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Task Coordination in Global Virtual Teams

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TASK COORDINATION IN GLOBAL VIRTUAL TEAMS

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Abstract

Organizations worldwide are increasingly making use of global virtual teams (GVTs). GVTs employ advanced information and communication technologies to collaborate in geographically and temporally distributed settings. Coordination is a fundamental activity to achieve effective teamwork. Management of task coordination (i.e., task dependencies) has been found to impact team performance. While coordination in traditional teams has been well studied, GVTs, with their unique challenges to coordination, require additional research. Through an in-depth investigation of task coordination in two GVTs, this study reveals the coordination problems caused by the structural characteristics of GVTs, how GVT structures contribute to the usage of specific task coordination mechanisms, how task coordination mechanisms can overcome GVT coordination problems, and how these mechanisms affect GVT outcomes. The findings indicate that task and members' characteristics can cause problems of duplicate work and lack of sharing of local information. Low task interdependence calls for coordination by direct supervision while high task interdependence necessitates team meetings. ICT accessibility and synchronicity characteristics may improve or impair the coordination process depending on the extent to which they can facilitate distribution of necessary information. Shared team interaction mental models may overcome the problem of duplicate work. Together with shared task and technology mental models, shared team interaction mental models also serve as important mediators between coordination mechanisms and GVT outcomes of task quality and member satisfaction. The derived model can serve to aid research on GVT task coordination and GVT practice.

Keywords: GVT structures, coordination problems caused by GVT structures, task coordination mechanisms, intermediate outcomes, GVT outcomes

Introduction

Global competition and advances in information and communication technologies (ICTs) have fuelled the emergence of global virtual teams (GVTs). While virtual team refers to geographically, organizationally, and/or time dispersed workers brought together by ICTs to accomplish one or more organizational tasks (Powell et al. 2004), GVT refers to globally dispersed workers in such arrangements. GVTs offer quick responses to customer needs, and utilization of expertise around the globe (Ahuja et al. 2004). Nevertheless, these potential benefits may not be realized if organizations fail to address the challenges to effective teamwork (Montoya-Weiss et al. 2001).

Coordination, or the management of dependencies (Malone and Crowston 1994), is fundamental to achieve effective teamwork (Zigurs et al. 2001). Task coordination has been found to impact virtual team performance (Maznevski and Chudoba 2001). While coordination in traditional teams has been well studied (Malone and Crowston 1994; Wooldridge 2002), GVTs, with their unique challenges to coordination (Cummings and Kiesler 2003; Hinds and Mortensen 2002), call for additional research. Member space-time dispersion and reliance on ICTs (Cummings and Kiesler 2003; Cramton 2001) can create coordination problems due to incompatibilities in member context and lack of information about other members (Hinds and Mortensen 2002).

In this study, we examine two teams in-depth to investigate GVT task coordination. The two main questions addressed are: How does GVT structure impact task coordination? How does task coordination impact GVT outcomes? Coordination theory and the

GVT literature are used to create an initial template incorporating GVT structural elements (task, member, and ICT characteristics), coordination mechanisms, intermediary variables, and GVT outcomes. The template is refined as a result of the in-depth analysis and a framework is developed to explain GVT task coordination. Researchers have highlighted the significant difficulties GVTs face as they attempt to coordinate their activities across time zones and cultural divides (Kayworth and Leidner 2002). Thus, a framework to explain GVT task coordination is likely to be valuable for GVT managers and provides a stepping stone for further study of GVT coordination.

Conceptual Background

GVT Structural Elements

The uncertainty of the task affects task coordination in traditional organizational structures (Pennings 1974) and is likely to influence GVT task coordination. Task interdependency is one of the sources of uncertainty (Comstock and Scott 1977). Task interdependency refers to work flow interdependency between team members (Pennings 1974) and can be classified as pooled, sequential, reciprocal, or team interdependence (Thompson 1967). In pooled interdependence tasks, each member completes their subtask independently followed by aggregation. In contrast, sequential interdependence tasks involve the completion of one subtask before the next begins. While sequential interdependence tasks flow in one direction, reciprocal interdependence tasks flow in a back and forth manner. In team interdependence tasks, there is no measurable temporal lapse in the flow of work among members. A hierarchical relationship in the above order has been found to exist among the four types of task interdependencies. While moving up the hierarchy, team interaction frequency increases and requires more elaborate task coordination mechanisms (Thompson 1967; Van de Ven et al. 1976).

GVT member characteristics of being assembled on an as-needed basis, space-time dispersion, context diversity, cultural diversity, and experience with ICTs are likely to impact GVT task coordination. GVT members are often assembled on an as-needed basis (Jarvenpaa et al. 1998). Since members are only assembled for the duration of the task, coordination mechanisms have to evolve quickly starting from scratch (Zigurs et al. 2001). Due to their global space-time dispersion, GVT members are typically culturally and contextually diverse (Cramton 2001; Powell et al. 1994). Cultural diversity (i.e., differences in assumptions and beliefs across cultures) appears to lead to coordination difficulties by enhancing member incompatibilities (Kayworth and Leidner 2002; Maznevski and Chudoba 2000). Context diversity, or the differences across sites in terms of member context, can create problems for building mutual knowledge (Cramton 2001). Since GVTs are made possible by ICTs, GVT members' ICT proficiency may affect the teamwork (Dube and Pare 2004). Although it is known that each of these attributes can add complexity to GVT coordination, this study seeks a more in-depth explanation of how they may influence GVT task coordination.

