Factors that Inhibit Globally Distributed Software Development Teams

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ABSTRACT

Globally distributed teams can frequently have problems specifically related to the distance and differences among team members. This paper synthesizes literature related to globally distributed software development teams to find the factors that inhibit team success. This research indicates that cultural differences, trust, communication, shared mental models, temporal agility, and work transitions can all cause problems on globally distributed software development teams. This research can help both researchers and practitioners gain valuable insights on factors that can affect the performance of globally distributed teams.

Keywords: Global software development; Distributed Teams; Cultural Differences; Communication; Trust; Shared Mental Models; Temporal Agility; Work Transitions

1. Introduction

Software is produced by creative individuals, allowing for the formation of nontraditional development teams that are outside of the normal business routines (Nash, 1994). These nontraditional teams can consist of individuals that work nontraditional hours in nontraditional locations. Software development is more frequently occurring in a globally distributed environment (Agerfalk et al, 2009).More and more companies are finding that teams with diverse backgrounds *that can communicate clearly and effectively* operate in a more successful manner than teams that are purely homogeneous (Granered, 2006). This is influencing companies to not only assemble teams from a variety of locations, but also work to ensure that said teams are functioning in an efficient manner.

Innovations in technology and communications have allowed for the seamless integration of globally distributed teams. Early research on distributed teams has had a focus on technology being a hindrance to team communication. However, these technologies have improved over the last decade and are still improving as we learn about distributed team functionality. Current collaborative technologies will pave the way for future innovations and will continue to improve the way that distributed teams collaborate (Olson & Olson, 2000).

There are a number of benefits that companies can achieve from software development using globally distributed teams. Development costs can be reduced; access to a larger, more skilled worker pool; cycle times can be reduced by using follow-the-sun development; and innovation and processes can be shared (Agerfalk & Fitzgerald, 2006; Sarker & Sarker, 2009; Desouza et al, 2006). As companies are actively seeking ways to reduce costs while maintaining or even improving quality, research such as this is becoming more valuable.

Developing software in a globally distributed environment is rarely trouble-free, however. Globally distributed software development environments have a slew of issues. Issues such as collaboration difficulties due to distance, communication difficulties, cultural differences, coordination complexity, technology, differing development styles, lack of trust, differing personalities, and proper work transition are all examples (Lee et al, 2006; Cusumano, 2008; Olson & Olson, 2000;Fiore et al, 2009;

Sarker et al, 2009). Finding a balance between the benefits and the detriments is necessary for achieving an ideal situation and a fully functional distributed team.

This research seeks to answer the question "What factors affect the performance of a globally distributed software development team?" Specifically, the paper will focus on the causal factors impacting performance from a team-level perspective. This research attempts to synthesize the body of knowledge surrounding globally distributed software development.

2. Literature Review

Existing research was reviewed to come up with key issues specific to globally distributed software development teams. A number of IT/IS journals were reviewed such as *MIS Quarterly, Information Systems Research, Communications of the ACM, IEEE Software, Information Systems Management,* and the *European Journal of Information Systems*. Related topics such as distributed software development teams, virtual teams, and globally distributed teams were searched. While virtual teams are typically defined as temporary teams, they were included in this review because software development projects can have a temporary facet associated with them. Furthermore, virtual teams are by nature distributed and have similar issues associated with them.

A review of the literature indicated some key areas associated with global software development teams. A table summarizing the key papers is located in Appendix A. Overall, it can be noted that a majority of the papers had similarities as far as the issues that were faced by distributed teams. A common thread such as team member trust and the fallout that can result from lack of trust among team members was seen in papers from over a decade ago up until most recently. Culture is another factor that has been prevalent in research related to global software development teams. It seems that even though a large number of papers mentioned culture as something that can have a negative effect on team performance, (i.e. development teams are well aware that cultural differences can cause problems) there does not seem to be an marked improvement in that area. Some have predicted that cultures are merging and homogenizing due to globalization. However, this does not seem to be the case as far as global software development research is concerned. Team mental models are an area that does not seem to be heavily studied in globally distributed software development teams, but nonetheless is an applicable area of study. The research surrounding team mental models fits in well with determining how these models affect performance. A number of additional issues were gathered from the readings. These issues are discussed in detail in the paragraphs following.

