Overcoming the Challenges of Communication and Intercultural Problems in Managing Distributed Software Projects

Tanmaya Kumar Das, Dillip Kumar Mahapatra, Gopa Krishna Pradhan

Abstract— Managing a large, distributed software-intensive system is a complex and intrinsically difficult task. The system is complex and can involve hundreds of staff, years of skilled effort, large budgets, and potentially thousands of activities. Many perspectives attest to the facts that the delivery of complex systems on time, within cost, and meeting customer requirements is a significant problem, and that the number of complex systems is increasing The most important factor that influences the management of geographically distributed software projects is communication among organizations, customers, the developing teams etc. This paper addresses the challenges of communication in managing these projects.

Keywords: Communication challenges, Collaborative tools, Cross cultural Communication, Distributed project management Media synchronization.

I. INTRODUCTION

The globalization of the economy has lead to several organizations to distribute geographically its resources and investments aiming to obtain better results. Physically distributed environment is a new tendency of software development, in which users and development teams are in different places, sometimes in different countries with diverse cultures. The software development area has been the first one in this distribution process, in countries such as India and Ireland. Greater productivity, cost and risk reduction and quality improvement, are some characteristics that large organizations pursue when spreading its software development processes offshore.

Software development by distributed collaborators has also been conceptualized as “global software development”. This conceptualization is based on the observation that software development is increasingly a multisite, multicultural, globally-distributed undertaking .Conceptually, global software development can therefore, be compliant with all of the three concepts mentioned above.

The process of globalization is encouraging people to work across national boundaries more and more often. The changes within the global business structure demand the need of business managers competent of managing projects and programs involving distributed teams and also gain a competitive advantage for their organizations through the mix of cultural values(Ref. 01).

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Diverse cultures encompass dissimilar cultural value systems. The value systems are generated from an assessment of existing means or resources, and needs. Cultures have different standards and some factors for example: actions, rituals or expressions of one culture can be observed as irrelevant or sometimes even threatening by other cultures. These factors can lead to cultural gaps between people within a work group.

People with diverse cultural value systems working together may lead to conflict situation and/or disagreement. Methods of handling conflict may differ from one culture to another. Business managers must be able to manage conflict using a variety of different styles, depending on the circumstances, in order to effectively manage a distributed team. A multi-cultural project team has a much broader range of knowledge, skills, abilities and experiences because of different cultural frameworks, and is therefore better armed to solve problems and make decisions.

Large scale software development needs substantial amount of coordination because software work is carried out simultaneously by many individuals and teams, and then integrated. Software parts need to integrate and interoperate properly, and development schedules need to be synchronized, creating dependencies among tasks and people. Global software development is not just a technical process of building software or information systems but also a social process involving stakeholders from multiple organizational units. Culture plays a major role in the effectiveness of such global teams. The problem is more profound especially for Indian companies that acquire foreign entities.

This paper emphasis on the extensive technology-supported teamwork and communication in global software development and also to overcome the intercultural problems in managing distributed software projects(Ref. 01).

II. COMMUNICATIONS AMONG DISTRIBUTED TEAMS

Communication is so important to project success that it has been referred to as the lifeblood of a project by more than one practitioner. The importance of communication across project interfaces between different groups within an extended project team and interfaces is one of the constraints that limit project success and may be called as an obstacle to project communication. To make sure that the right people get the required information at the right time in project management and make the right decision on that project it requires an ideal deal of planning.

For effective information distribution, there must be selection of the right equipments as well as methods to make sure that the information reach to the preferred people. The best methods to use in information distribution are based upon the information that needs to be distributed, environment, project size, and access to software, company policies, and the audience needed to get the information and the timeline for a desired response.

For any software project management, there are very common project communications interfaces are used like; between organizations, between departments within an organization, between teams within a department and within distributed teams (Ref. 03).

The best environment is when all developers (local and remote) feel part of the larger team and make decisions for the benefit of the single team. But how is it possible?

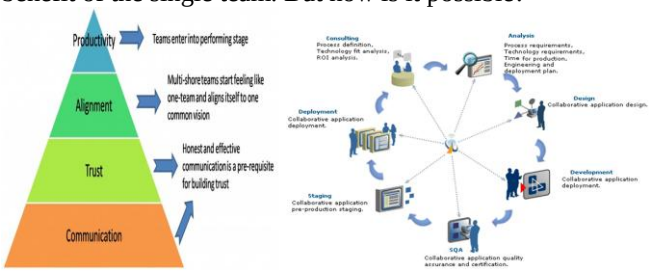

Fig.1 Communication and information sharing among distributed teams

Information sharing and communication are key challenges in distributed software projects and require high levels of communication.