The information processing perspective suggests that use of ICTs can directly improve organizational performance by simplifying key coordination problems of scheduling, synchronization, and allocation (Malone and Crowston 1994). However, Kling et al. (2001) caution that an ICT can also be a dagger, cultivating more coordination problems. These contradictory viewpoints suggest that we look more closely at the relationship ICTs and coordination in the context of GVTs which rely considerably on ICTs to accomplish their task. Particular ICT characteristics are likely to impact GVT task coordination. Media synchronicity theory suggests five ICT capabilities that enumerate how individuals may work synchronously (Dennis and Valacich 1999). Immediacy of feedback, or the extent to which the medium enables rapid bi-directional feedback on the information received, enables mid-course corrections in message transmission so that misunderstandings can be corrected. Symbol variety refers to the number of ways in which a message can be communicated, while parallelism is the number of simultaneous conversations that can exist effectively. Rehearsability is the extent to which the medium enables the sender to fine-tune a message before sending. Reprocessability refers to the extent to which a message can be reexamined within the context of the communication event. This study seeks to investigate how these ICT characteristics may impact GVT task coordination.

Besides these inherent characteristics, ICT accessibility may also affect task coordination. Media accessibility theory suggests that availability, reliability, and access speed are important in determining media usage (Alavi and Tiwana 2002; Carlson and Davis 1998). Availability is the physical presence of the medium while reliability refers to the dependability and up-time of the medium (Goodhue and Thompson 1995). Access speed refers to the promptitude of the medium. Since GVT members may have different accessibility to media, it is important to coordinate the work flow with respect to these differences to prevent information processing problems.

Task Coordination Mechanisms and Shared Mental Models

Theory on task coordination mechanisms in traditional teams may provide a useful start to investigate such mechanisms in GVTs. Previous studies have suggested a typology of three modes of coordination (i.e., impersonal, personal, and group) (Van de Ven et al. 1976). Impersonal mode involves a codified blueprint of action which requires minimal verbal communication between task performers. Typical mechanisms are preestablished plans, schedules, formalized rules, and procedures. Personal mode involves dyadic communication between two members on a personal basis or communication that does not include all team members. Its mechanisms are vertical and horizontal communication channels (Thompson 1967). Group mode exercises group communication. Its mechanisms include team meetings that allow members to directly coordinate tasks with one another.

Previous work has shown the interrelationship between task interdependencies and coordination modes in the traditional team context. Particularly, pooled interdependence needs to be coordinated by rules (impersonal mode), sequential interdependence necessitates planning and scheduling (impersonal mode), reciprocal interdependence calls for mutual adjustments (personal mode), and team interdependence demands group decision making (group mode) (Grant 1996; Van de Ven et al. 1976). Whether this finding applies in the GVT context will be explored in this study.

Team cognition literature suggests that coordination mechanisms aid coordination through developing shared mental models (Espinosa et al. 2002). Mental models are organized knowledge structures that allow individuals to interact with their environment. Due to lack of opportunity for communication, GVTs are not always able to engage in necessary strategizing. In such cases, shared mental models may be crucial to team functioning. Mathieu et al. (2000) specified four types of shared mental models in a team out of which three are likely to be related to task coordination (i.e., technology, task, and team interaction mental models). Members should understand the ICT with which they are interacting, and hold shared task models as well as shared conceptions of how the team interacts.

GVT Outcomes

Team outcomes can be classified as task-related and team-related (Pinsonneault and Kraemer 1989). Task-related outcomes consist of decision characteristics (e.g., quality), decision implementation characteristics (e.g., implementation cost), and attitude toward the decision (e.g., members' acceptance of the decision). Team-related outcome, which is members' satisfaction with the team experience, is likely to influence members' willingness to collaborate in future projects (Hackman 1989). Together, task and team-related outcomes comprehensively cover the main aim of coordination (i.e., to get the work done and develop members as a team) (Zigurs et al. 2001). Therefore we would like to investigate the impact of task coordination on these outcomes.

Research Methodology

Exploratory case studies were conducted of GVT task coordination. Exploratory case studies are suitable for studying such a contemporary phenomenon within its real-life context in order to generate theory from practice (Eisenhardt 1989; Yin 1994).

Case Background

The two GVTs in this study, teams A and B, were made up of Master's level students from three universities (located in North America, Europe, and Asia) participating in a course on global project coordination. Each GVT was assigned a global industry-sponsored project that was formulated, monitored, and assessed by their organizational sponsor through a manager. The teams fulfilled the distinctive characteristics of GVTs (i.e., members were space-time dispersed, contextually and culturally diverse, assembled on as needed basis, and relied mainly on ICTs to communicate and collaborate). The teams closely approximated organizational GVTs in terms of task and project realism. Team members were selected by matching their resume and skills profile to the project requirement, as is done in organizational GVT. At the end of the course, each GVT had to present their results to the organizational sponsors and course faculty. The sponsor and faculty members then awarded them a grade based on the quality of work done.

