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Lessons Learned in Virtual Teams from Global Software Development

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Bachelor of Software Engineering & Management Thesis

Abstract

Increasing globalization has strongly urged software organizations to lower software development costs and access to best skilled resources, which lead using of global software development team as one of many possible solutions. More and more software companies have become multinational and used benefits of offshore insourcing, outsourcing and virtual software development team in order to increase their competiveness and keep their software development cost down. However, substantial number of them fails to achieve their expected high result due to many inherent drawbacks of virtual software development and software companies have limited time and budget for researching these problems and ways to successfully solve them. The paper investigates major factors that enable global software development teams work successfully based on literature. Methodology applied for the research is literature review. Lately, many researches have been done on understanding success factors of global software development. Contribution of the paper, is presenting lessons learned from previous researches, which have been made on the subject. The paper concludes with summarized lessons learned as guideline for effectively using a global team in IT companies.

Introduction

More and more IT companies becoming international and consist of globally distributed branches, units and teams. Especially, globally distributed team or virtual teams are increasingly used by software organizations over the last decade. *"About 40% of the Fortune 500 now use global software development teams or outsource development"* (Ramesh & Dennis 2002). Intel Corporation's recent study showed that approximately two-thirds of their employees collaborated with their team members virtually (Jay, Nunamaker, Reinig & Briggs 2009). Many IT organizations in the USA, Europe are now using globally distributed teams in India, China or other low cost countries in order to keep their software development cost down.

This prominent use of virtual teams in IT branch is caused by number of reasons. First of all, globalization and economic crisis creates huge challenge for any business organizations which requires them to improve their competitiveness and lower expenses. Global software development (GSD) enables Software organizations to use large number of talented software professionals overseas, where salaries are typically lower than those in the Europe and United States (Carmel & Agarwal 2001). Use of globally distributed team improves organizations global competitiveness by allowing great deal of flexibility, saving travel cost, providing multiple perspectives and enabling them to access highly skilled human resources around the world. Plus, advances in communication and information technology, gives new perspective for IT organizations to build and manage virtual teams.

However, in many cases global software development teams fail to fulfill high expectations from their organizations due to many inherent problems. *"On the basis of widely available and varying estimates, perhaps half of all system projects are failures"* (Prikladnicki Audy & Evaristo 2004). *"Any software professional knows that 'normal' – let alone 'global' – software development is fraught with difficulties"* (Carmel 1999). For example, management problems, low level of communication, collaboration and trust among team members, low commitment to project goal due to lack engagement in social activities and face to face interaction, problems in coordinating team members efforts. Therefore, in recent decades, researchers and IT organizations are starting to turn their attention toward trying to investigate the factors that enable global software teams to work effectively across geographic and cultural boundaries.

The paper investigates major success factors of globally distributed software development team based on literature. The objectives of this paper are to explore the factors that enable globally distributed team to work successfully and summarize lessons from the related literature and case studies done practical IT companies in previous researches. Contribution of the paper, is presenting lessons learned from previous researches, which have been made on the subject as complex guideline for managing globally distributed team successfully. This will be done in the following phases:

1. Developing a theoretical understanding of virtual software development team and its characteristics
2. Identifying what kind of major problems they face
3. Gathering lessons learned from literature
4. Analyzing and summarizing lessons learned

The paper has the following structure: The next section describes the research methodology; Section 3 presents the theoretical understanding of global software development: particularly software virtual team and it's characteristics, major problems they face; Section 4 describes an overview and lessons learned from the prior researches; Section 5 draw together findings and present the result as 6 summarized lessons; Section 6 summarizes the paper content.

Keywords: global software development, globally distributed software development team, success factors, lessons learned.

Research Methodology

The focus of this research is studying lessons learned on how global virtual teams in software organizations can work with success and which factors contribute for this. Literature review is chosen for the research methodology. In literature review, *"the researcher is concerned with charting the development of a set of ideas, and with placing them within a descriptive framework"* (Cornford & Smithson 2006). Review presents prior researches on the subject and current state of knowledge. There were plenty of researches and case studies already have been done on the various aspects of global software development, global software team and their success factors. Literature review method is used as a way to gather, categorize and summarize lessons learned from previous researches. By this, paper contributes by providing a more refined understanding of the global software development team, its problems and success factors (Cornford & Smithson 2006). Further, it summarizes lessons learned found in multiple other studies as guideline for successfully managing global software team. Research data is collected from articles, papers and published case studies that collected its empirical data from virtual software teams and multinational software organizations.

According to the Cornford and Smithson (2006), *"… a review is built up from a careful process of selecting and reading material and analyzing it for distinctive content"*. Based on their recommendation, the research is consisted from the following phases:
- Searching and finding related literature
- Choosing and categorizing related literature
- Conducting deep analyses on chosen literature and gathering lessons learned
- Analyzing lessons learned

Searching and finding related literature Related literature for the research is consisted of papers, articles, books, conferences, presentations and publications on related content by various authors. The primary resources of the information were Internet (search engine such as www.google.com, http://webbgunda.ub.gu.se/ etc, scientific search engines, online library catalogs, electronic databases) and libraries. Most of the articles and research papers are picked up from journals and conferences. The major journals from which most research articles are collected from are:

Academy of Management Executive, 2004, Vol.18, No.2.
Academy of Management Journal, 2004, Vol.47, No.2.
British Journal of Educational Technology, 2008, Vol.39, No.5.
Communications of the ACM, December 2001, Vol.44, No.12.
Communications of the ACM, October 2006, Vol.49, No.10.
Communications of the ACM, December 2007, Vol.50, No.12.
Communications of the ACM, February 2008, Vol.51, No.2.
Communications of the ACM, April 2009, Vol.52, No.4.
Communications of the ACM, December 2009, Vol.52, No.12.
IEEE Software, March/April 2001, 2002.
IEEE Transactions on Professional Communication, March 2006, Vol.49. No.1.
Infoworld, March 5, 2001.
Information Systems Research, September 2004, Vol.15, No.3.

Library Technology Reports, January, 2008.
MIS Quarterly, March 2010, Vol.34, No.1.
Organization Science, 2000, Informs, Vol.11, No.5, September-October 2000.
Proceedings of the 35th Hawaii International Conferences on System Sciences, 2002.
R&D Management 2003:3, Blackwell Publishing Ltd, Oxford, UK and Malden, USA.
Research in Science & Technological Education, April 2008, Vol.26, No.1.
Software Process Improvement and Practice, 2003:8, John Wiley & Sons Ltd, 2004.
Social Behavior and Personality, 2009, 37/8, Society for Personality Research Inc, 2009.

The major conferences from which most research articles are collected from are:
Informing Science and IT Education Joint Conference, 2006.
International Conference on Information Systems, December, 2001.
VoNet – Workshop, April, 1998.
39th Hawaii International Conference on System Sciences, 2006.
17th Bled eCommerce Conference, 2004.

Search is made on three main areas: global software development, globally distributed software development team, virtual team. As a result of the search, around 60-65 articles, conference papers and publications are found.

Choosing and categorizing related literature After the search, document analysis is made on the collected literature. At first, all documents are lightly red and categorized by their content and prioritized by their relevance to the research topic. The papers are categorized into following research areas:

- Understanding of globally distributed software development team
- Lessons learned for globally distributed software development team

The highest priority ten papers are chosen for further analysis.