2.1 Cultural Differences

One of the most important factors to be considered when dealing with a global team is cultural differences (Olson & Olson, 2000). Cultural differences can be an issue when teams are from a variety of locations (Cusick & Prasad, 2006; Olson & Olson, 2000). Cultural differences can include facets such as cultural background, customs, or even management styles. Hofstede(1983) defines culture as "collective mental programming" (pg. 76) consisting of many different national cultures. Culture (and cultural differences) is/are not purely a product of where team members are located; it can be a potential issue any time teams are heterogeneous. The field of information technology is no stranger to research surrounding culture. This is due in part to the nature of the field; a unique skill set is required in order to create software.

Understanding the cultural makeup of cross-cultural teams can help minimize issues related to cultural relationship problems (Evaristo, 2003).Some ways to alleviate issues associated with cultural differences are cultural training, face-to-face meetings, and team building activities. However, team interactions should be monitored to keep abreast of potential roadblocks. The above activities are not

always the solution that will solve all issues associated with culture. Activities should be carefully planned so as to help the team bond together (and prevent backfire). Newell et al (2007) found that cultural training caused distributed team members to misinterpret actions as shortcomings rather than taking a situational view. It is important that any of the remedies applied are done so in a productive manner.

Hofstede (1983) determined that there were four cultural dimensions - power distance, individualism, masculinity, and uncertainty avoidance; and later long-term orientation (Hofstede, 1991). He studied these dimensions and their differences between fifty-three countries. Researchers such as Kongut & Singh (1988) and Erramilli (1991) have combined the four dimensions from Hofstede (1983) into one measure – cultural distance. These categories can assist team members in better understanding who the team member is on the other side of the globe.

By understanding the categorization of countries on the globally distributed development team, distributed teams gain knowledge of heterogeneous behaviors and how they affect the team (Evaristo& Scudder, 2000).Heales et al (2004) found that national culture can influence development decisions, so keeping a decision concise and consistent may help to reduce barriers put forth by other regions.It can be helpful to come together as an organization to form an organizational culture which entails pieces of each individual's culture but truly brings the organization together as a whole. It is important that companies that have workers on teams that are not collocated develop an organizational culture that allows trust to blossom (Dani et al, 2006). Inclusion of members from multiple locations can help to gain insight from many perspectives and allow the team to function as a whole. Trust is an important factor and is discussed in detail in the next section.

2.2 Trust

Trust has been largely explored in the area of distributed teams and virtual teams. While not completely unique to globally distributed teams, trust is a factor that is significantly important to the proper formation and function of a team. Teams that are high in trust have a more proactive style of action, are more optimistic, and have more predictable, substantive feedback (Jarvenpaa et al, 1998). This can carry forward to make the team more productive. Trust is an important factor in distributed environments and when present, can help reduce complexity and uncertainty (Al-Ani & Redmiles, 2009), two items that can cause team members to doubt one another.

For trust to be formed, a common goal must be present to commence the creation of a relationship (Brenkert 1998). Software development projects are an excellent example of something in which a common goal is achieved. Even though team members may be located in different countries, time zones, or cities, all of the members are seeking to finish the project in a timely and efficient manner. Trust comes into play with that to help the team achieve goals as a team (rather than individually). It should be noted, however, that when teams consist of heterogeneous members, collaboration can be more difficult; thus having an effect on knowledge sharing (Newell et al, 2007) which can also affect the team performance. Team members also might feel reluctant to share information and duties because they are concerned about losing their jobs and/or responsibilities (Newell et al, 2007). It is imperative to communicate openly and frequently as a team (starting with management) to prevent such issues.