Team A worked on a global project sponsored by a major international computer company. The objective was to reengineer the financial analyst organization within the sponsor company to attain a more effective structure. Members had to interview different ranks of executives within the company to elicit ideas on how to improve the Financial analyst structure. Almost all aspects of

Team A's task such as interview questionnaire creation, identification of problem areas, and generating the recommendation, required input from and coordination between all team members (i.e., team interdependence task). Team B worked on a global project sponsored by a major international consulting company. The goal was to understand risk assessment procedures in businesses in a variety of industries. Members were required to collect information about risk measurement, risk monitoring, and risk management in global businesses through interviews with top executives. The sponsor company had given them a pre-designed risk assessment questionnaire for data collection. Since members of Team B could carry out their work quite independently of each other except during the data consolidation phase, the team task was deemed to be comparatively low in interdependency (i.e., pooled interdependence task).

The GVTs met face-to-face once at the beginning and once or twice toward the end of the project. Throughout their projects, they collaborated using a variety of ICTs, such as teleconferencing, e-mail, ICQ (an instant messaging tool), E-circle (an online community tool), and a Web discussion board. The Web discussion board was linked to the course Website where members of all teams could post text messages. The messages were structured into topics using discussion threads. E-circle is a free, private (password protected) online community Web space to share member information and files, plan group events, and maintain group calendars and lists.

Data Collection and Analysis

Data was collected using multiple sources (observation, communication logs, and project documentation) over the project period of five months. Each source added depth and strengthened the grounding of theory by triangulation of evidence (Eisenhardt 1989; Yin 1994). Project documentation included project description, team background information, lessons-learned papers, project reports, and team grades. Data analysis was carried out through template coding (King 1998) and axial coding (Strauss and Corbin 1990).

Template coding structures the analysis process by developing *a priori* categories and subcategories (King 1998). With this approach, better grounding of construct measures can be achieved (Eisenhardt 1989). We used QSR Nudist to record codes along with the communication logs. Based on our literature review, the original template for our study is shown in Table 1.

The GVT task, members, and ICT characteristics and outcomes were one-time coded. During analysis and as a result of a growing understanding of the phenomenon, the codes in task coordination mechanisms and intermediate outcomes categories were adjusted, inserted, and deleted to retain theoretical flexibility (King 1998). The final list of additional categories and subcategories is shown in Table 2. An example of category added was the problems caused by GVT characteristics. Codes deleted due to absence in the data included ICT parallelism and rehearsability. Task and team-related outcomes were refined to task quality and member satisfaction.

Following template coding, we conducted axial coding to achieve our theory generation objective. The aim is to make connections between categories (Maznevski and Chudoba 2000) by utilizing a coding paradigm involving conditions (the cause), context (properties of phenomenon), intervening conditions, action and interactional strategies, and consequences (outcomes) (Strauss and Corbin 1990). We analyzed each case separately to allow its unique patterns to emerge (Eisenhardt 1989). We then generalized the patterns across cases to look for larger patterns over time (Yin 1994). Some relationships were evident from direct statements of the participants in lesson-learned papers. For example, the relationship between members' time-space dispersion and lack of sharing local information was evident from the following sentences in one of Team B's lesson learned papers:

> *Information is hard to get to everybody. Having the [project manager] in another part of the world with some parts of our team can cause problems. All the written information reaches us on the other side of the ocean, but the oral discussions between the project manager and those teammates do not always reach the other team members and that is not desirable.*

Some relationships were also evident from the identified patterns that one code seemed to cause another. Categories intersection in Nudist node search function was sometimes used to confirm their co-occurrence. For example, the difficulty of having a team meeting due to members' time-space dispersion was identified from the following e-mail logs:

> *Since [Europe] has problem with [US] 10pm, [Europe] 7am, [Asia] 1pm video conference group meetings...how about considering another weeknight…instead of Wednesday night 10pm. Assuming we do get the room every other week for Wednesday night 12:00pm [US] time after class, we should choose some other WEEKNIGHT like monday, tuesday or thursday nights.*