Table 1. Literature review

Author	Date	Length of study	Conditions	Relevance to the topic
Gassmann & Zedtwitz	2003	1994-2000	Based on 204 interviews with project managers and directors in 37 multinational companies.	Virtual team management strategy based on degree of centralized control
Prikladnicki, Audy & Evaristo	2004		Case studies in 2 software development teams from multinational organizations located in Brazil. Data collection consist of 22 interviews, 2 questionnaires as empirical base, in addition document reviews, mission analysis, business process, meetings and software development process description.	Software development process, knowledge management, requirement engineering
Maznevski & Chudoba	2000	21 months	Case studies in 3 global virtual teams within a single organization. Data collection consists of interviews, questionnaires, observations, communication logs and company documentation.	Global virtual team dynamic
Ramesh & Dennis	2002		Case studies in global virtual software development teams in 3 Indian multinational companies. Data collection is consist of 12 interviews.	Communication through media, characteristics of media, standardization of work processes and its input and outputs
Cusumano	2008		Literature, working experiences in virtual team	Software development process in global software development
Kimball	1997		Literature, working experiences in virtual team	Knowledge management, communication strategy

Jay, Nunamaker, Reinig & Briggs	2009		Field experience with hundreds of virtual teams and extensive laboratory studies	Management of global virtual team, reward system
Lee, Delone & Espinosa	2006		Interviews with 22 managers of large global software development projects from 7 companies operating in Australia, India, Ireland, Mexico, South Africa, U.K and U.S.	Organization and management of global virtual team, coping strategy, adaptive use of technology, knowledge management
Jarvenpaa & Shaw	1998		Literature, experience	Trust, trust building in virtual team

Conducting deep analyses on chosen literature and gathering lessons learned The papers that have high priorities are deeply analyzed and necessary contents were picked up first. Then less prioritized papers are red and relevant contents were picked up.
The collected data were analyzed for the following purposes:
1. For definition of the subject
2. For gathering summarized lessons from previous researches

The section Lessons Learned is dedicated for gathered lessons from the individual papers. Papers are described by their brief content and lessons picked up from that paper.

Analyzing lesson learned Here gathered lessons from the individual papers are analyzed and discussed. During this, lessons related same subject are merged. At the end, summarized lessons are presented.

Global Software Development

Virtual team is a building block of global software development. There are many different names and definitions used for global virtual team in different literatures such as virtual team, globally distributed team, international virtual team etc. Each of these names refers to slightly different meaning. This paper uses term 'global virtual team' or 'globally distributed team'.

According to Lipnack and Stamps, *"a virtual team is a group of people distributed globally and guided by common purpose and work across space, time and organizational boundaries with links strengthened by information and communication technologies"*. While globally distributed teams are type of virtual teams *"whose members located in at least two different countries"* (Jarvenpaa, Knoll & Leidner 2000, Maznevski & Chudoba 2000). It doesn't mean that members in virtual team communicate across distance only using technology without any face to face interaction. In fact, face to face meetings are very important in the beginning of the project to establish positive team environment and build trust between team members. Also *"participation in virtual team maybe temporary for some members and the teams' boundaries vary with the specific project requirements"* (Gassmann & Zedtwitz 2003).

It can be seen from above definitions that characteristics of global virtual software development teams are:
- group of people working on same software project
- work across different geographic locations (particularly different countries)
- work across different time-zones
- team members have culturally (language, custom, behavioral norms etc) diverse background
- most part of the communication is supported by information and communication technology rather than face-to-face communication

Due to above characteristics, global software teams face following barriers and difficulties:
- knowledge transfer (specially tacit knowledge) becomes difficult
- remote communication problems: ambiguity in communication, less communication richness
- difficulties coordination of team members efforts
- cultural issues (language barrier)
- reduced opportunity for building personal relationships

- low level of team spirit
- low level of trust between team members
- big, complex projects may require physical collocation of project managers, team leaders and core members which increases development cost
- lack of common standard for process, activities and terms (software configuration, difficulties in establishing shared understanding)
- technical issues (difficulties in configuring and installing technology remotely, complicated technology)
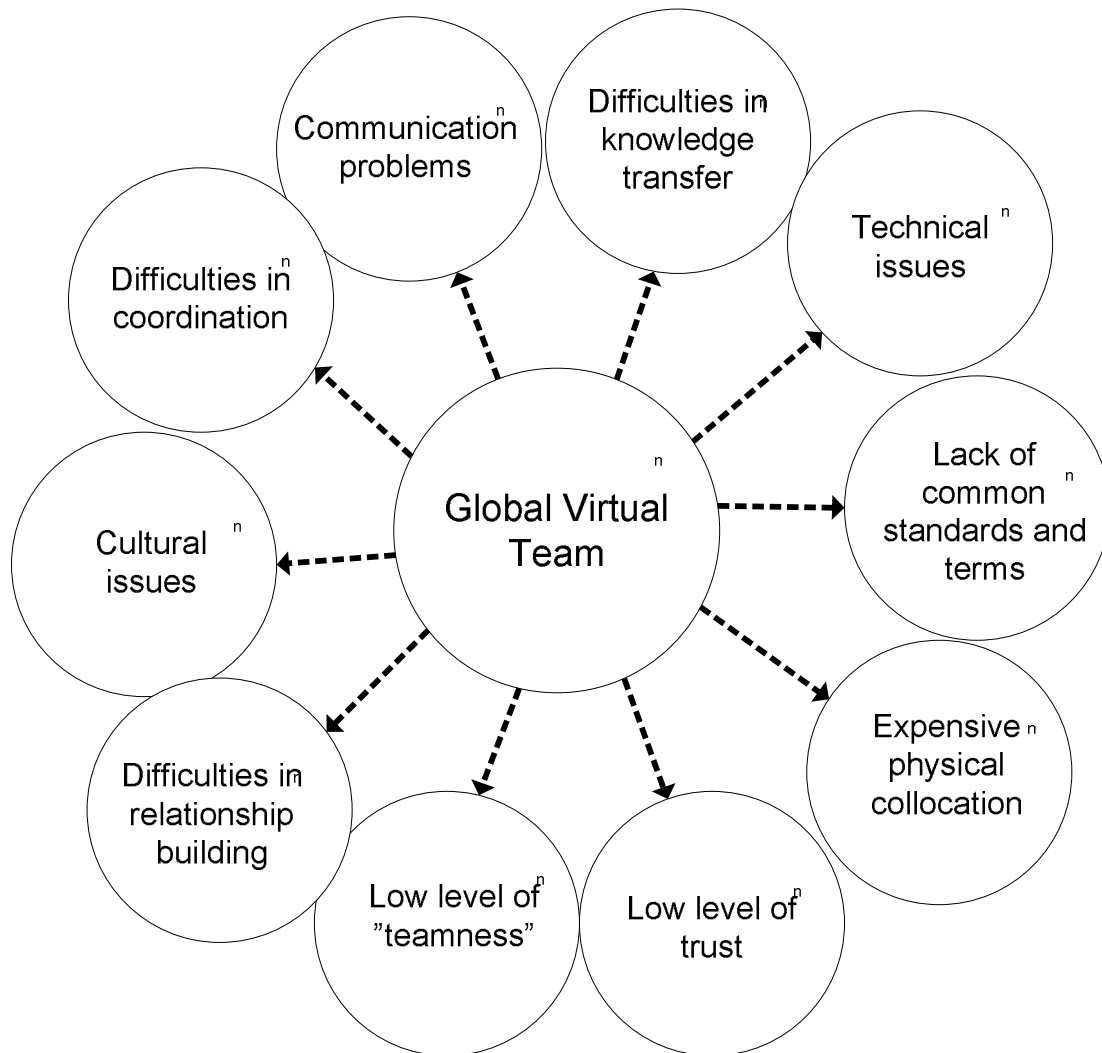(*See Figure 1*)

Figure 1. Problems that draws global virtual team apart

Thus, a main challenge for global virtual teams is successfully solving these difficulties and developing high quality software within a deadline and budget (Lee, Delone & Espinosa 2006). However, many software companies failed to achieve this, because they have limited time and budget for researching these problems and ways to successfully solve them.

Lessons Learned

The section present overview of lesson learned from individual papers. Total 32 lessons are picked up from 9 papers. (*See Table 2*) Below described lessons for each papers. It has following structure: 1) Overview of lessons picked up from articles presented in table 1; 2) Papers are presented as brief content of each paper, followed by lessons picked up from that paper.

