinating with other remotes sites with respect to changes and progress (Nicholson et al. 2007; Sakthivel 2004). For these reasons, participants in China and India stressed the importance and necessity of educating qualified local project managers for globally distributed software development.

One further implication of this research for practice is to bring forward the importance of cultural awareness to management about globally distributed software development. The commonly used strategy to promote cultural awareness is to provide cultural diversity training to all the global virtual team members before or/and during the

project (Krishna et al. 2004; Treinen and Miller-Frost 2006). Another strategy is to arrange face-to-face meetings at the remote sites. Face-to-face meetings help to provide socialization opportunities for trust building (Child 2001; Oshri et al. 2005). In addition, visiting the remote sites helps to develop a better understanding of the local socio-cultural context. The third strategy is to incorporate some cultural knowledge into some commonly used tools to promote awareness (Herbsleb and Mockus 2003). For example, the Calendar tool can be designed to display the holiday schedules of other locations.

Research Limitations and Future Research

In the literature review section, we argued that globally distributed software development is situated within a complex and multi-leveled socio-cultural context, which may include national, organizational, professional level, and/or team levels. In this research, we identified the influences of national culture and organizational culture on temporal separation and coordination. In particular, the global and diverse perspectives of the SerTech's organizational culture have mediating effects on the temporal separation resulting from cultural differences at the societal level. It should to be noted that these research findings and implications were generated based the specific case context of SerTech, a multinactical IT company. Given a different research setting, for example software development projects distributed between two different companies in different countries, the dynamics of cultural influences at different levels may be different. Therefore, there is a need for more studies in this area that explore different case contexts and examine the applicability of the research framework developed in this research.

Conclusion

This paper contributes to the literature on global virtual teams, globally distributed software development, and offshore outsourcing by presenting an analysis of the combined effects of cultural differences and temporal separation on temporal coordination in globally distributed software development. This study identifies relevant cultural differences and multiple manifestations of cultural influence on temporal separation. Drawing on the existing literature and our research findings, we developed and refined a research framework (Figure 2) to illustrate how cultural factors affect temporal separation and coordination in globally distributed software development. This framework contributes to the development of theory that articulates the relationships among culture, time zone differences, temporal separation and temporal coordination. This paper also contributes to practice by outlining several managerial strategies to address the challenges associated with cultural differences. We contend that the influence of culture on temporal separation and coordination is multi-faceted and dynamic.

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Appendix A: Interview Guide

Background Information:

Can you give me a brief description of your job title and job responsibilities? Did you have any prior cross-cultural experiences before you joined the company? For how many years have you had cross-cultural work experiences?

Project Information:

What cross-cultural, globally distributed projects have you worked on or are currently working on? In these projects, who do (have) you collaborate (collaborated) with and what countries are (were) your collaborators in? Approximately, how much of the work is (was) conducted in the face-to-face environment and how much of the work is (was) conducted in the virtual environment? What types of communication technologies are (were) used for communication and coordination?

Critical Incidents – Think about some project currently on-going or recently completed that is cross-cultural:

Can you tell me a (some) particular example (case, incident) in which cultural differences affected some aspects of work during the project? What happened? In your opinion, what may cause the differences? How did it affect the project? How was it resolved?

Cross-cultural Management:

Have you attended any cross-cultural training programs or seminars before? What did you learn from these programs that helped you to manage the cross-cultural differences encountered in your work? What is your strategy for managing the cross-cultural differences? What do you think organizations could do to better help the global virtual team members in cross-cultural management?