Face-to-face communication, frequent customer conversations and collaborating team members are fundamental but how can it be a high level of collaborative communication?

Honest and effective communication is a pre-requisite for building trust.

Teams of all kinds are commonly spread across multiple geographical locations but can still work effectively, primarily because of the increased availability of networks. However, it is especially important with distributed teams to find ways to compensate for the loss of the casual human interaction that is so important in building strong personal relationships.

A. Challenges of Communication

Communication is the process of getting information to project stakeholders and developer teams at different places in a timely manner by: Implementing the communications management plan and Responding to unplanned requests for information. Information distribution requires effective use of communication.

One of the big challenges faced by distributed teams is how to get over the communication gap created by the physical distances that separates them. We all know that communication, either verbal or non-verbal, is fundamental for any project to be delivered successfully. When a team is good at communicating, they cultivate a more effective sense of collectivity and cooperation, having faster feedback, by sharing information (knowledge) and having valuable discussions. But this is not quite the real world for distributed development teams. It's much harder, to know what exactly is happening on each other's mind. What problems and technical challenges are they facing? What are they doing now? What points are they considering when designing a new feature? How important is for them to write tests? Are they following the project development standards?

We do summarize ten highlighted challenges faced by distributed teams when working towards a common objective in a globally distributed environment.

- Without regular (as far as possible, daily) communication, it is easy to misunderstand what another team member is doing and miss important things. This could lead to the team going out of sync and not discovering it in time.
- For a distributed team, connectivity is of utmost importance. Issues like power supply failure, Internet connectivity problems, login failures etc. could lead to a lot of time being wasted during meetings / discussions.
- When the team members are based in different time zones, the overlap may be very thin. Hence, some or the other team member may be required to make compromises on personal time.
- When communication happens through email exchanges, the action items or discussion points may get lost if not properly maintained and recorded. This is true even with a local team, but is more pronounced in distributed teams. Without face-to-face interaction, the chances of vital information and/or creativity getting lost in translation is very high.
- Establishing rapport with team members one has never 'met' could take time and may give rise to a feeling of distance between them. This could lead to hesitation in discussions, hindering open and free communication that is essential for the team to function well.
- When working with or learning new tools, a person isolated from his team may hit roadblocks and find it difficult to get help. Similarly, it might not be as easy to provide training to a remote team member as it is to one sitting nearby, even with technologies like remote desktop access, screen sharing etc.
- Pairing for a task over the Internet is not as easy as when two people are seated side by side.
- Maintaining a remote team to work together could be expensive because of the technical & human resources required to keep them in sync, motivated and up-to-date. For example, without effective version control system, project/defect tracking tools, conference call/chat software's, multiple team leads for different locations etc. the team could lose its way.
- It's difficult enough to try to carry on teamwork and business across oceans when all participants share the same language and cultural norms, but add language and cultural differences into the mix and there is potential for miscommunication and misunderstanding (and sometimes comic relief!) when teams work together virtually.
- Distributed teams don't get much face time with the leadership of the organization or team, and may feel left out and become unmotivated if leadership doesn't continuously integrate offshore teams into core business culture, activities, and initiatives(Ref. 05).

We like to address some of the main communication obstacles like;

***Political*:**
Whenever there are many groups involved, there's the possibility of vested interests and power games getting in the way of dialogue. Such political obstacles usually originate in the upper ranks of an organizational hierarchy, a step or two above levels at which projects are planned and executed. Project managers therefore need to make special efforts to be aware of the key political players in the organization. In traditional corporate environments these might be functional or senior-level managers who aren't always obvious project stakeholders.
Once the political players have been identified, the project manager should take steps to gain their confidence and buy-in on project goals. This should help eliminate political barriers to project communications. In my experience, it is best to settle political issues at the level where they originate - escalating political problems up the hierarchy (i.e. to the manager's manager) generally doesn't help, and may even be counterproductive.