Table 2. Overview of virtual team study

Prior researches	Lessons Learned
Paper 1. Gassmann & Zedtwitz 2003	Lesson 1: Nature of project, type of innovation, knowledge mode and degree of resource bundling determines the centralization of project control. Lesson 2: Higher the project control is centralized, then more it will be suitable for project characterized as radical innovation, systematic project work, prevalence of tacit knowledge and the presence of complementary resources. Lesson 3: Higher the project control is decentralized, then more it will be suitable for project characterized as incremental innovation, autonomous project work, prevalence of explicit knowledge and the presence of redundant resources.
Paper 2. Ramesh & Dennis 2002	Lesson 1: Characteristics of media for communication in global virtual team should match nature of the project work. Lesson 2: Digital media plays a central role in global software virtual teams. Lesson 3: Tightly integrating team members through both information richer media and lean digital media is key for software virtual team success. Lesson 4: Need for communication between team members can be reduced by standardizing the work processes, inputs and outputs.
Paper 3. Cusumano 2008	Lesson 1: Applying iterative approach mixed with waterfall in the implementation phase can be suitable for the global software development project. Lesson 2: Requirement engineers and project leaders should be located as near as possible to the customer site.
Paper 4. Maznevski & Chudoba 2000	Lesson 1: Global virtual team dynamics consists of series of interaction incidents and these incidents affect effectiveness.
Paper 5. Prikladnicki, Audy & Evaristo 2004	Lesson 1: Well-defined software development process is one of key success factors for virtual software projects. Lesson 2: Knowledge management decreases development cost and improves product quality in global software development. Lesson 3: Requirements engineering is an important aspect for global software development. Lesson 4: Distributed software project requires well planning in advance. Lesson 5: Training development teams for distributed software development is necessary for preventing later problems during the project.
Paper 6. Lee, Delone & Espinosa 2006	Lesson 1: There should be a common platform to establish a shared understanding of application knowledge and tasks for global distributed project. Lesson 2: At the initial project setup, development team needs to consider allowing future flexibility in system development life cycle when choosing software development process and making other strategic decisions. Lesson 3: Members of globally distributed team should be educated and trained for challenges in distributed work arrangements. Lesson 4: All necessary collaboration and communication technology should be installed and be ready before actual project work starts. Lesson 5: Adaptive use of technology is crucial for global virtual team success. Lesson 6: Successful global distributed team applies coping strategies specifically for distributed work arrangement. Lesson 7: Making team members' tasks and progress transparent and visible decreases negative effect of geographical barriers global virtual project. Lesson 8: Having knowledge repository where can gather and share distributed global project experiences and domain knowledge is helpful for success of future distributed projects.
Paper 7. Jay, Nunamaker, Reinig & Briggs 2009	Lesson 1: Reward system is one of the important drivers in virtual team. Lesson 2: Organize activities for making team members to know each other. Lesson 3: Kick-off meeting is necessary when the project starts. Lesson 4: Setting up common standards and terminology is necessary. Lesson 5: Being clear, explicit, unambiguous prevents many problems and saves time.
Paper 8. Kimball 1997	Lesson 1: Specific strategy for knowledge management is needed for virtual team. Lesson 2: Team members' involvement is crucial for virtual team success. Lesson 3: Having an integrated communication strategy is important for effectiveness of communication technology.
Paper 9. Jarvenpaa	Lesson 1: "The existence of trust is critical in global virtual team" (Jarvenpaa &

& Shaw 1998 | Shaw 1998).

Paper 1. Gassmann & Zedtwitz 2003

Gassmann, Zedtwitz (2003) identified four types of virtual organizations and developed four principles that affect success of virtual teams. Their empirical research based on interviews with directors and project managers in 37 international companies. They concluded that proper application of these principles can improve effectiveness of virtual team.

P1.Lesson 1: Nature of project, type of innovation, knowledge mode and degree of resource bundling determines the centralization of project control. Gasssman and Zedtwitz's (2003) work helped to define how virtual teams are organized in software organizations based on degree of centralized control. According to them, virtual team can be controlled in four forms within an organization. They are: decentralized self-coordination team, system integration coordinator, core team as system architect and centralized venture team *(see Table 3).*

Form of control	Characteristics	When to use
Decentralized self coordination	No formal project authority No dedicated budgets for the project	Project is not vital to the company
System integration coordinator	Team is coordinated with other teams through system integrator A system integrator defines interfaces between modules, work packages, coordinates team works, supervises system integration, manages knowledge transformation process	Suitable for complex projects where different teams work on different parts of the system
Core team as system architect	Team leader is a member of core team which consist of key decision makers of project The core team control and coordinate the whole project, develops the system architect, maintain coherence of the system	Suitable when system is divided into subparts and different teams are working on each part.
Centralized venture team	Team is controlled and guided by centralized venture team which consist of project managers, team leaders and core team members Centralized venture team develops a project plan, defines and tests a system, often introduces a product to market	Used for highly important, strategic innovation projects under intense time pressure due to its high cost

Table 3. Form of virtual team control by Gassmann & Zedtwitz (2003)

Above is presented the four types of project control. Suitability for the project is depends on four characteristics of software project. According to Gassmann and Zedtwitch, they are:
1. Type of innovation. There are two types of innovation: incremental and radical. Incremental innovation based on high continuity and gradual improvement. Accordingly has high affinity to existing technology and software process. Radical innovation relies on new technology or software process, open for new market and innovation.
2. Nature of the project. They are two types: systemic and autonomous. In a systemic project work tasks are highly interdependent. These interdependencies can be restricted access to shared resources; output of one task is input of another etc (Gassmann & Zedtwitz 2003). Autonomous project is highly structured; tasks and responsibilities are clear; work tasks are separable and dependency between tasks is low; system is divided into subsystems with well defined interfaces.
3. Knowledge mode. Knowledge can be explicit and tacit; individual and social. Explicit knowledge is easy to codify, document and transfer. Tacit knowledge is hard to codify and document. Individual knowledge is*'…specific to every human being and producible without other people having to be around'* (Gassmann & Zedtwitz 2003). Social knowledge is *'…knowledge shared among a group of individuals, its interpretation being subjective to the composition of this group'* (Gassmann & Zedtwitz 2003).
4. Degree of resource bundling. Recourse bundling has two types: redundant and complementary. Redundant resource bundling is competencies and skills overlapped. Complementary resource bundling is competencies and skills not overlapped.

P1.Lesson 2: Higher the project control is centralized, then more it will be suitable for project characterized as radical innovation, systematic project work, prevalence of tacit knowledge and the presence of complementary resources. If team members' knowledge is tacit and difficult to convey to others, then it will increase interdependencies between tasks and system components. *"When projects' complexity is large and not discernable into smaller subsystems. Resources are thus bundled and subjected to centralized management"* (Gassmann & Zedtwitz 2003).

P1.Lesson 3: Higher the project control is decentralized, then more it will be suitable for project characterized as incremental innovation, autonomous project work, prevalence of explicit knowledge and the presence of redundant resources. If information and knowledge are explicit and easily conveyable, teams and sub teams have predefined interfaces, independent tasks, and resources which would enable them to work autonomously then project can be more decentralized. Projects are possible if technical data and project information are easy to share among sub teams. *"Specific module complexity of each decentralized team is relatively low and does not require intensive coordination with other project teams"* (Gassmann & Zedtwitz 2003).

Paper 2. Ramesh & Dennis 2002

Ramesh & Dennis' (2002) work focused on how to correlate team members' effort and how to manage communication and coordination processes in software virtual team. They investigated software development life cycle in global virtual software development teams in three Indian multinational companies. In their work they supported Daft and Lengel's media richness theory which says media type for communication should be chosen to depend on work task. Their research work concluded by proposing new type of global virtual teams: the object-oriented team based on communication pattern of virtual teams.

P2.Lesson 1: Characteristics of media for communication in global virtual team should match nature of the project work. Media richness theory (MRT) is originally proposed by Daft and Lengel (1986). They argued that *"managers could improve performance by matching media characteristics to the task needs"* (Ramesh & Dennis 2002). Tasks can be uncertainty (needed information for executing the task is unavailable) and equivocality (task can be executed using available information). According to the MRT, medium's information richness determined by four factors: *"the ability of the medium to transmit multiple cues (e.g., vocal inflection, gestures), immediacy of feedback, language variety, and the personal focus of the medium"* (Ramesh & Dennis 2002). Information richer media is suitable for equivocal tasks, because it transmits information rapidly so that communicators can get immediate feedback and providing multiple cues, and accordingly better understands the information they are getting. On the other hand, leaner media is better for uncertainty tasks.