It is imperative that trust be formed early on in the development project. Team-building exercises or face-to-face meetings are great methods for building trust. Face-to-face meetings should be held when issues being addressed are milestones such as a kick-off or final walkthrough (Fisher & Fisher, 2001). This will ensure that members get together as a team and will give everyone a chance to communicate together as a whole. Depending on the importance of the project, it may be necessary to temporarily relocate key personnel. Baskerville & Nandhakumar (2007) found that collocation is

necessary for the formation of personal trust. Personal trust can take some time to form, but once present takes some time to diminish.

When communications are task-oriented, (i.e. those that request information/provide an opinion) some time is initially needed for trust to form (Kanawattanachai & Yoo, 2007).Project managers should include extra communication time so that tasks are communicated clearly. Project-related communication, while important, is not the only communication necessary to strengthen trust when teams are globally distributed. Social communication is productive in that it also strengthens trust (Jarvenpaa & Leidner, 1999). When social-based trust is established early on, it can assist with the creation of a team culture (Henttonen & Blomqvist, 2005). Team members are able to share non work-related information (such as what the weather is like and what they did last weekend) and also bring in work-related information such as a new tool the team is using or questions about processes/procedures. By having a mix of the two, it is possible that members will feel comfortable communicating more frequently.

Nicholaou & McKnight (2006) found that perceived information quality builds trust. When two parties are in an information exchange situation (such as a globally distributed team working on a project), trust can be formed by being "competent, benevolent, and honest" (Nicholaou & McKnight, p. 348).This can be solved by frequent communication (such as in weekly or daily meetings, by email, or even picking up the phone for an unscheduled phone call). Trust is inherently situational; when uncertainty is low, the need for trust is less than in a situation where uncertainty is high (Jarvenpaa et al, 2004). That said, trust can be needed more or less, but either way, once it is had, it should be maintained.Successful formation of trust is also imperative for the success of an open source software team (Stewart & Gossain, 2006). Open source software development teams are frequently distributed.

Trust is typically the real reason for failure of a virtual collaborative relationship but frequently technology is blamed (Paul & McDaniel, Jr., 2004). By ensuring that tools that promote information sharing are in place, more effective collaboration and the promotion, enablement, and extension of trust can occur (Al-Ani & Redmiles, 2009). A team that has trust is a more productive team, and communication can aid in the development of that trust (Granered, 2006).When team members are open, give detailed feedback, and respond in a timely manner, the evolution of trust is enhanced (Henttonen & Blomqvist, 2005). However, team members must be cautious, particularly in the early stages of trust formation, not to communicate excessively, hence a negative effect on trust (Jarvenpaa et al, 2004).Trust can also decline when reneging and incongruence are highlighted by behavior control rules (such as certain rules and procedures that will lead to a certain outcome); particularly at the end of the project (Piccoli& Ives, 2003). The next section goes into detail about communication and its effect on globally distributed teams.

2.3 Communication

Communication was another factor that was written about with frequency. Communication is inherently difficult on distributed teams. Being that team members must rely on communication technologies to accomplish tasks; it is imperative for companies to provide adequate software/technology to facilitate communication (Sarker & Sarker, 2009). Communication can consist of technologies such as email, telephone calls, virtual meeting spaces, video conferencing, and using collaborative technologies.

Technologies have improved so that communication for distributed teams can be fruitful. Electronic Meeting Systems can counteract the potential negatives of just a conference call by strengthening the means of communication (Chidambaram & Jones, 1993). Many members of distributed development teams check email outside of normal work hours in order to prevent project delays. Trading off which location has the late night shift can alleviate issues related to burnout and exhaustion. Something

relatively simple, such as adding video capabilities to audio-only communications can improve team interactions and decision-making (Baker, 2002). However, any benefits achieved by the utilization of technology for communication will still not completely prevent conflict (Hinds & Bailey, 2003), so teams must be monitored for functionality.

Language can also act as a barrier when trying to communicate with developers in other countries (Holmstrom et al, 2006). It is important to rely on a common shared language amongst team members. Taking extra time to clarify items can help prevent problems due to misunderstandings. Meeting minutes and weekly summaries can ensure that all team members are on the same page.