Table 1. Original Template

Categories and Subcategories	Definition
Task Characteristics	
Task interdependence (Van den Ven et al. 1976)	Extent to which members are dependent upon one another to perform their job. It includes pooled, sequential, reciprocal and team interdependence
Members Characteristics	
Time-space dispersion (Alavi and Tiwana 2002)	Extent of time and space separation between team members
Context diversity (Cramton 2001)	Extent of differences in situational context in which members are embedded
Cultural diversity (Hofstede 1990)	Difference amongst members in terms of culture (assumptions, beliefs, values, etc.)
Assembled on as-needed basis (Jarvenpaa et al. 1998)	Assembled for the duration of a task and dismantled afterwards
Experience with ICT (Carlson and Zmud 1999)	The knowledge-base regarding a medium that is built up in the process of using that medium over time
ICT Accessibility Characteristics (Carlson and Davis 1998) includes **Availability, Reliability, Access Speed**	
ICT Synchronicity Characteristics (Dennis and Valacich 1999) includes **Immediacy of Feedback, Parallelism, Symbol Variety, Rehearsability, Reprocessability**	
Task Coordination Mechanisms	
Rules (Grant 1996)	Standards which regulate interaction between individuals
Scheduling/Sequencing (Grant 1996)	Organizes production activities in a time-patterned sequence such that member inputs occur independently by being assigned separate time slot
Direct supervision of work (Cummings and Kiesler 2003)	Manager supervising the tasks
Team meetings (Van de Ven et al. 1976)	A group brought together to coordinate tasks directly with one another
Intermediate Outcomes (Mathieu et al. 2000)	
Shared technology mental models	Organized knowledge structures about the dynamics and control of the ICT and how it interacts with the input of other team members
Shared task mental models	Organized knowledge structures about how the task is accomplished in terms of procedures, task strategies, likely contingencies or problems, and environmental conditions
Shared team interaction mental models	Organized knowledge structures about member roles and responsibilities, interaction patterns, information flow and role interdependencies
GVT Outcomes (Pinsonneault and Kraemer 1989)	
Task related outcomes	Consists of decision characteristics (e.g., quality), decision implementation (e.g., cost), and attitudes toward decision (e.g., acceptance)
Team related outcomes	Members' satisfaction with process and willingness to work in future GVT

Table 2. Additions and Refinements for Final Template

Categories and Subcategories	Definition
Members Characteristics (Carlson and Zmud 1994)	
Personality differences	Difference in members behavioral and emotional characteristics
Problems Caused by GVT Structures	
Role ambiguity (Biddle 1986)	Incomplete/unspecified expectations regarding work to be done
Duplicate work (Wooldridge 2002)	Multiple team members working on identical tasks
Lack of sharing local information (Wooldridge 2002)	Lack of exchanging local information and cooperating to achieve a non-local view of the task/subtask
Task Coordination Mechanisms	
Liaison (Zigurs et al. 2001)	Individuals who act as a conveyor of information between the team and the stakeholder and vice versa
Swift leadership (Jarvenpaa et al. 1998)	Rotating leadership based on members' level of expertise
Intermediate Outcomes	
Member(s)' competition (Wooldridge 2002)	Improving one's own outcome in response to others
Even distribution of information (Cramton 2001)	Information is equally distributed among members
Group cohesion (Chidambaram et al. 1990)	Degree of mutual cooperation, confidence, and trust that exists among group participants
GVT Outcomes	
Task quality (Maznevski andChudoba 2000)	Degree of excellence of the given task
Members' satisfaction (Pinsonneault and Kraemer 1989)	Fulfillment of needs or contentment gained by team members through collaboration

Task Coordination Process in Team A

On team formation, the task coordination process began with the manager's use of a direct supervision mechanism to build the foundation for the team's shared task and technology mental models. This is evidenced from the following message posted in the Web discussion:

> *This project is commissioned to come up with the most cost effective organization model … while providing the following…The recommendation should include:*
> *1. The various alternatives with all the pros and cons and the team's recommendation…*
> *2. How to implement the model, considering all the various human and infrastructure (i.e., technology, cost, availability of resources, etc.) issues and recommendations.*
> *…You can use the 7 day x 24 hour newsgroup to get to know your classmates and find out who else shares your interests in various projects. The URL for the Web discussion area is…*

With the shared task mental model, two members simultaneously formulated a questionnaire and e-mailed it to the rest of the team. This duplicate work happened because the newly assembled team was not sure who should do which subtask. To resolve this conflict, one member took charge in deciding whose questionnaire the team would build on, as evidenced in the e-mail log:

> *[X] had also started the questionnaire for the FAs. Although [Y] started this first, maybe it is a good idea to continue with the one that [X] started to avoid confusion later when the questionnaire for business managers is started.*

Realizing the nature of their task interdependence and armed with shared task and technology mental models, Team A then attempted to use team meetings to discuss the questionnaire. Team meetings enabled even distribution of information, and facilitated group collaboration to deal with the task. Nonetheless, when arranging for an ICQ meeting, the team faced numerous difficulties due to members' time-space dispersion and context diversity (e.g., one member went to Japan in the middle of the project). They also experienced ICT reliability problems (e.g., some members were suddenly being disconnected), which diminished the capability of the team meeting mechanism to evenly distribute information to the whole team. To resolve this issue, the ICQ record was captured and distributed via e-mail for the benefit of those who suffered from unreliability ICT and/or for those who could not attend the meeting. In addition, some members occasionally faced ICT availability problems that would lead them to make use of other ICTs.