Also, Media Synchronicity Theory (MST) (Dennis & Valacich 1999) argues asynchronous digital media such as e-mail is more suitable for conveyance of information, while convergence of information is better done through information richer synchronous media such as face-to-face communication.

P2.Lesson 2: Digital media plays a central role in global software virtual teams. During the entire project duration, software development teams and its members need to produce software products and exchange them between each other. For exchanging software, use digital media is inevitable. Digital media can be used to convey other electronic work products such as: project documentation (project plan) and software documentation (SRS, Design and Architecture of the system etc).

P2.Lesson 3: Tightly integrating team members through both information richer media and lean digital media is a key for software virtual team success. Information rich media allows synchronous, rapid feedback that enables communicators to adjust their messages based on degree of understandability of their previous message. If receiver understands message sender can move on to next message, if don't, then sender explains the message (Clark 1992; Dennis & Kinney 1998). But information rich media reduces deliberation (Weick 1985). *"When information comes too quickly and immediate responses are required, individuals fail to process information and fall back on habitual processes and stereotypes" (Weick 1985).* Therefore exchanging information digitally first which allows deliberation of information followed by communication by information richer media would increase efficiency of communication.

P2.Lesson 4: Need for communication between team members can be reduced by standardizing the work processes, inputs and outputs. *"When work and those that perform it are tightly coupled to other work and workers, a change in one area has ripple effects in others"* (Ramesh & Dennis 2002). Therefore

software development team should avoid coupling between team members and system components on which they are working. This coupling can be reduced by standardization of the process, inputs and outputs. According to Mintzberg (1993), standardization of processes is defining in advance how the work should be performed. Standardizing output is defining the work result and work processes are left open for the performer. Standardizing input means defining the prerequisite (such as skills) for the work to be performed.

Paper 3. Cusumano 2008

Cusumano's work focused on strategies and success factors for globally distributed teams to work efficiently. He described how to apply iterative software development approach in global software development and explained its phases in system development life cycle.

P3.Lesson 1: Applying iterative approach mixed with waterfall in the implementation phase can be suitable for the global software development project. Iterative software development model is widely recognized as having many benefits compared with traditional waterfall model. *"The best practices I am familiar with begin with an iterative process, adopt waterfall-like practices in the middle implementation phase, and then move back to iterative to complete the project"* (Cusumano 2008). But most customers don't like iterative contract; they like fixed price and deadline. From the software provider side, it is too risky to make contract with fixed price, because cost can be exceed from initial estimation during the project, especially for large projects. *"One strategy is to persuade the customer to agree to an initial scoping and prototyping engagement lasting from a few days to a few weeks, depending on the size or complexity of the task" (Cusumano 2008).* After this, cost estimation could be more precise. Also if possible, it is best to persuade customer to pay for the product incrementally.

P3.Lesson 2: Requirement engineers and project leaders should be located as near as possible to the customer site. When collocating the globally distributed team, experienced requirements engineer and project leader should locate near the customer site so that they can closely cooperate with customer when capturing the requirements. Also it is important to have a frequent contact with customer and keep updating customer about the project progress. This helps to make estimation of budget and resources to plan the project. After detailed requirements are produced and initial project plan is developed, design, implementation, testing and integration of the system or components can be done by globally distributed teams or members in other part of the world. Finally, acceptance test will be done at the customer place. After this, next iteration starts with the same procedure. Since all team members can't collocate at customer site, it is very important that at least requirement engineers and key decision makers collocate at the same place with customer to closely cooperate.

Paper 4. Maznevski & Chudoba 2000

They described how global virtual teams operate effectively using Adaptive Structuration Theory (DeSanctis & Jackson 1994). Their research based on case study of three global virtual teams within a single organization for 21 months. According to them, key for effectiveness of global virtual team is matching the communication pattern to the work task. Also they emphasized that face-to-face communication is needed even for the virtual teams to pump life to the remote communication and team spirit. The contribution of their study is developing *"a grounded theory of global virtual team dynamics and effectiveness"* (Maznevski & Chudoba 2000).

P4.Lesson 1: Global virtual team dynamics consists of series of interaction incidents and these incidents affect effectiveness. Maznevski and Chudoba's study shows that, interaction within global virtual team consists of social interaction incidents. Interaction incident is a *"continuous communication among two or more members using one medium"* (Maznevski & Chudoba 2000). Incidents varied by three attributes. They are decision process, message complexity, and form. Decision processes can be information gathering, problem solving, idea generating, comprehensive decision making and generating commitment to action. Message complexity divided into simple, single-dimensional and multidimensional messages. Incident form can be medium and duration.

Paper 5. Prikladnicki, Audy & Evaristo 2004

Prikladnicki, Audy & Evaristo (2003) studied problems global software teams have faced and success factors that improve profit and productivity of multinational and virtual teams. Their research based on two years case studies from two international software development organizations located in Brazil. They identified difficulties software virtual teams have faced and how these problems solved in practice and concluded their research by proposing reference model to avoid or minimize these problems.

P5.Lesson 1: Well-defined software development process is one of key success factors for virtual software projects. "*A well-defined process is a process with good documentation, detailing what is being done (product), when (steps), for whom (actors), the artifacts used (input) and the developed artifacts (output/results) (Pressman 2001)*" (Prikladnicki, Audy & Evaristo 2004). If software process is not well-defined, it could cause many problems related with various aspects of the project such as requirements, integration, configuration, coding standards related problems, communication and coordination problems within a development team etc. When defining the development process, it is important to consider project environment especially for distributed software development. According to them, there are three strategies: forcing standardization (forcing one standard for involved teams), mixing methodology, and imposing high-level guidelines (Prikladnicki Audy & Evaristo 2004).

P.5Lesson 2: Knowledge management decreases development cost and improves product quality in global software development. Knowledge management provides many strategies to create; transfer, share, collect knowledge and experiences beneficial to the project**.** Especially it is difficult to externalize tacit knowledge of team members when communication way is virtual. Therefore it is important to document or codify this tacit knowledge so that team members able to learn from others experience or learn from company's intellectual pool. This will improve quality of decision and product, save development cost, decrease task accomplishment time and enrich organization's knowledge repository.

P5.Lesson 3: Requirements engineering is an important aspect for global software development. Requirements engineering has critical impact on project success. It is process of identifying, analyzing, documenting, verifying the condition or capacity of a system to be developed. *"The problems related with requirements engineering are one of the main reasons for software projects failures"* (Oberg *et al.* 2000). How well captured requirements comply with the system to be developed and how well system satisfies the customer demand determines the success of project. Undetected, unsolved problems related with requirements could cause a large amount of extra expense for the project and delay project deadline. Therefore it is essential to have close communication with the customer to discover these problems early in the development phase. Also requirements change during the project development. Damian, and Zowgui (2002) confirmed that problems with communication, knowledge management, cultural diversity, and the time differences which occur during distributed software development make difficulties in communication with customer, identifications of requirements, requirements management. Authors suggest that customer communication is basis for solving these difficulties. Thus need to *"conduct as many meetings as necessary to understand all requirements and to document all meetings in detail, in order to get the acceptance of all people involved*" (Prikladnicki Audy & Evaristo 2004).

P5.Lesson 4: Distributed software project requires well planning in advance. Authors agree that many problems occur during the system development life cycle because of lack of a formal planning phase. Good initial planning is a critical for distributed project success. During this phase many important strategic decisions are made that decides project fate. Here decided whether project should be developed by distributed software team, how to organize team for the project, strategies for the whole development process and consider possible risks related with distributed development such as complexity of requirements, lack of necessary resources, lack of experience in distributed development and technological possibilities etc.