Different communication styles can lead to hurt feelings and lengthened cycle time for resolution of issues (Herbsleb & Grinter, 1999). Vlaar et al (2008) looked at how distributed team members create understandings. The authors use the terms sense giving (alter/influence how other think), sense making (primary formation of meanings), sense demanding (asking other team members for clarification), and sense breaking (helping to correct others' incorrect views of reality). These terms consist of individuals coming together to influence each other of a consensual meaning. The authors found that these understandings help promote value creation. More on shared understandings is presented in the next section.

2.4 Shared Mental Models

Fiore et al (2009) put forth that using a narrative form can assist team members in a richer knowledge transfer and thus result in enhanced team development. When team members are working together on a project, it is important that the same common meanings are used. Members of a team might not have a long history of working together, but collective knowledge can allow members to find a sort of common ground to progress as issues arise (Baskerville & Nandhakumar, 2007).

These meanings, referred to as mental models, can help ensure team members are on the same page. Mathieu et al (2000) looked at team mental models and how team process and performance affected these models. The authors found that shared mental models can predict team performance quality. When definitions and common meanings are the same among all team members, walls that were previously built up can be dropped. IN fact, shared mental models can have an increase on the effectiveness of software development teams (Yang et al, 2008). Team mental models are key to achieving shared understanding. It is important for team members to reach consensus on ground rules and values of effective communication (Guo et al, 2009).Lack of shared context has been found to increase conflict in globally distributed teams (Hinds & Mortensen, 2005). This is likely due to the fact that much communication back and forth is necessary in order to clarify meanings. This can leave team members feeling frustrated.

Organizational learning can be improved when shared meanings are developed; particularly clarification of corporate strategic objectives, sharing among team members, and relationship improvements gained by communication amongst the management team (Barcus & Montibeller, 2008). Maruping et al (2009) found that collective ownership and coding standards increased expertise coordination. This can also improve the technical quality of the software. Keeping a flexible yet concise workforce is looked at in the next section.

2.5. Work Transitions and Temporal Agility

Research by Sarker et al (2009) indicated that two of the most important factors associated with distributed software development are work transitions (how work is distributed across the globe and how 24 by 7 work is accomplished) and temporal agility (minimizing wait for information).Distributions can be physical (different locations), organizational (different departments, same project), temporal (separated by time), or across stakeholder groups (users, managers,

developers) (Gumm, 2006). Simple things such as delay of response to email can drastically affect the productivity and incentive to communicate (Herbsleb & Grinter, 1999). Consideration for the other teams' working hours can help keep the project on task. O'Leary & Cummings (2007) looked at previous research to define spatial, temporal and configurational (site, isolation, and imbalance) dispersions and put forth potential measurements. These measurements have potential to be used in this research once data is collected.

This literature review, while extensive, is by no means all-encompassing. However, as mentioned in the beginning of this section, the common themes were brought out with the creation of the spreadsheet (Appendix A). The factors above are detailed and will provide an interesting area of research.

3. Future Directions

Future research would involve studying organizations that currently have globally distributed software development projects. The researcher is looking at additional information regarding the factors mentioned above: cultural differences, communication, language, shared mental models, trust, work transitions and temporal agility and what impact they have on software development performance.

A few areas of future research stuck out as I was conducting the literature review. The first area looks at organizational subcultures. Organizations can sometimes contain subcultures that consist of cultures within cultures. These subcultures must be monitored to ensure that company performance is not affected (Hofstede, 1998). I would like to look at how subcultures affect software development team performance. Even when subcultures are present, national cultures can heavily influence IS development decisions (particularly evolutionary/redevelopment) (Heales et al, 2004). This research will be valuable in determining whether or not subcultures have influence over national cultures.

Open sourcing is a recent term that is used to refer to open sourced software development that is performed by outsourced teams. Open sourced development projects are considered to be global in nature (Agerfalk& Fitzgerald, 2008) and thus could be composed of a distributed global team. Since this is a fairly new term, little research has been conducted relating team performance specific to open sourcing (Agerfalk & Fitzgerald, 2008). I would be interested in looking at open sourced software development projects and which factors affect team performance. Additionally, are companies more open to open sourcing (no pun intended) since open sourced software development is frequently distributed?