Geographical:
It has been observed that the frequency of communication between software developers would drop radically over a short distance and that the frequency would remain at the same low level over longer distances, whether the software developers were located at few meters or miles apart. The physical separation between team members raises the need for mediated communication between team members, as frequent face-to-face communication is not a feasible option for people working in distinct sites. The decline of face-to-face communication as a viable communication medium puts forth several challenges on planning and implementing communication practices within a distributed team and project.
Firstly, the richness of mediated communication media is less than that of face-to-face communication. The lack of media richness affects different engineering tasks differently: while some tasks can be performed fairly well with leaner communication media, ambiguous tasks, such as planning, solving severe problems or maintaining the sense of togetherness within the team, can be greatly hampered by the lack of additional cues provided by non-mediated communication. In addition to limitations imposed on communication media richness and synchronicity, physical co-presence provides team members with awareness of many aspects related to their team and project. Overall project awareness — the comprehension about what is going on in the project — can be much more difficult to attain when people are not sharing the same physical space. Physical co-location forces this awareness to team members: when-ever there is active discussion within the shared physical workspace, team members are involved in it, whether actively or passively.

Temporal distance:
Distributed software development often involves working in different time zones. This temporal distance — distance in time — further limits the possibilities for communication and collaboration between distributed team members. The difference between time zones of different sites decreases the number of common working hours for both sites, thus constraining the opportunities for having shared, synchronous communications. The limitation on common working hours for all sites affects the daily work by introducing delays, as one party may be requesting information when another party is not working. Moreover, the lower number of common working hours limits the maximum length of common meetings, which in particular affects planning sessions in iterative and incremental software development projects.
As with physical distance, the challenge for providing awareness for the whole team is an important issue, and solving this issue becomes increasingly difficult as temporal difference increases. The less overlap the team members across different sites have in their working hours, the fewer are the opportunities to use synchronous communication within the team. Synchronous communication is especially useful in providing real-time information about the status, progress and context of the project, in addition to being useful in communicating and collaborating across sites instantaneously and on ad-hoc basis.

Organizational distance:
Under the term organizational distance, we group all phenomena resulting from working across organizational boundaries, whether they are caused by differing working practices, organizational culture, financial rivalry or other conflicts of interest. While many of these issues will be present when working with an external customer, involving multiple organizations to work with the actual software development is usually even more challenging.
Many distributed software projects may be built through relationships between either two organizationally separate entities, which may belong to the de jure part of the same company structure or be completely separate legal entities. In larger companies, it may not even be relevant whether the two organizations are part of the same company, as the organizational culture may still be different in different branches of the company, and as there might be intra-company rivalry and conflicting interests between the two organizations.
The implications of organizational distance on tool support for distributed software development are manifold. Depending on the level of trust between the organizations — and the measures in place to increase and control the trust — there might be trade secret and intellectual property rights to be respected and protected. In many of the case projects studied, we found a need to hide some information, e.g. resource utilization or technical details, from external organizations.

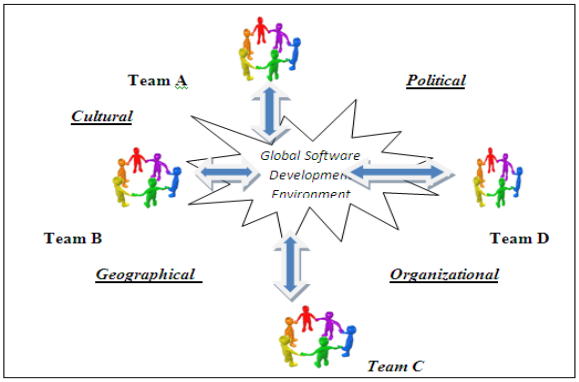

Fig. 2: Communication obstacles in Distributed Software Project management

***Cultural*:**
It is essentially the totality of assumptions and values commonly held within an organization. Clearly, this can vary considerably between organizations - some may be more open than others, for example.

Communication at the interface between two organizations with vastly differing cultures can be difficult. For example, one might expect some differences of opinion at a joint project planning session involving a very forward-looking, can-do supplier and a conservative, risk-averse customer. Another example: in one organization it might be considered perfectly natural for a developer to air a dissenting opinion at a meeting whereas in another it might not. Project managers can ease such difficulties by understanding the divergences in attitudes between the parties involved, and then acting as intermediaries to facilitate communication.
In geographically distributed (or virtual) teams, differences between regional cultures can come into play. These could manifest themselves in a variety of ways such as differences in fluency of language, or social attitudes and behaviors. Here again, the project leader, and the rest of the team for that matter, need to be aware of the differences and allow for them in project communications.