P5.Lesson 5: Training development teams for distributed software development is necessary for preventing later problems during the project. Software development team members are usually high computer or technical literate individuals. Therefore they face less technical barriers when project is globally distributed. However, globally distributed team members are from different countries; accordingly have different cultures and backgrounds. Human factors, specifically social, cultural, linguistic, interpersonal relationship factors contribute many distributed project failures. Training team members for working in distributed project can prevent many later problems during project development. Team training focusing on team dynamic, communication, trust, cultural difference, coordination significantly improves both individual and team effectiveness and reduce problems.

Paper 6. Lee, Delone & Espinosa 2006

Their work focused on problems and barriers in global software development and ways to successfully solve them. They studied task processes and its inputs and outputs in software teams in 22 globally distributed software projects. Their research concluded by proposing special coping strategies to overcome the difficulties encounter during a global software development and minimize their negative effects.

P6.Lesson 1: There should be a common platform to establish a shared understanding of application knowledge and tasks for global distributed project. It is important to create common ground for shared domain application knowledge, common task process and common task context in the initiation phase of the project. Team members are having shared domain knowledge reduces communication problems and communication needs in a team. Having common task process means project has common software development processes; same work/management styles apply to entire project; responsibilities are clearly defined. Having common work context means team members are having common assumption how work should be done.

P6.Lesson 2: At the initial project setup, development team needs to consider allowing future flexibility in system development life cycle when choosing software development process and making other strategic decisions. Standardized processes and other project settings used for global software development should allow making changes easily with low cost during the software development process.

P6.Lesson 3: Members of globally distributed team should be educated and trained for challenges in distributed work arrangements. In an initiation phase of the project, globally distributed team members should have common deep understanding of distributed work environment, possible difficulties that could occur during the project and strategies to overcome them. It will help them to be more effective in problem solving, task accomplishment and less resistant to changes during the project.

P6.Lesson 4: All necessary collaboration and communication technology should be installed and be ready before actual project work starts. During the initiation phase, carefully chosen compatible technological environment, integrated project management tool, multiple collaboration tools should be installed across the project sites.

P6.Lesson 5: Adaptive use of technology is crucial for global virtual team success. Using multiple technologies and tool (For example, email, messenger, audio and video conferencing, internet meetings etc) will improve effectiveness of communication. Also when choosing technology or tool need to consider whether it is suitable for a given task.

P6.Lesson 6: Successful global distributed team applies coping strategies specifically for distributed work arrangement. These strategies could be increasing *"frequency and intensity of software development activities and processes"* (Lee, Delone & Espinosa 2006), increasing internal and external communication (for example, opening global communication channel for 24/7 basis), considering time differences, continuous communication when setting work hours/shifts and vacation schedules, decreasing task dependencies which allows flexibility and future changes with low cost, being sensitive to external changes and responding it quickly, making project documentation clear, detailed and unambiguous using more diagrams and tables if necessary, having frequent regular meetings and progress reports etc.

P6.Lesson 7: Making team members' tasks and progress transparent and visible decreases negative effect of geographical barriers global virtual project. Distributed team members being aware of who is doing what, whose work is progressing how far makes team environment more like collocated team and increase trust among team members.

P6.Lesson 8: Having knowledge repository where can gather and share distributed global project experiences and domain knowledge is helpful for success of future distributed projects. When IT organizations widely use global software development, it is necessary to manage global project repository where gather and share lessons learned from previous projects. It will improve future global distributed team's ability to cope with global challenges.

Paper 7. Jay, Nunamaker, Reinig & Briggs 2009

They researched challenges virtual teams face and how they could overcome. Their work based on long duration field studies with hundreds of virtual teams in various branches such as government, military and

business organizations and from exploring literature on the subject. Their study concluded by principles for effective virtual teamwork.

P7.Lesson 1: Reward system is one of the important drivers in virtual team. Motivation in virtual teams tends to be lower than in traditional collocated teams. Because of very little face-to face and verbal communication, there is less socialization, friendship, interpersonal communication in virtual team. Also being geographically distant from team members there will be less social comparison among them and accordingly less competition and inspiration. Project tasks will be easily less prioritized by other work task and day-to-day activities. Same with the saying, *"out of sight, out of mind,"* (Jay, Nunamaker, Reinig & Briggs 2009). Thus it is necessary to value individual contributions; make them visible to other team members and company; find ways to combine individual goals with team goal and use other reward strategies.

P7.Lesson 2: Organize activities for making team members to know each other. Building personalized relationship is very necessary to build trust, and improve collaboration and coordination within a team. But it is difficult in virtual team compared to traditional collocated teams, where it is much easier to establish friendship among team members during lunch breaks, conversation and discussion of common interests and personal issues in a hallway. Therefore explicit activities are needed to be organized for team building.

P7.Lesson 3: Kick-off meeting is necessary when the project starts. Kick-off meeting can have three main goals. 1) To make sure that tools and technology are correctly installed and configured; all team members are able to use them. People easily quit if they stuck on technical problems at the initial phase of project. 2) To make initial schedule of the meetings, tasks and deliverables for team members. Tasks and deliverables should be clearly defined with fixed deadlines. This will improve team member's commitment to the team. 3) To introduce team members to the team. Having team members introduce themselves, what they like to do and other facts that might be interesting to others is important part of team building. Kick off meeting can be virtual. But it is better, sometimes even necessary to organize face-to-face meeting to bring people together. In this meeting, team can decide mutually acceptable terms, schedule, task and resource division. Face-to-face interaction strengthens relationships and sustains it for a long period.

P7.Lesson 4: Setting up common standards and terminology is necessary. Virtual team members usually have diverse backgrounds compared to traditional face-to-face teams. This could contribute to many conflicting situations and misunderstanding due to their different culture, language and behavioral norms etc. To prevent this, virtual team need to agree on common terminology, standards and unit of measurement.

P7.Lesson 5: Being clear, explicit, unambiguous prevents many problems and saves time. Working across geographical distance decreases possibility for resolving ambiguity. Thus work process should be defined as detailed as possible; particular concepts and terms should be expressed explicit during virtual interaction; documents should be as clear as possible. Tasks, instructions should be given to members precise, clear and unambiguous; especially if it is related to use of new technology and processes.

Paper 8. Kimball 1997

Kimball's work covers issues: how to manage team working across distance, how to improve collaboration of virtual teams. He described nature and types of virtual teams, communication and collaboration technologies, and management strategies for supporting virtual team.

P8.Lesson 1: Specific knowledge management strategy is needed for virtual team. Knowledge management strategy for virtual team should aim to creating a mechanism for transforming individual knowledge into team knowledge. It could be creating environment within a team where team members feel comfortable to share their knowledge and experiences to others. Team manager could plant a seed for productive conversation (whether formal or informal) in a team.

P8.Lesson 2: Team members' involvement is crucial for virtual team success. Team manager plays important role to actively involve everyone for a team goal and keep everyone's contribution high. For this manager need to recognize each member's importance, *"encouraging members to explore questions that matter including questions about how they are working together"* (Kimball 1997), encourage team members' learning process, recognize their achievements etc.

P8.Lesson 3: Having an integrated communication strategy is important for effectiveness of communication technology. Different communication technologies can give different effectiveness depending on participant, purpose of the application, nature and goal of task. If right technology is chosen for right task, virtual environment can support high quality interaction.

Paper 9. Jarvenpaa & Shaw 1998

Their work addressed trust in virtual team. They investigated nature of trust among global virtual team members who has no interpersonal relationship and which factors evoke it. The paper described different forms of trust and interrelationships between them, trust generating process, and factors that evoke trust in virtual team.

P9.Lesson 1: "The existence of trust is critical in global virtual team" (Jarvenpaa & Shaw 1998). According to Mayer, Davis, and Schoorman (1995) *"trust is willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party"* (Mayer, Davis, and Schoorman, 1995, p. 712). Need of trust is multiplied in global virtual teams, because uncertainty or risk is far higher in this kind of teams compared to traditional collocated teams. Factors that affect trust building are: personal relationship, common social or demographic background, expected future associations and cooperative behavior (Sitkin and Roth, 1993).