4. Implications for Research and Practice

There has been a large amount of research conducted on distributed software development teams but a majority of the research has focused on outsourcing. There are different implications when these distributed teams are part of the same organization. Bird et al (2009) found that when globally distributed development is conducted in-house, quality is not negatively affected. However, when teams are distributed (as is common in offshore projects) both productivity and quality can be negatively affected (Ramasubbu et al, 2008). Future research can be conducted on a number of software development companies to view how performance is affected by globally distributed software development.

In order to continue to gain benefits from distributed software development teams, it is imperative to determine if the factors above truly affect performance. Finding methods to alleviate problems on

development teams can help businesses have more efficient development practices. As mentioned throughout the paper, many of the issues associated with globally distributed software development teams have been in the research for decades. These issues will continue to be important but the ways that companies seek to alleviate them may change over time. It is imperative that research continue to be conducted in order to keep it relevant.

5. Conclusions

This research seeks to bring together existing and new research on factors that will affect the performance of globally distributed software development teams. Performance can entail quality or costs. Although cost is often mentioned as a driving force behind why a company might choose to partake in global software development (Desouza et al, 2006; Berg & Stylianou, 2009), the company's strategy should also be considered.

Globally distributed software development teams have any number of different facets. Research such as this seeks to assist organizations in the management of these teams so that the options available continue to be flexible. By attempting to look into the reasons behind why and how team performance can be affected, this research can benefit both practice and research.

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Appendix A

Barcus, A. & Montibeller, G. (2008). Supporting the Allocation of Software Development Work in Distributed Teams with Multi-Criteria Decision Analysis. *Omega The International Journal of Management Science,* 36(3), 464 – 475.	Software project allocation on distributed teams: bottom up approach to improve communication and maintain consistent terminology.	Consistent terminology
Baskerville, R. & Nandhakumar, J. (2007). Activating and Perpetuating Virtual Teams: Now That We're Mobile, Where Do We Go? *IEEE Transactions on Professional Communication,* 50(1), 17 - 34.	Personal trust is necessary for establishing virtual team relationship for extended periods of time; however collocation is necessary to establish personal trust. Additionally, personal trust dissipates over time particularly when team members are not collocated.	Trust Virtual teams
Berg, B. &Stylianou, A.C. (2009). Factors Considered When Outsourcing an IS System: An Empirical Examination of the Impacts of Organizational Size, Strategy, and the Object of a Decision. *European Journal of Information Systems,* 18(3), 235 – 248.	Firm organization size, competitive strategy, and what is being outsourced significantly affects outsourcing decision	Outsourcing
Bird, C., Nagappan, N., Devanbu, P., Gall, H., & Murphy, B. (2009). Does Distributed Development Affect Software Quality? An Empirical Case Study of Windows Vista. *Communications of the ACM,* 52(8), 85 – 93.	Globally distributed software development projects, when managed effectively, can have a successful outcome	Relationship between sites Cultural barriers Communication Consistent use of tools End to end ownership Common schedules Organiational integration
Chidambaram, L. & Jones, B. (1993). Impact of Communication Medium and Computer Support on Group Perceptions and Performance: A Comparison of Face-to-Face and Dispersed Meetings. *MIS Quarterly,* 17(4), 465 – 491.	An Electronic Meeting System (EMS) can help reduce the negative factors of audio conferences in dispersed teams	EMS, face-to-face vs. dispersed