***Linguistic*:** Here we use the term linguistic in the sense of specialized terminology used by different disciplines such as Accounting, IT, Marketing etc. Often when specialists from diverse areas get together to discuss project related matters, there's a tendency for each side to make assumptions (often tacitly) regarding a common understanding of specialized jargon. This often leads to incomplete (at best) or incorrect (at worst) communication (Ref. 01).

A shared world-view, which includes a common understanding of tools, terminology, culture, politics etc. - is what enables effective communication within a group. Project managers can facilitate a common understanding in their projects by analyzing and addressing communication constraints at interfaces (Ref. 01).

2.2 Dealing with Communication Challenges

As there are different teams of all kinds are commonly spread across multiple geographical locations but can still work effectively, primarily because of the increased availability of networks. However, it is especially important with distributed teams to find ways to compensate for the loss of the casual human interaction that is so important in building strong personal relationships (Ref. 05).

i. Communication Methods

The communications requirements for distributed teams can not be addressed without good advance planning. Mainly we consider two key tools i.e. . *Communication Methods* which is used to distribute information using meetings, video and audio conferences, computer chats, and other technology base methods and Information *Distribution Tools like* Hard copies, press releases, and shared databases, Electronic communication and conferencing tools (e-mail, fax, voice mail, telephone, video conferencing, and web publishing and Electronic project management tools (protect management software, meeting support software, portals, etc.)

More precisely, some of the additional communications methods to consider for use with distributed teams include; *satellite team at customer site, conference calls, electronic mail, on-line meetings* and *face to face(one-on-one).*

- *Satellite Team at Customer Site*

During the early activities of a project, direct interaction between members of the customer and the delivery team is especially important. For this reason, consider arranging for a subset of the project team to work on the customer site for at least the initial phase of a project. Direct interaction enables the delivery team to better understand the customer's business and technical environment, and also provides an early opportunity to establish the personal relationships with the customer that contribute significantly to project success.

Depending on specific project needs, some members may or may not remain on site permanently for the duration of the project. When a release is complete and ready for final testing and implementation, the team at the customer site may need to be augmented to ensure a smooth transition of the release into production.

- *Conference Calls*

Plan to make extensive use of conference calls to bring team members from dispersed sites together to review status, resolve issues or walkthrough designs and strategies.

- *Electronic Mail*

Electronic mail is now a standard communication method for most office-based operations worldwide. E-mail can be especially effective for distributed teams as it facilitates communications across time zones, allowing ideas to flow freely regardless of the time zone at each end. As well, the use of e-mail has the benefit of generating a documented and searchable audit trail.

- *On-line Meetings*

The increased availability of high speed networks and technologies such as audio conferencing, videoconferencing, whiteboard, and application sharing over the Internet, has made possible network-based on-line meetings. On-line meetings provide the convenience of an interactive meeting without the cost of travel.

- *Face to Face*

Even with everything that technology can provide, there is no complete alternative to the benefits of meeting face-to-face. In recognition of this, make sure that the project budget allows for regular face-to-face visits between key team members, at both the customer and the delivery team's premises. A certain amount of face to face contact is the only way to ensure that the contribution made to project success by direct human interaction is not lost.

ii.Managerial Skill for Communication

Of course, getting to that leading edge doesn't happen overnight. Even seasoned project managers need to master new skills when it comes to taking things up to the cloud. If you're one of them, here are 3 skills that you'll need to master before you reach elite status (Ref. 01):

- *Cross Cultural Communication:*

The Project manager needs to take into consideration the various cultural preferences and expectations of the distributed project team members. It's never a good idea to assume that how to define great communication and inspiring motivation translates perfectly (or even functionally) into someone else's culture. What one culture finds aggressive, another can find ambitious. What one culture finds motivating, another can find confusing. Talk to the people in a team and, if necessary, connect with cultural advisors outside of the project who can provide a quick "crash course" in how to communicate with cross-cultural team members. The manager doesn't need to become a cultural expert here. But necessary to know the basics so what it means to communicate and what are communicating.

- Meeting Management:

1) For efficient management, Meetings must actually have a purpose. However, working with distributed teams requires some adjustments here. It may not be needed to have daily meetings. But likely to set up a kind of meeting management system, so that team members stay "plugged into" the project, even though they might be located on the other side of the world. Technology certainly helps here. It is important for a manager to understand that meetings in the distributed project world take on a slightly more important symbolic meaning than they normally do. They can serve the purpose of getting everyone (virtually) together, which can be significantly helpful for the overall integrity of the project.