Discussion

Managing globally distributed team is far more complicated compared to traditional collocated team and many authors dedicated their researches on this subject. The previous section described lessons from various authors on how to manage global virtual team successfully from different perspectives. This section analyzes lessons picked up from articles in the previous section and categorizes them by their problem area. Total 32 lessons are picked up from the 9 papers. They are categorized into six lessons (*See table 4*). It can be seen that different authors focused on a different aspect of global virtual team. Some papers investigate global virtual team from management perspective, how IT companies should control and manage virtual team effectively, how to use knowledge management in distributed environment (For example, Prikladniki, Audi & Evaristo 2004; Kimball 1997), process standardization (Ramesh & Dennis 2007; Prikladniki, Audi & Evaristo 2004) etc, while others focused more on human behavioral factors such as trust building (Jarvenpaa & Shaw 1998), individual motivation, coping cultural difference etc. Another substantial amount of research is dedicated for effectively using technologies and media (Lee, Delone, Espinosa 2006). All of them aim to cope with one or many barriers and difficulties global virtual team faces and proposed many possible solutions. Categorized lessons are presented below.

Table 4. Categorization of lessons from the papers.

Lessons	Paper1	Paper 2	Paper 3	Paper 4	Paper 5	Paper 6	Paper 7	Paper 8	Paper 9
Lesson1. Specific strategy	X	X	X		X	X			
Lesson2. Team building						X	X	X	X
Lesson3. Preparation in advance		X			X	X	X		
Lesson 4. Adapted process			X	X	X	X			
Lesson 5. Knowledge management					X	X		X	
Lesson 6. Adaptive use of technology		X			X	X		X	

Summarized Lessons

This subsection describes six lessons that are evolved from the 32 lessons picked up from the research articles in the previous section. Description of each lesson has following structure: the first paragraph includes introduction of the content, resources of the information including which authors have studied which area of the topic, the following paragraphs describes the summarized lesson.

Lesson 1. IT company should adopt specific strategy for managing global virtual team.

Brief description and related studies Work environment in global software development differs many ways from traditional collocated environment. Therefore, specific strategy needed to support distributed development for overcoming its inherent barriers and difficulties. Managing a global virtual team requires complex management, communication strategies and techniques to ensure its success. From the investigated papers, five out nine papers focused on this area. Gassmann and Zedtwitz's (2003) defined organization's administrative structure to control virtual team. They present four types of control and factors that affect choice of each control form. Lee, Delone and Espinosa's (2006) proposed specific coping strategies for managing global virtual team. Cusumano (2003) proposed strategy for applying mixed (iterative and waterfall) approach in global software project. Ramesh and Dennis (2002) developed an object oriented model for organizational strategy for coordination in global virtual team based on Mintzberg's ("*Structure in Eyes: Designing Effective Organizations*", 1993) standardization of processes approach. Prikladnicki, Audy and Evaristo (2004) also supported well defined process and data for distributed project.

Lesson 1. Organization needs specific strategy for organizing and controlling global virtual team. Virtual team controlled by four forms within an organization. They are: decentralized self-coordination team, system integration coordinator, core team as system architect and centralized venture team (Gassmann & Zedtwitz 2003). Decentralized self coordination team has least control from organization's authority, while centralized venture team has highest control by the organization. Strategy for choosing from these control types based on type of innovation, systemic nature of project, the knowledge mode, and degree of resource bundling (Gassmann & Zedtwitz 2003). Higher the project control is centralized, then more it will be suitable for project characterized as radical innovation, systematic project work, prevalence of tacit knowledge and the presence of complementary resources. Higher the project control is decentralized, then more it will be suitable for project characterized as incremental innovation, autonomous project work, prevalence of explicit knowledge and the presence of redundant resources.

One important feature of distributed work environment is that it needs both flexibility and rigor. Too much rigor would hinder agility and flexibility in software development which would make it difficult to make changes during the development, but without rigor and discipline team work became disordered and ineffective. Therefore, at the initial project setup, development team needs to consider keeping proper proportion of both flexibility and discipline in system development when choosing software development process and making other strategic decisions. For example, Cusumano (2008) suggested that when applying iterative approach for distributed project consider to blending Waterfall approach in the implementation phase. Thus, iterative or agile model need to be modified so that it allows discipline, while pursuing flexibility.

Another important approach is Ramesh and Dennis (2002)' object oriented strategy for organizing and coordinating work in global virtual team. This strategy aim to reduce communication between team members and decouple them through standardizing the processes, its inputs, outputs and use of semantically rich media. Tightly coupled system and work are not recommended in software development. It makes development inflexible for change. The object-oriented model decrease coupling through 1) standardizing and well-defining processes, its inputs and outputs; 2) exchanging these well defined inputs and outputs through well-defined interfaces (Ramesh & Dennis 2002). They also confirmed that organizations that used virtual team effectively, had been evaluated high level of the Capability Maturity Model. Well defined process means that inputs and outputs of project phases are clearly defined and there are clear defined rules for how to perform tasks. Example of well defined input is use of standard templates for documents. Moreover, if global virtual teams working in a same project uses different process, then processes are need to be standardized. There are three strategies for process standardization. They are: forcing; mixing and imposing high level guidelines. Forcing standardization is imposing one of the

standards used in a project to all teams involved in that project. Mixing standardization is blending different processes into new process model (Prikladnicki, Audy & Evaristo 2004).

One of the important factors for effective cooperation is a face-to-face communication. But it could be extremely costly for virtual team. Therefore in global project face-to-face meeting conducted only under intense need. For example, during initiation phase of the project team members can be gathered for kick off meeting to get introduced to each other and make strategic decisions such as agreeing on terms and condition, making initial planning and schedule etc. One way to save cost for face-to-face meeting is having team members who already know each other or already have been worked together before. It reduces necessity of collocated meetings.

There are many other strategies dedicated specifically for global virtual team proposed by different researchers. For example, opening global communication channel for 24/7 basis for increasing internal and external communication (Lee, Delone & Espinosa 2006), follow the sun approach considering time differences, continuous communication when setting work hours/shifts and vacation schedules, having frequent regular meetings and progress reports etc. Identifying and applying suitable strategies for the project early in the project duration is decisive for their effectiveness.

Lesson 2. Team building is crucial in global virtual team.

Brief description and related studies Human factors are centre of global virtual team. Team building, relationship between team members and their collaboration are important in global virtual team. *"The real basic structure of the workplace is the relationship. …work gets done through these relationships"* - Michael Schrage. This subject is studied four out nine analyzed papers. Kimball (1997) described team manager's role in team building, roles in a team, norm, styles and behaviors in team atmosphere. Jay, Nunamaker, Reinig and Briggs' research (2009) emphasized importance of reward system, relationship building and clarity in communication. Jarvenpaa and Shaw (1998) explored nature of trust, forms and processes of trust, different types of trust building in global virtual team.

Lesson 2. Team manager plays important role in team building process. Effective teamwork is directly related to team leader's management skill. His/her duty is to integrate team as a one unit makes everyone feel involved in team work. Team manager should be able to move virtual chairs into a circle so everyone feels involved (Kimball 1997) and get best out of everyone. He/she needs to have good ability judge the situation and create strategies suitable for it. For example: manager should recognize members' importance and their achievement, encourage team members' learning process (Kimball 1997), coordinate team members' effort and work processes. Also manager can improve member's commitment by combining their goal with team goal. Prior studies confirmed that if there is no individual benefit, individual commitment to the team goal drops to ground. One way to enhance individual commitment is to make team members' contribution and performance visible in a team and organization which would enhance their career prospect. Knowing each others' tasks and progress and who is doing what makes allows team members to see bigger picture of project progress and increase trust among team members.

Building relationship in virtual team is inherently difficult. Because there is no such opportunities in distributed team such as informal discussion during lunch, having informal conversation in hallway like in integrated teams. Personalized relationship plays important role in team building and improves collaboration and coordination within a team. But it is difficult in virtual team compared to traditional collocated teams, where it is much easier to establish friendship among team members during lunch breaks, conversation and discussion of common interests and personal issues in a hallway. Thus, it is team manager's duty to organize activities to support relationship building in a team. He/she can organize various activities to make team members to know each other. For example, it can be virtual synchronous kick-off meeting or humorous ice-breaker activities (Jay, Nunamaker, Reinig & Briggs 2009). Thus, good team manager finds ways to overcome barriers virtual team faces.