Cummings, J.N., Espinosa, J.A., & Pickering, C.K. (2009). Crossing Spatial and Temporal Boundaries in Globally Distributed Projects: A Relational Model of Coordination Delay. *Information Systems Research,* 20(3), 420 - 439.	Work hour overlap can positively affect communication for globally distributed teams; temporal boundaries cause more issues with communication technologies than spatial. Coordination delay can hinder project progress.	Spatial boundaries Temporal boundaries Coordination delay
Cusick, J. & Prasad, A. (2006). A Practical Management and Engineering Approach to Offshore Collaboration. *IEEE Software,* 23(5), 20 – 29.	Model for successful offshore collaboration: careful setup and planning, knowledge transfer and training, use of proven Web delivery foundation, established procedures/policies, communication and checkpoints.	
Cusumano, M.A. (2008). Managing Software Development in Globally Distributed Teams. *Communications of the ACM,* 51(2), 15 – 17.	Basic elements for a successful globally distributed team: use iterative development, produce highly detailed requirements for key components, update customer frequently, break system up into well-defined subsystems, team participants should possess strong organizational/process skills.	
Desouza, K.C., Awazu, Y, & Baloh, P. (2006). Managing Knowledge in Global Software Development Efforts: Issues and Practices. *IEEE Software,* 23(5), 30 – 37.	Postmortem project reports can assist in refining knowledge management to alleviate future issues. Knowledge management systems can assist globally distributed team members in gaining shared understanding (by having access to the same information).	

Evaristo, R. (2003). The Management of Distributed Projects Across Cultures. *Journal of Global Information Management,* 11(4), 58 - 70.	Looks at trust as a moderator between cultural differences and distributed project performance. Cultural differences can greatly impact the generation/formation of trust which will stem to project performance.	Trust Cultural differences Distributed project
Gumm, D.C. (2006). Distribution Dimensions in Software Development Projects: A Taxonomy. *IEEE Software,* 23(5), 45 – 51.	Physical, organizational, temporal, and stakeholder distributions are all included in software development project distribution.	
Guo, Z., D'Ambra, J., Turner, T., & Zhang, H. (2009). Improving the Effectiveness of Virtual Teams: A Comparison of Video-Conferencing and Face-to-Face Communication in China. *IEEE Transactions on Professional Communication,* 52(1), 1 – 16.	Shared understanding amongst virtual team members can improve team meeting outcomes and reach levels similar to that of face-to-face teams	Virtual Teams Shared Mental Models
Heals, J., Cockcroft, S., & Raduescu, C. (2004). The Influence of National Culture on the Level and Outcome of IS Development Decisions. *Journal of Global Information Technology Management,* 7(4), 3 – 28.	National culture affects decisions; IS development is influenced at the managerial level	cross-cultural teams
Henttonen, K. & Blomqvist. (2005). Managing Distance in a Global Virtual Team: the Evolution of Trust Through Technology-Mediated Relational Communication. *Strategic Change,* 14(), 107 - 119.	Social-based trust can be created in the beginning stages of a relationship and thus assist with creating a team culture. Face-to-face meetings can assist in the development of social-based trust. This will also facilitate communication.	

Herbsleb, J.D. & Grinter, R.E. (1999). Architectures, Coordination, and Distance: Conway's Law and Beyond. *IEEE Software,* 16(5), 63 - 70.	Coordination mechanisms and informal communication are paramount to successful multisite development. Common understanidng of the development process and design stability are necessary. Development is best split up when requirements/architect ure/processes are stable	Geographicall Distributed Development Trust Communication Time Difference Common Understanding
Hofstede, G. (1998). Identifying Organizational Subcultures: An Empirical Approach. *Journal of Management Studies,* 35(1), 1 – 12.	Method developed for empirically assessing subcultures and thus be able to keep abreast of intraorganizational cultural variety	3 subcultures: professional, customer interface, and administrative
Holstrom, H., Fitzgerald, B., Agerfalk, P.J., & Conchuir, E.O. (2006). Agile Practices Reduce Distance in Global Software Development. *Information Systems Management,* 23(3), 7 – 18.	Temporal (time zone), geographical, and sociocultural distance (organizational and national culture, language, politics, individual motivations, and work ethics) are challenges associated with global software development. Quality was considered high for the two companies using paired programming. Flexibility was key. Maintaining good communication, control and coordination are additional challenges noted by the authors.	Temporal distance, geographical distance, sociocultural distance
Javenpaa, S.L., Knoll, K., & Leidner, D. (1998). Is Anybody Out There? Antecedents of Trust in Global Virtual Teams. *Journal of Management Information Systems,* 14(4), 29 - 64.	Team building did not directly affect trust. Reinforcement of trust may be achieved by proactive behavior, positive tone, rotating leadership, task communication, task goal clarity, time management, role division, and interaction and response to prior	Trust Virtual team