- Technology:

2) It is more important to use the technology that helps project managers for efficient management of distributed software projects.

These days, there are a select few project management software solutions that not only take project managers to manage, but actually make it beneficial and rewarding to do business there. That's because these superior project management software solutions are designed and thus:

- are robust, highly functional and yet easy to use with very little orientation or ramp-up time
- integrate seamlessly with CRM, Google Docs, Accounting, Outlook, and other useful cloud-based productivity tools
- offer a secure cloud environment for sharing and transmitting project information
- are highly customizable to meet the unique needs of each project – or changes that take place during a project
- offer real-time status updates so that project managers get instant access to the quality decision-making information they need

iii. Communication Supporting Tools

The knowledge on choosing, using and evaluating communication and collaboration tools for teams aims at modeling, refining and generalizing the findings and results from research on communicative and collaborative activities within and between teams. Specifically, media choice theories try to explain the reasons why certain tools should be used for a certain task or activity (Ref. 03).

In many cases, there are several ways (media) for delivering the same message. These media typically differ in the extent they restrict or constrain the possibilities to express, deliver and present the idea. Such constraints can be either due to the medium's ability to address different human sensory systems (e.g. audio-only medium vs. text-only medium), to its ability to represent the intended message (e.g. availability of special characters for mathematics or the resolution for graphics), to the message producing capabilities of the medium (e.g. possibility to use moving image), and to the social "constraints" of a given medium (e.g. availability of a certain medium for senders and recipients).

In this paper, two vital and useful techniques for choosing the right tool for different communication situations in software engineering are characterized.

Assessment of Message characteristics and media

There are four characteristics those try to assess what characteristics of a message and its medium lead to successful communication: its capability for immediate feedback, the number of cues and channels available, the language variety, and the degree to which intent is focused on the recipient.

Based on these characteristics, it can be suggested that face-to-face communication is the most reliable medium for communication, followed by video (visual + audio communication) and audio-only communication. Text-only media are considered to be less reliable, or leaner, media for communication. In addition to a categorization based on a purely sensory basis, it can also be suggested that differences in the richness of the media based on the intended audience for the message: media that are more directed or addressed (e.g. personal letters, or one-to-one discussions) are considered richer than unaddressed media (e.g. bulk letters, reports, or lectures from one-to-many).

For the message, there are two characteristics to consider: message uncertainty and message equi-vocality. Message uncertainty is a factor derived from the difference between information already possessed by the individual (or organization) and information required for a certain task or activity. Message equi-vocality is a concept for message ambiguity, caused by conflicting interpretations about e.g. a situation or environment.

- **Media Synchronization**

The extent to which a communication environment encourages individuals to work together on the same activity, with the same information, at the same time,that leads media synchronization.

Effective media use requires a match between media capabilities and the fundamental communication processes needed to perform the task. The synchronization technique focuses on two communication processes: conveyance (exchange of information), and convergence (development of a shared meaning for the information).

While many tasks involve both conveying information and converging on shared meanings, a single communication media is often able to either convey information or converge knowledge. The media synchronization suggests that multiple communication media should be used when performing a task.

iv. Communication and collaboration tools

There are several categorizations for communication and collaboration tools depending on the purpose of the assessment and viewpoint of the evaluator.

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Media synchronicity theory gives five characteristics for a communication tool, through which one may evaluate its suitability for the two communicative goals defined by these two techniques, information convergence and conveyance. The five characteristics such as Immediacy of feedback, Symbol variety, Parallelism, Rehears ability ,Re-processability (Ref. 03).

Immediacy of feedback represents the extent to which the communication tool allows the communicating parties to be aware whether the message was received, understood and acted upon by the recipients. As the tool provides support for feedback from recipient to sender, it helps the sender (the source of information) to verify and evaluate the reception of the message. Through feedback it is possible for the recipient to notify the sender about ambiguous issues in the message, and for the sender to reply with clarifications and to provide additional information. The extent to which a tool provides possibilities to feedback — and the latency between a message and the feedback for the message — define much of the suitability of the communication tool for tasks requiring tight and synchronous collaboration.