When the manager gave advice about the questionnaire to several collocated members, they would inform the rest of the team about it. This liaison role was important to keep all members in the loop, which in turn helped to develop group cohesion. In the next subtask (the interview), one member was extremely worried about the team progress. In response to this concern, all members began sharing their interview result as soon as they finished interviewing. However, although the intention to share was there, sharing of local information was sometimes compromised due to unreliable ICT as evidenced below:

> *Are you sure that you posted the interview on the Web? I cannot find it under the FA s reports. Please make sure to post it, it would be useful to read this before doing our interview.*

In addition to the active sharing of local information, after discussing together as a team, Team A established "drivers" for each subtask. The driver would ensure that the deadlines were met. He/she would also be in charge of soliciting and merging members' ideas into the best solutions. This resulted in a clear demarcation of responsibilities and a greater focus on what to do, thus creating a shared team interaction mental model.

At this point, we observed that Team A heavily made use of the ICT-mediated team meeting mechanism to coordinate their task. While in their early meetings they came across numerous ICT accessibility problems, after some time the team managed to institute shared technology mental models regarding the ICT accessibility characteristics. With more organized knowledge, they could identify the potential accessibility problems beforehand to arrange for some safety nets, such as taking down minutes in every teleconference to be distributed later through e-mail for ensuring even distribution of information to all members. Once able to handle ICT accessibility problems, the team began to notice the drawbacks of ICT synchronicity characteristics for the purpose of team meetings. For example, they perceived the Web discussion board as having low immediacy of feedback because there was no "uploading notification" in the Web discussion board. Subsequently, whenever someone updated information to the Web discussion board, that person would send a notification e-mail to the other team members.

Team A also experienced a problem caused by the use of ICQ and e-mail (both with low reprocessability capability) to coordinate their task. There was a misunderstanding of who should interview the financial analyst. In an e-mail sent earlier, it was clear that the interview task was the Asian members' task. However, in a subsequent ICQ meeting, other members volunteered to interview the financial analyst. No one corrected this error during the ICQ session because e-mail does not have an indexing capability to promptly retrieve the relevant message. The team realized this problem after an Asia member contacted the financial analyst and found out that she had been interviewed. This duplicate work resulted in arguments among the members, posing a danger to group cohesion. Fortunately, a member from Asia quickly restored the situation, as evidenced below:

> *If [North America] has proceeded with the interview, we should show our unity by letting them continue... otherwise it may reflect negatively on us. But [North America] may like to inform our [Asia] side who we should interview then...(maybe it is a communication error?)*

Gaining more experience with the ICT, Team A kept updating their technology mental model until they converged to concurrently use three ICTs. E-mail was used for daily communication, the Web discussion board for sharing ideas and findings, and teleconference for weekly decision-making meetings.

As a result of the emergence of swift leadership (drivers for each subtask), drivers attempted to schedule the team's information flow, for example:

> *Some changes on dates of our proposed solutions deadlines:*
> *1. 1st draft: Saturday, 12 pm. Both teams send out proposed solutions (as detailed as possible). Each team then reviews other team's proposal---for input and addition to own team's 2nd draft proposal.*

> *2. 2nd draft: Tuesday, 12 pm. Both teams send out the 2nd draft proposed solutions. Discuss them during phone conference on Tuesday, 12 pm.*
> *3. Final: Thursday 12 pm. Both teams send out final proposed solutions. Discuss remaining issues during phone conference on Thursday, 12 pm.*

The above scheduling subsequently updated their shared team interaction mental model. Team A's shared team interaction mental model was coherent, thus reducing role ambiguity. Leadership in different areas could be observed, members' roles became clear, and the interrelationships between members in the team became salient. At the end of their collaboration, the team managed to attain relatively high task quality (53.4 marks out of 60).

Besides having a high task quality, we also observed that Team A successfully maintained its group cohesion during the coordination process, resulting in high members satisfaction as evidenced from the following lesson-learned paper extract:

> *Despite the widely diverse culture, there is a lot of cohesiveness, team spirit and teamwork in the group. Regardless of the working and communication style, there is a tacit agreement to be receptive and accommodate (to the work arrangements).*

Task Coordination Process in Team B

As in the case of Team A, when Team B was formed, the manager laid the foundation for shared task and technology mental models as shown in the following e-mail:

> *Here are some of things that I will need from each of you by Tuesday….*
> *Make a preliminary list of industries within your region…*
> *We will be looking at value chains within multiple industries and trying to rank risk…*
> *The manual I am putting together will make it clear…*
> *For document sharing, I need to know what types of software everyone wants to use…*

In addition to this e-mail instruction, the manager also sent the team a manual for their task; comprehensively directing what the team should do for their first subtask (i.e., identify companies in suggested industry sectors to interview). Considering the team's low task interdependency, ideally this detailed instruction and manual should serve as an efficient tool. However, this kind of electronic-mediated direct supervision caused some problems in Team B. The root of the problems lay in the ability of the ICT to transmit and retain a message. Two members accidentally deleted the e-mail message from the manager, signaling that e-mail has low reprocessability capability. ICT reliability also affected the delivery of the manager's instruction. One member could not open the attached manual and had to request other teammates to forward her the message. Finally, due to relatively low symbol variety of an e-mail message, some members did not fully understand the message. For example, a member was confused whether the subtask should be done individually or collectively within the same geographical location. Thus, in Team B, ICT accessibility and synchronicity characteristics seemed to inhibit the effectiveness of the manager's direct supervision toward the construction of a shared team interaction mental model.