Reward system is one of the important drivers for team members and important lever for team building. Team members' motivation and inspiration tends to be lower in global virtual team due to lack of frequent face-to-face communication and socialization, interpersonal communication and geographical distance. Team members' extra efforts such as working extended hours, arriving to work earlier than others is invisible to team and managers. Thus having informal or formal reward is important for encouraging team members. It is necessary for team manager to recognize members' contribution, value their extra effort and provide frequent feedback for their work progress.

Ambiguity and misunderstanding is constant companion in virtual work environment. Communication across geographical distance, cultural difference, language barriers can cause misunderstanding during technology supported communication. However, virtual team has less opportunity to resolve misunderstanding and ambiguity. And it could block the team work progress, if left unresolved. Being clear and explicit prevents many problems. Thus work process should be defined as detailed as possible; particular concepts and terms should be expressed explicit during virtual interaction; software documents should be as clear as possible. Instructions and directions from a manager should be detail and easily understandable; especially if it is related to use of new technology and processes. Tasks and responsibilities should be well defined.

Another factor that many authors dedicated their work is a trust. Effective team building is based on team member's trust. Team members need to trust each other in order to cooperate effectively. Need of trust is multiplied in global virtual teams when degree of centralized control is low. In such case team members experience many uncertainties. Global virtual team lacks personal relationship, team members' common social or demographic background, expected future associations and cooperative behavior (Sitkin and Roth, 1993) which are bases of trust. If global virtual team has strict rules and discipline having negative posture when these rules violated, then there is low level of trust within a team (Jarvenpaa, Knoll & Leidner, 1998; Jarvenpaa & Leidner, 1998). When there is rich flow of information within team, where members have good possibility to learn from each other, its good base for knowledge based trust. During technology supported communication, trust can be build via rich medium that allows *"a broad bandwidth that handles multiple senses or interactive communication that allows interruptability and instant feedback"* Nohria and Eccles (1992). Also Walther (1995) argues that trust can be build over time in long term communication even via less rich medium. Also studies shows that team members engaging in a social dialog such as talking about each other's personal matters increase level of trust.

Lesson 3. Global virtual project should be carefully prepared in advance.

Brief description and related studies Global virtual team members need to be prepared in advance for problems and barriers in distributed work environment, effective communication and coordination to avoid future problems. Three out of nine papers are concerned about this subject. Prikladnicki, Audi and Evaristo (2004) emphasized existence of well defined process, need of well planning, investment in training development team for distributed environment as important factors of successful global project. Lee, Delone and Espinosa (2006) also mentioned that global virtual team members should be trained in advance and tools and technologies should be ready before project starts. Jay, Nunamaker, Reing and Briggs (2009) recommended initial kick off meeting and agreeing terms and terminology beforehand to avoid misunderstanding and ambiguity.

Lesson 3. Preventing problems is always better than trying to solve them when they already occurred. "Lack *of investment in the training of project teams to become global teams can lead to unexpected problems in project development"* (Prikladnicki, Audy and Evaristo). Global virtual team composed of members from different culture and backgrounds. Human factors, specifically social, cultural, interpersonal relationship factors contribute many distributed project failures. Training team members for working in distributed project can prevent many later problems during project development. Team training focuses on coping strategies, team building, communication, trust, cultural difference, knowledge management, effective use of technology, in short working in distributed work environment, significantly improves both individual and team effectiveness.

Some authors recommended initial kick off meeting for this. But as mentioned earlier, collocated meetings are very expensive. Thus depending on the project, importance of issues to be discussed and budget, this kick off meeting can be both virtual and collocated. Kick off meeting can have following purposes: 1)introduction and team building, 2) training team members for distributed work environment, 2) establishing shared understanding of terms, terminologies and setting up common standards, 3) ensure technical readiness, 4) initial project planning. Each of these goals will be briefly discussed below.

In the introduction phase, include brief information about project, introduction of team members and their background to the team. Having team members introduce themselves, what they like to do and other facts that might be interesting to others is important part of team building. The next goal, training of team members for distributed project, is already discussed earlier.

Establishing shared understanding of terms and terminologies are essential for team where members have different cultural background. All terms, conditions, terminologies should be explicitly defined so that everyone has same understanding of the meanings. Without this, many conflicting situations and

misunderstanding can arise between team members due to their different culture, language and behavioral norms etc. Also team should agree on common standards for coding, software documents, processes and various metrics etc and decide system development life cycle. Case studies revealed that lack of standards and well defined process cause many difficulties in coordination and synchronization of efforts. *"A well-defined process is a process with good documentation, detailing what is being done (product), when (steps), for whom (actors), the artifacts used (input) and the developed artifacts (output/results)"* (Pressman 2001). Thus, adopting single, well defined process for entire project is basis for successful project.

Most communication and collaboration is conducted via technology in virtual team. Thus technological readiness is one of the most important prerequisite before project starts. It includes installing and configuring tools and technologies, training team members for using them. It will block the task accomplishment and dampen inspiration if team members can't use technology and tools properly. After this team should make initial schedule of the meetings and agree on tasks and deliverables for team members. Tasks and deliverables should be clearly defined with fixed deadlines. Unclear, ambiguous tasks and responsibilities create many later problems and decrease commitment. Also tasks and modules should be divided in a way that they are as independent as possible so that failure or change in one task shouldn't affect others.

Lesson 4: Software development process should be adapted for virtual software environment.

Brief description and related studies Researchers and project managers in It organizations are already have admitted the importance of continuously improving virtual processes successfully for virtual team work, but only few have managed it well. Developing software in distributed environment requires different development approach compared to traditional integrated software development. This subject has captured research attention for many years. Four papers from analyzed researches studied global software development from process aspect. For example: Cusumano (2008)as well as Lee, Delone and Espinosa suggested adapted iterative model for distributed project, Prikladnicki, Audi and Evaristo (2004) emphasized importance formal planning phase for distributed project, Ramesh and Dennis emphasized importance of well defining work processes.

Lesson 4. Distributed software project not only needs to be able to highly responsive to changing demands from customer or other unforeseen external changes, but also it needs to have discipline and rigor for communication and coordinating work processes in virtual environment. Iterative development approach is proven to be successful in managing change during the product development due to its early prototypes to customers and many other advantages. But iterative approach is proven to be best suitable for small and collocated projects (Lee, Delone & Espinosa 2006). It gets chaotic and problematic when iterative process is applied for big or globally distributed projects where software development has more complexity due to time difference and geographic boundaries. Distributed work environment needs standardized documentation, well defined processes, and tight project control. Thus many IT organizations adopt waterfall like sequential development process for global projects due to its simplicity. It even better suits for embedded software development projects where specifications usually tightly fixed (Cusumano 2008). But still most software projects need flexibility for changes in requirements and external conditions. Therefore some authors suggest that conventional iterative process need to be adjusted so that it allows more control and discipline. Cusumano (2008) suggested iterative approach mixed with waterfall for global software development. The project should follow iterative process, except implementation phase where waterfall-like practice should be adopted. Some global virtual teams adopt mini-waterfall like cycles inside iterations for a 1-2 weeks long in which they develop and integrate a module and do system testing. The key is the careful scheduling and coordination of effort and less interdependent, loosely coupled modules.

Distributed team work requires well planning in advance and some authors suggest separate planning phase in software development process. When there is no formal planning phase in a distributed project, there is a big risk to discover unforeseen issues and problems during the greater development process. For example: unclear or too complex requirement, technological problems related with installation and configuration, availability of the resources etc. During planning phase, critical strategic decisions and distributed work arrangements for entire project will be made. *"The SEPG representative mentioned that a planning phase is very important for distributed projects, because we are able to select the proper projects to be developed by distributed teams, and also to define the better way to engage the teams in the project"* (Prikladnicki, Audi & Evaristo 2004).