The symbol variety of a communication medium determines the possibility to express various messages and meanings over the medium. The concept of symbol variety is closely related to the concept of medium reliability. However, the symbol variety of a communication medium extends the concept of richness in the sense that it focuses also on the variety of symbols within a single medium rather than looking at the variety of additional cues available for conveying message through the communication tool. The effect of a high symbol variety in communicative processes is to make the expression of complex ideas easier, as the medium with the higher symbol variety provides more ”building blocks” for constructing the message.

Communication media differ in the *degree of parallelism* they provide for the communicating parties. Some communication media require the full attention of the communicating parties, while another may allow people to perform other activities at the same time, without lowering the efficiency and utility of the communication medium. The degree of parallelism affects the way a communication tool can be integrated into other work activities. For some tasks, e.g. programming, it may be beneficial to be able to communicate with peers and still be able to continue to work on the task, while for other tasks, e.g. planning sessions conducted via a communication medium (e.g. teleconference or video conferencing) it may be more desirable to force every participants' attention to the task at hand. Parallelism is also related to the immediacy of feedback of the communication medium. In many cases, a medium providing less immediacy of feedback tends to provide more parallelism.

Rehears-ability is a characteristic of a communication medium that allows the sender time to review, rethink and rephrase the message before sending it to the recipient. The possibility of spending time to review and modify the message privately before sending it helps the sender to fine-tune the expression, and gives extra time to ensure that the message is properly expressed, understandable and consistent.

The ability to rehearse the message makes it easier to produce understandable messages even if language skills would be less than perfect. In addition to allowing time to review spelling and syntax of the message, it also makes it possible to restructure the message, making communication more precise and efficient. As senders may review the communication be-fore sending it, it reduces the barrier to initiate discussion, and makes it easier to engage in on-going exchange of ideas.

Reprocess-ability of messages from a communication medium is a characteristic related to rehears-ability, but addresses the issue of managing the messages during or after the communication has occurred. Reprocess ability represents the extent in which the sender or the recipient is able to revisit the communication event at a later point of time. A communication medium with high reprocess-ability provides its users with means to review the con-tents and participants of communication, to process the communicated in-formation, and to relate the message with earlier communications and other sources of information. The ability to do so helps the communicating party to form a better understanding of the nature and meaning of the communication, to acquire and review additional information required to comprehend the intended message, and to reorganize the information into more suitable form for further use. Reprocess-ability further enhances the ability of a participant in communication to explain the contents of the communication to other parties, who have not taken part in the original communication event.

v. Dealing with communication obstacles

As previously in section 2.1, we have mentioned few obstacles for communication during distributed software project management. Here we discuss the use of collaborative tools to deal with these obstacles such as geographical distance, temporal distance, organizational distance and cultural distance (Ref. 02)

- In distributed projects, there are several practices and tools, which aim for improving the project level awareness, such as task and issue trackers or frequent regular team meetings. Using such instruments adds overhead to the project, but is crucial in implementing project awareness in distributed teams, and thus reduces the risk of duplicate or erroneous work within the project. In addition to providing informal awareness about the project context and status, physical proximity provides awareness about presence and availability of people. In a shared team room it is easy to evaluate whether a fellow team member is available for interaction. In distributed settings, there is a need for tools providing presence awareness for remote team members. Such tools in a common use usually include instant messaging systems, which al-low people to set their own presence status (e.g. available, busy, out of the office) and calendars, which allow others passively check the availability of a team member.
- As the temporal distance limits availability of synchronous communication, the role of asynchronous communication becomes more important. Written agendas and meeting minutes are needed to involve people from distant sites in meetings and decisions, and written specifications and technical documentation are needed at least to some extent. The lack of interactivity as well as the lower richness of asynchronous media will affect both the convergence and conveyance of information within the team, hindering especially the completion of equivocal and uncertain communicative tasks, such as planning and conflict solving.

In addition to the purely technical domain, this situation can have considerable effects on teamwork, job satisfaction and personal motivation as well.

- Many distributed software projects may be built through relationships between either two organizationally separate entities, which may belong to the de jure part of the same company structure or be completely separate legal entities. In larger companies, it may not even be relevant whether the two organizations are part of the same company, as the organizational culture may still be different in different branches of the company, and as there might be intra-company rivalry and conflicting interests between the two organizations.