Around one month after team formation, Team B had their first face-to-face meeting. While there was already a subtask to be completed prior to the meeting, it was either being done individually or collectively by collocated members, suggesting almost no team interaction prior to the face-to-face meeting. After the first meeting, armed with their shared technology mental model, some members tried to initiate electronic-mediated team meetings to maintain their interactional dynamics. While doing so, the team realized that their time-space dispersion and context diversity made the meeting arrangement a difficult task. The difficulty in agreeing on their meeting time was because they only had a one hour common time frame. The arguments about when they should meet significantly reduced group cohesion. Some of the meeting attempts were also unsuccessful because some members suddenly "disappeared." It later turned out that they had other commitments, an indicator of context diversity.

The teleconference logs indicated that most of the time members were not discussing their task coordination. Instead, a representative of each site used the opportunity to report their work status to the manager. Even so, minutes were taken and sent through e-mail so that all members would be able to catch up with what went on during the meeting. This served to somewhat distribute information about who interviewed whom and contribute to a shared team interaction mental model. However, some members within one continent would sometimes do their own work and report it to the manager via e-mail without letting the others know. On some occasions, members did share their local information with the whole team, but due to ICT reliability and

access speed, the other teammates could not view the information. Moreover, since the local information was shared through e-mail which has no inherent indexing capability, some members inadvertently neglected the information shared. Over time, the team updated their shared technology mental models and decided to use E-circle instead of e-mail for file sharing due to its high reprocessability capability for information sharing. A member noted:

> *We have been able to overcome such barriers through the use of tools such as E-circle, which has aided us tremendously in sharing files.*

Interestingly, it was observed that the members in Asia usually shared their interview contact list with the members in Europe, but not with those in North America. To remedy the situation, a direct-supervision mechanism was heavily exercised by the manager. This time, the mechanism was meant to develop a shared team interaction mental model so that everybody knew what the others were doing. The manager wrote an e-mail to the team as follows:

> *I need to know which subteams will be contacting which of the contacts I sent you earlier today. I want to include your names in the letter so that they will be expecting you. I need this as soon as possible. If you are already on holiday or gone for the week-end I will just assign them by the industries you selected which is listed in the minutes*

Unfortunately, despite the manager's effort, the seed of group friction was already sown. Members from two sites clashed during Team B's second face-to-face meeting to present the interim results to the sponsor company. A member remarked in his lesson-learned paper:

> *After a while, the charm from differences gets lower and you tend to get tired.…One thing worth remembering is that emotions stem from aggregated experience and as such more cultural colored than the "rational" part of us.…So lesson learned—don't forget the multicultural surrounding when things go emotional just because the difference normally tends to be insignificant.*

Thus, cultural diversity and personality differences among members along with the uneven distribution of information reduced group cohesion. Later on, the manager split the team into two with each subgroup having members from each of the representing locations. An important point to stress here is that the group could be split because of the team's low task interdependence. Having a pooled interdependence task, it was possible for each member to individually perform their own work before consolidation of results. The manager also instructed each member to share their local information within their subgroup. Furthermore, when the team was in their last subtask (data consolidation) that required sequencing, the manager also put forward a scheduling mechanism to enhance the shared team interaction mental model as captured here:

> *Each week I need a summary of activities from each group leader about what their team has done.…Every Wednesday, I need a copy of all the handouts, etc. of the interviews plus a copy of the tape. You can hand them into me…or mail them to me.…[you] can also fax the paper material to me.*

While subgroup competition diminished group cohesion, leading to unsatisfied members, interestingly, this strategy resulted in a reasonably high task quality (53 marks out of 60). Subgroups attempted to outperform each other and, consequently, when the results were compiled by the manager, the team had relatively high task quality.

Cross Case Findings Discussion

Based on cross-case analysis and analytical generalization, we derived a GVT task coordination framework as shown in Figure 1.

ICT Characteristics and Direct Supervision of Work

Both teams experienced direct supervision at the start, as the project manager briefed the team about their task. Unlike traditional teamwork, besides painting the picture for their shared task mental model, a GVT project manager needs to establish the foundation for the team's shared technology mental model as well (1, 2a in Figure 1). This is because although over time and through experience, the team will update their technology mental model (2b in Figure 1), GVTs are transient and cannot afford to lose much time in figuring out which ICT they should use.