	messages.	
Jarvenpaa, S.L. & Leidner, D.E. (1999). Communication and Trust in Global Virtual Teams. *Organization Science,* 10(6), 791 - 815.	Project-related communication strengthens and maintains trust. Social communication (when it is in addition to project-related communcation) can also strengthen trust. When initial trust is high, problem-solving and conflict resolution are obtainable even if communication is limited to electronic.	Communication Global virtual team Trust Cultural differences
Jarvenpaa, S.L., Shaw, T.R., & Staples, D.S. (2004). Toward Contextualized Theories of Turst: The Role of Trust in Global Virtual Teams. *Information Systems Research,* 15(3), 250 - 267.	Trust can depend on the situation at hand; when uncertainty is low, the need for trust is reduced. Additionally, when trust is high, team members are more forgiving when communication delays and reductions occur. In the early stages of the relationship, if trust is high and communication is frequent, a slight negative effect is seen.	Virtual team Trust Communication
Kanawattanachai, P. & Yoo, Y. (2007). The Impact of Knowledge Coordination on Virtual Team Performance Over Time. *MIS Quarterly,* 31(4), 783 – 808.	Volume of task-oriented commnication significantly affects team performance (particularly in the initial formation stages). It can take some time for a team to develop a TMS (Transactive Memory System - a particular level of encoding, retrieving and storage of knowledge) but once developed, communications can be	TMS Trust

	streamlined	
Lee, O., Banerjee, P., Lim, K.H., Kumar, K., Van Hillegersberg, J., & Wei, K.K. (2006). Aligning IT Components to Achieve Agility in Globally Distributed System Development, *Communications of the ACM,* 49(10), 49 – 54.	Globally distributed system development can be achieved by: flexible partnerships, coherence between global business and system development strategies, IT platform standardization, make use of local expertise (maintain global standards), roles and responsibilties clearly defined, systems component version control, know about new technologies, and knowledge of relationships between IT strategy, IT infrastructure and project management	
Maruping, L.M., Zhang, X., &Venkatesh, V. (2009). Role of Collective Ownership and Coding Standards in Coordinating Expertise in Software Project Teams. *European Journal of Information Systems,* 18(4), 355 - 371.	Use of coding standards improves expertise coordination and enhances technical quality of the software project	Expertise coordination in agile development software projects
Mathieu, J.E., Heffner, T.S., Goodwin, G.F., Salas, E., & Cannon-Bowers, J.A. (2000). The Influence of Shared Mental Models on Team Processes and Performance. *Journal of Applied Psychology,* 85(2), 273 – 283.	Overlap of team member knowledge along with synergy of the knowledge can have a predictable outcome.	Team mental models

Newell, S., David, G., & Chand, D. (2007). An Analysis of Trust Among Globally Distributed Work Teams in an Organizational Setting. *Knowledge and Process Management,*14(3), 158 - 168.	Keeping relationships at a professional level hindered the development of trust and thus created an 'us versus them' situation amongst the distributed teams. Cultural training did not alleviate issues between the teams but merely redirected team members to see issues as 'cultural differences' rather than lack of trust and reduced knowledge sharing.	Trust Distributed work settings Culture Knowledge sharing
O'Leary, M.B. & Cummings, J.N. (2007). The Spatial, Temporal, and Configurational Characteristics of Geographic Dispersion in Teams. *MIS Quarterly,* 31(3), 433 – 452.	This paper looks at previous research and breaks down geographic dispersion into temporal, spatial, and configurational dimensions. Specific formulas are set forth for each dispersion index.	Spatial distance Temporal distance Configurational (site, isolation, imbalance)
Olson, G.M. & Olson, J.S. (2000). Distance Matters. *Human-Computer Interaction,* 15(2/3), 139 – 178.	Common ground must be established to effectively communicate (and achieve greater productivity). Tightly coupled work is difficult to achieve in remotely located teams; formal communication processes should be established. Organizations need to be prepared to collaborate; work setting should facilitate sharing. Collaboration technology readiness must stem from the organization and the technology it has in place.	Common ground Coupling of work Collaboration readiness Collaboration technology readiness