The implications of organizational distance on tool support for distributed software development are manifold. Depending on the level of trust between the organizations — and the measures in place to increase and control the trust — there might be trade secret and intellectual property rights to be respected and protected. In many of the case projects studied, we found a need to hide some information, e.g. resource utilization or technical details, from external organizations. As organizational boundaries can in many cases give rise to communicative boundaries, there is a need for practices and tools to overcome the negative aspects of these boundaries. Explicitly defined work practices and tools — and also the expectations on how to apply these practices and how to use the tools — are necessary to resolve any existing conflicts and to forestall future problems. It is especially useful to agree on which communication tools to use and how they should be used when communicating over organizational boundaries. Such agreements on tool use may include response-level agreements (e.g. email should be answered within the next working day), and practices related to instant messaging and presence (e.g. ”busy” status should be respected).

- The main considerations of cultural distance in selecting and using communication tools in distributed software projects are related to understanding the diversity in work practice preferences, to the varying level of language skills and to the opportunities for supporting convergence with proper selection of communication tools.

The solution to neutralize the negative effects of diversity of communicative behavior in different cultures is to provide the cross-cultural team with multiple media for communication and give them multiple forms of collaboration. In practice, this means acknowledging the need for both text and audio-based communication, as well as keeping both synchronous and asynchronous communication modes available. Furthermore, awareness of the existence of differences in communication and collaboration preferences within the team will help in starting discussions about potential challenges and in coming up with solutions fitting the actual configuration of the team. The level of language skills is also an important factor when selecting the communication tools for a distributed software project. In our studies, we have found that if, as a result of a self-assessment, an individual considers his/her language skills as inadequate, it leads to a preference to use textual communication; this is shown at least in the preferred choice between the use of instant messaging and telephones. We attribute this preference at least partially to the interactivity and rehears-ability properties of a communication media: when a person considers his/her language skills to be inadequate, he/she will prefer to use a medium that allows one to rehearse the communication event, i.e. to draft the message first, and then revisit it for possible grammatical or spelling errors, if necessary.

vi. Choosing communication media

The work role of a person seems to affect the media choice for communication. Our interview data shows that technical personnel — e.g. developers, testers and architects — preferred the use text-based communication media over audio-based communication media.

We found out that even in cases where the technical personnel had the same communication media available as, e.g., the managerial or sales personnel, they usually preferred to use text-based tools when they themselves initiated communication. The preference for text-based tools may be related to several issues specific to their work items and working environment, as well as to their personal qualities (Ref. 06).

On the other hand, people in managerial roles often preferred the use of telephones, as hearing other people provides more cues to the communication; some project managers told that they could get much more information about the project context from the tone and intonation than from the actual words said.

vii. Communicating technical information

Properties of the task seem to have a strong effect to media choice in the projects studied. Technically oriented tasks were often communicated via a text-based medium. Text-based media in general is well suited for conveying technical, software-related information, as most of this technical information is fully text-based and needs to be distributed in a precise form. The use of lean, text-based medium for such certain and unequivocal information is suggested by the media richness theory, but this finding is also supported by the media synchronicity theory. Furthermore, the main two text-based tools used by the projects, email and instant messaging, were used for slightly different tasks. Instant messaging was preferred for finding out the correct answer for a single technical question, while email was more focused on sharing managerial information and more comprehensive and detailed knowledge about the software. As email messages have more ability to act as stand-alone, independent documents, this medium seems to have the ability to converge information into coherent knowledge (Ref. 01).

viii.Communication modes

In software projects, the need for communication takes many forms. While many development tasks mostly require one-to-one communication, i.e. when finding the correct or preferable answer to a problem, there are several occasions where one-to-many or many-to-many communication is needed. One-to-many communication is commonly needed to share information about the project, while many-to-many communication is often used to come up with preferred solutions and to solve problems. As there are different communication modes for these different communication needs, and available communication tools differ in their support for different modes, the communication mode is an important factor for media choice in software projects (Ref. 03).

III. CONCLUSION

To address the communication challenges and cultural diversity of managing globally distributed knowledge workers in global software development, we proposed a research framework to articulate how these challenges are manifested in global virtual work environments and how communication and collaborative tools are used to avoid the challenges in distributed knowledge workers may influence global software development work practices. We also believe that organizational human resource practices should adopt the sense-making approach for communication and intercultural issues in order for organizations to compete in the global market in the future, cultural diversity knowledge should become an important part of the organization's intellectual capital and strategic resources

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