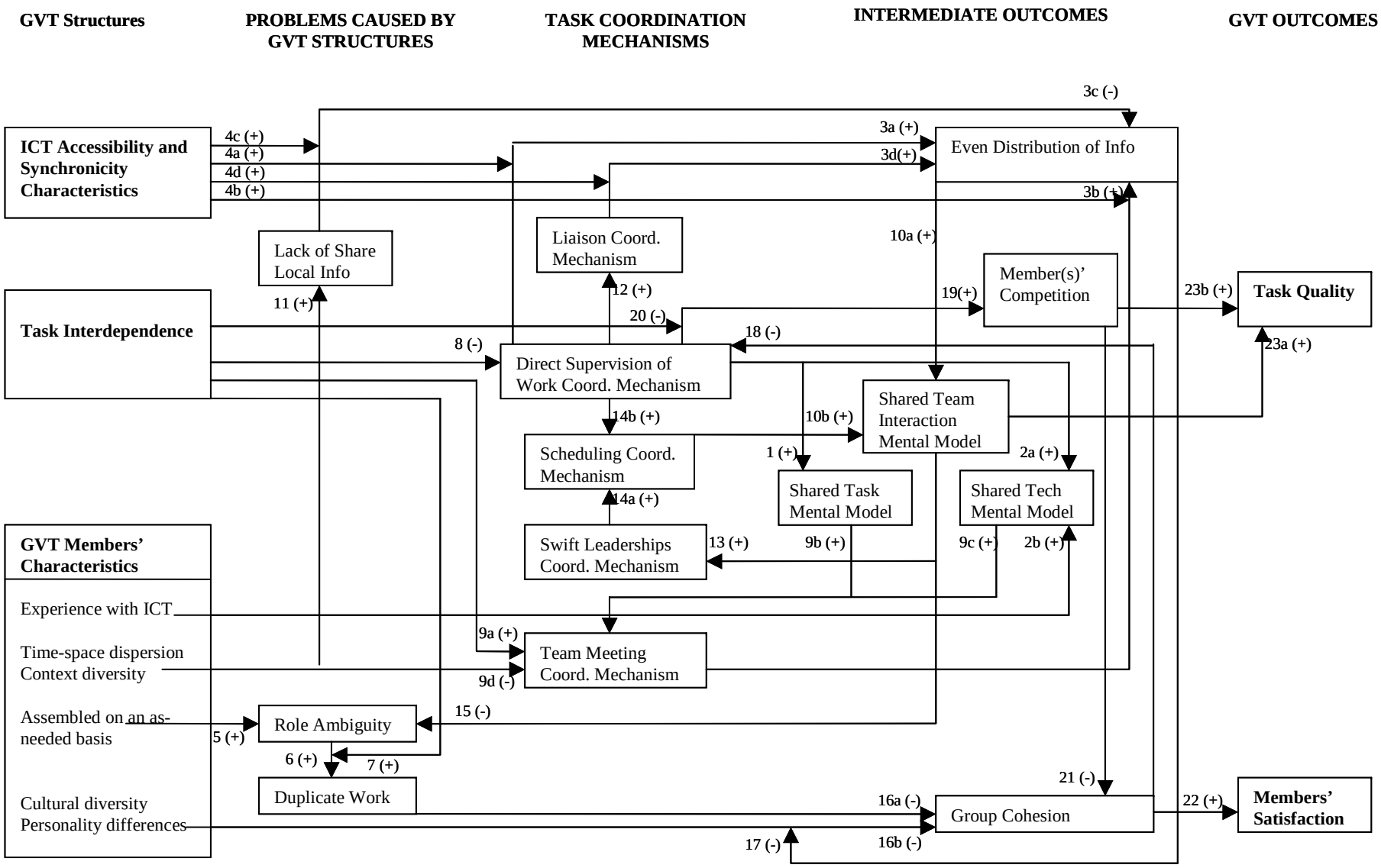

Figure 1. GVT Task Coordination Framework

Unfortunately, the effectiveness of electronic-mediated direct supervision in distributing the same message to all members is bounded by the accessibility and synchronicity characteristics of the ICT being used to deliver the message (3a, 4a in Figure 1). If the message is transmitted using an ICT that is unavailable to some members, there will be uneven distribution of information within the team. Transmitting the message using an ICT with low symbol variety, such as e-mail, risks the message being interpreted wrongly and differently by different members. Moreover, an unreliable ICT and/or a low reprocessability ICT may be responsible for messages being lost.

GVT Members' Characteristics, Task Characteristics, and Problem of Duplicate Work

Once they knew the deliverables, figuring out who should do which subtask became the next coordination challenge for the team. Being assembled on an as-needed basis, role ambiguity was high in the beginning of their collaboration (5 in Figure 1). High role ambiguity, in turn, resulted in duplicate work in the GVT with high task interdependence, but not so in the GVT with low task interdependence (6, 7 in Figure 1). Unlike Team A whose task needed input from all members, almost all of Team B's task allowed members to work independently most of the time.

GVT Structures, Team Meeting, and Even Distribution of Information

Team A mainly used team meetings, whereas Team B was dominated by direct supervision of work. This difference can be explained by the information processing fit. According to Tushman and Nadler (1978), tasks with a minimal amount of interdependence can be preplanplanned and their information processing requirements are minimal. In contrast, highly interdependent tasks cannot be preplanned and are associated with greater uncertainty. In effective GVTs, the higher the task interdependency, the more communication incidents will be initiated (Maznevski and Chudoba 2000). Since team meeting has higher information processing bandwidth than direct supervision, both teams had chosen the most appropriate task coordination mechanism with respect to their task interdependence (8, 9a in Figure 1). Thus, in GVTs (as in traditional teams), fit between task characteristics and coordination mechanisms leads to beneficial outcomes.