Paul, D.L. & McDaniel, Jr., R.R. (2004). A Field Study of the Effect of Interpersonal Trust on Virtual Collaborative Relationship Performance. *MIS Quarterly,* 28(2), 183 – 227.	The presence of interpersonal trust helps reduce complexity and have a positive effect on VCR (virtual collaborative relationship)	Interpersonal trust (calculative, competence, relational, integrated)
Piccoli, G. & Ives, B. (2003). Trust and the Unintended Effects of Behavior Control in Virtual Teams. *MIS Quarterly,* 27(3), 365 - 395.	Decline in trust in virtual teams is made more apparent in cases where behavioral control mechanisms highlight instances of reneging and incongruence. This is particularly detrimental at the end of the project. Continuous and frequent interaction can minimize.	Reneging, incongruence lead to decline in trust
Ramasubbu, N., Mithas, S., Krishnan, M.S., & Kemerer, C.F. (2008). Work Dispersion, Process-Based Learning, and Offshore Software Development Performance. *MIS Quarterly,* 32(2), 437 – 458.	Dispersion of tasks in offshore software development adversely affects software development performance; structured processes and process-based learning can help to neutralize adverse affects	Structured process models; investments in structured processes and activities associated improve performance
Sarker, S., Munson, C.L., Sarker, S., & Chakraborty, S. (2009). Assessing the Relative Contribution of the Facets of Agility to Distributed Systems Development Success: An Analytic Hierarchy Process Approach. *European Journal of Information Systems,* 18(4), 285 – 299.	Managers focus on resources, technical workers focus on operational aspects. Factors of importance for on-time completion were people, technology, temporal, work transition, methodological, communicative, environmental, and cultural. Effective collaboration agility facets were: communicative, cultural, work transition, temporal, people, methodological, environmental, and technology.	Facets of agility for on-time completion

Sarker, S. & Sarker, S. (2009). Exploring Agility in Distributed Information Systems Development Teams: An Interpretive Study in an Offshoring Context. *Information Systems Research,*20(3), 440 – 461.	Agility in globally distributed teams can be broken down into process, linkage, and resource agility. Cultural barriers must be contracted and efforts to shape communication	Agility Global IS Development
Stewart, K.J. & Gossin, S. (2006). The Impact of Ideology on Effectiveness in Open Source Software Development Teams. *MIS Quarterly,* 30(2), 291 – 314.	Affective trust (formed from emotional attachment and related to why a developer might join, stay on, and contribute) is an important factor of input effectiveness.	Affective trust Cognitive trust OSS team effectiveness
Vlaar, P.W., van Fenema, P.C., &Tiwari, V. (2008). Cocreating Understanding and Value in Distributed Work: How Members of Onsite and Offshore Vendor Teams Give, Make, Demand, and Break Sense. *MIS Quarterly,* 32(2), 227 – 255.	Distributed team members use sense giving (alter/influence how others think) sense making (primary formation of meanings) sense demanding (asking other team members for clarification) and sense breaking (helping to correct others' incorrect views of reality) to help alleviate problems associated with understandings (and achieve performance improvements)	Sense giving Sense making Sense demanding Sense breaking
Yang, H.D., Kang, H.R., & Mason, R.M. (2008). An Exploratory Study on Meta Skills in Software Development Teams: Antecedent Cooperation Skills and Personality for Shared Mental Models. *European Journal of Information Systems,* 17(1), 47 - 61.	Shared mental models positively affected software development teams	Shared mental models Team effectiveness