Arranging GVT meetings can be effortful yet rewarding. Even when the team is armed with a shared task and/or technology mental model, it is difficult to congregate time-space dispersed and context diversified members (9b, 9c, 9d in Figure 1). Nevertheless, once the members manage to agree on when and "where" to meet, team meetings can bring about even distribution of information toward the development of the shared knowledge of members' interaction patterns (3b, 10a in Figure 1). Team B also used team meetings but mainly for communicating with the supervisor (not for task coordination).

Due to members' time-space dispersion and context diversity, GVTs may suffer from lack of sharing local information (11 in Figure 1). We observed that Team B members did not actively share their local information, leading to uneven distribution of information (3c in Figure 1). To further ensure even distribution of information, each time Team A's manager directed the task coordination of several collocated members, these members would liaise the information to the whole team (12, 3d in Figure 1). Unfortunately, ICT accessibility and synchronicity characteristics can be a bottleneck for even distribution of information through all the different coordination mechanisms (4b, 4c, 4d in Figure 1). As discussed previously, ICT unavailability, unreliability, low symbol variety, and low reprocessability can act as constraints to even distribution of information. Further, members will be frustrated when they attempt to coordinate using an ICT with low access speed. Also, the low immediacy of feedback of an asynchronous ICT (e.g., Web discussion board) may cause senders not to be aware of information ignored by recipients. However, as individuals garner experience in communicating using a specific medium, they may develop a knowledge base for better applying this medium (Carlson and Zmud 1999). As observed from the two cases, after several mishaps caused by the ICT, members in both teams were able to organize a knowledge structure that described the dynamics and control of the ICT. Therefore, GVTs must be cognizant of these limitations of ICTs and work toward rapidly developing shared technology mental models.

Even Distribution of Information, Group Cohesion, and Task Quality

Team A had highly even distribution of information from the beginning until the end of their collaboration, which was not the case for Team B. This is because Team B only had a few team meetings for coordination purposes, they did not share much local information, and there was no liaison to transmit any local updates from the project manager to the whole team. The team meetings in Team A evenly distributed information which in turn resulted in a shared team interaction mental model. Following

the construction of shared team interaction mental model, over time, we could observe the appearance of swift leadership in Team A (13 in Figure 1). Leadership in Team A was rotated based on expertise and each leader would organize "production activities" in a time-patterned sequence (scheduling), which in turn would update the team's shared team interaction mental model (14a, 10b in Figure 1). Without swift leadership, in Team B, the project manager was the one who laid down the team's schedule and dictated Team B's team interaction mental model (14b, 10b in Figure 1). In Team A, we found that after a shared team interaction mental model had existed in the team for some time, each member's role became less ambiguous (15 in Figure 1). In contrast, role ambiguity in Team B was high until the end of the project.

Regarding GVT outcomes, with decreasing role ambiguity, Team A managed to avoid any duplicate work which would have been detrimental to group cohesion (16a in Figure 1). Fortunately for Team B, their high role ambiguity did not cause duplicate work, due to their low task interdependence. However, this did not guarantee them high group cohesion. Team B members claimed that at first they were amazed by their cultural diversity and personality differences and were very accommodating toward the differences. Nevertheless, over time the novelty began to be erode and these differences impaired group cohesion (16b in Figure 1). Things became worse since there was uneven distribution of information in Team B (17 in Figure 1). To handle the situation of low group cohesion, the manager through direct supervision decided to split Team B into two subgroups (18 in Figure 1), particularly since their task had low interdependence (20 in Figure 1). Competition invited by the formation of these subgroups further diminished group cohesion as a whole (19, 21 in Figure 1). With low group cohesion, Team B had lower member satisfaction compared to Team A (22 in Figure 1).

Having a shared team interaction mental model early in their collaboration, Team A members dutifully followed their roles and responsibilities until the end of the project. Team A wrapped up their task with relatively high task quality (23a in Figure 1). In spite of relatively high role ambiguity, Team B managed to attain reasonably high task quality thanks to competition the subgroups (23b in Figure 1).

Conclusion

This study develops a framework to explain GVT task coordination, a phenomenon which impacts GVT performance and yet has not been well studied. The framework outlines how GVT structural characteristics create problems and influence the usage of specific task coordination mechanisms. The framework also outlines how task coordination affects team performance. The findings show how task and member dispersion characteristics can cause coordination problems as well as determine the task coordination mechanisms required by GVTs. The study also indicates that ICTs, while enabling GVT task coordination, have characteristics that may constrain distribution of information in the team. Cultural and personality diversity may impair group cohesion. Formation of shared mental models through task coordination overcomes the problem of duplicate work, and positively impacts GVT task quality. By providing a detailed look at GVT task coordination, this study motivates further research to elucidate the phenomenon and inform practice.

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