Another important aspect of distributed development is requirement engineering. It is highly recommended that requirement engineers should be able to closely communicate with customers. They should locate as near as possible to customer site. If budget allows, requirement elicitation should be face-to-face. They need this close contact to capture and document clearly defined requirements and further changes on it. Also customer needs to be updated frequently on the progress of the project. Having iterative contract with the customer is critical for the project to accommodate further unexpected changes in initial estimation, requirements or plan. When requirements are well captured and documented, it can be send to developers. Then components of the system can be developed in different countries by different developers simultaneously. For this, system needs to be divided into well defined, less coupled sub systems and components so that separate team or individual can develop it independently.

Lesson 5: Knowledge management plays important role in distributed work environment.

Brief description and related studies Effective knowledge management is crucial for exploiting the benefits of multiple perspectives in globally distributed team. Knowledge management in virtual team context aims to make individuals' knowledge accessible to other members. It stimulates information sharing and learning from each other's experiences in a team through use of tools and activities. It allows external and internal information sharing in a team, update team members about current progress of the project, tasks on a critical path etc. Three authors from the investigated researches proposed use of effective knowledge management and creation of learning environment in virtual team.

Lesson 5. Since virtual teams have limited communication possibilities, explicit knowledge and having well defined, clear documentation is critical for the effective teamwork. Having standardized, concise documentation contributes to effective collaboration and prevents ambiguity and unclear assumptions. Through knowledge management, knowledge repository can be created in a virtual team which can generate many useful information and experiences from globally distributed team members. It is also useful for further globally distributed projects in the software organization. Prior researches confirms that teams having prior experiences on global software development work more effective compared to teams that have no such experience. Thus knowledge management facilitates global virtual team to learn virtual team working experiences from organization's global knowledge repository. Thus it is important to not only create database, but also create mechanism to efficiently using this data and training team members for this.

Sharing tacit knowledge is difficult in global virtual team due to less communication richness. This tacit knowledge of team members need to be made explicit in order to stored in a repository. If team member's experiences are documented in a systematic way, individuals can learn from other individuals' experiences. This increases product quality and decreases time for task accomplishment. Another way to share tacit knowledge is communication between team members in a various organized activities. "*Virtual teams form and share knowledge on the basis of information pull from individual members, not a centralized push*" (Kimball 1997). Thus it is important to create a mechanism for team members to share each others' tacit knowledge through effective communication. For this, environment for informal communication needs to be created where interpersonal relationship or interactions are nurtured and team members feel comfortable to share their individual experiences. Informal conversation or chat can be perfect for this. Also creating some kind of shared space (for example, forum) among team members is a good start. Environment can be stimulating, but not controlled or organized as task. In order to have a fruitful communication, "*some kind of common, cognitive ground for the group can be created*" (Kimball 1997). For example, team leader can facilitate discussion among team members on a particular issues or problems.

Lesson 6: Adaptive use of technology is crucial for global virtual team success.

Brief description and related studies In global virtual team, most communication is supported by information technology. Virtual team members communicate for exchanging their opinions, sending their task outputs and various documentations, coordinating their efforts, learning from each other, socializing etc. All these communications are conducted through variety of media, ranging from old media such as telephone calls, fax to internet based audio and video conferencing, e-mail, and groupware etc. Their choice of medium based on various reasons. For example, budget, purpose of the communication, characteristic of information that will pass through medium etc. Many studies and researches dedicated for a technological aspect of global virtual team over the years and developed many strategies and theories on the subject. Four authors of analyzed researches studied technology as important factor for global virtual team success.

Lesson 6. There are many different type of communication and collaboration technologies are available for global virtual team such as synchronous and asynchronous, internet based and computer based etc. Each of them serves more effective for some tasks, but less effective for other tasks. Thus it is crucial to understand which media and tool is better for which kind of tasks. According to media richness theory (MRT), originally proposed by Daft and Lengel (1986) task accomplishment improves if media characteristic matches to the task needs. This theory confirms that medium's information richness determined by *"the ability of the medium to transmit multiple cues, immediacy of feedback, language variety, and the personal focus of the medium"* (Ramesh & Dennis 2002). Example information rich media are face-to-face meeting, audio and video conferencing, telephone conversation, messenger in which communicator can get immediate feedback and respond back immediately. Less information rich media or leaner media includes: various documentation, e-mail etc. Task can be divided into 2 category: an uncertainty task (needed information for executing the task is unavailable), and an equivocality task (task can be executed using available information). Equivocal tasks can be coordination activities such as meetings, discussions etc. The theory suggests that information richer media should be used for an equivocal task, because it

- *" transmits short snippets information rapidly through multiple synchronous channels (e.g., face-to-face discussion with its spoken words, voice inflection, and non-verbal gestures)"* (Ramesh & Dennis 2002);
- allows quick response which is good for clarifying ambiguity and misunderstanding;
- allows synchronous feedback so that sender adjust message presentation based on a receiver's reaction.

Information rich media such as face-to-face meeting, telephone conversation connect team members closer than less information rich media. Thus they are suitable for various discussions and developing interpersonal relationship between team members. As for uncertainty task less information rich media are more suitable, because it transmits information without unnecessary, superfluous data.

However, successful use of technology in a virtual team always involves both lean and information rich media. According to Weick (1985) rapid synchronous information transmission in information rich media has one drawback. Receiver has too little time to process the information because it requires quick response. But equivocal task needs careful deliberation. Thus, it is good to send information via lean media beforehand (e.g., e-mail), so that communicator prepared for the upcoming discussion or conversation.

Sharing information through rich media works well in small group. But as group gets bigger and information gets more complex, then it gets too messy and problematic. For example sending information through telephone calls to five people work well, but to thirty people it gets costly and time consuming. In such case, semantically rich media is helpful to broadcast information to large number of recipients. Also Ramesh and Dennis (2002) recommended use of semantically rich media for decreasing communication need in a global virtual team. Because semantically rich media conveys information in a container that has a well defined semantically rich interfaces. This well defined container presents the information in a way that easily understandable for the recipient. For example SVN repository, bug repositories, in which documents and codes can be seen with all the changes, comment together with author names, dates and version numbers. It allows a sender to edit, change information they send and receiver to process the information. It also provides multiple view of the information with different categorization and search capabilities. It gives a good overview of the overall project progress and others work. In software virtual teams, communication among team members mostly is done through semantically rich media. Semantically rich media is the heart of the virtual team work.

There is another theory developed by Dennis and Valacich (1999), Media Synchronicity Theory (MST). According to MST, transmission of information can be 2 types: conveyance and convergence. The theory asserts that asynchronous digital media (for example: e-mail) is better for conveyance of information. Moreover, asynchronous media plays central role in global virtual team, in which team members communicate across different time zones so they cannot always able to find other person available so can get immediate response. As for convergence of larger and complex information, rich, synchronous media (for example, video conferencing) is more suitable. Also if task is too complex or equivocal, mixed approach is recommended, first using asynchronous media and then using synchronous media.

Conclusion

As globally distributed software teams are increasingly used by IT companies, it gets more and more attention from researchers and various studies made on many different aspects for global virtual team.

Before nineties, remote communication in software development team mainly relied on telephone, fax and mail. But nowadays, rapid development in technology provides far more possibilities for virtual communication, which improves communication in various aspects such as speed of information transition and information richness of media etc. Further development of communication technologies are expected to diminish barriers and problems in virtual team and decreases gap between virtual presence and presence in reality which reduces the need for collocating teams. Increasing internationalism in IT industry provides software companies wide choice of talented professionals around the world which can be accessed virtually. Due to this software quality expected to increase and at the same time development cost will be decreased.

The paper investigates major factors that enable global software development teams work successfully based on literature. Methodology applied for the research is literature review. During the research, total 65 papers, research articles and publications are collected and nine papers are chosen for deep analysis. 32 lessons are gathered from these nine papers and they are categorized into 6 major lessons. They are:

Lesson1. IT companies should adopt specific strategy for managing global virtual team.
Lesson 2. Team building is crucial in global virtual team.
Lesson 3. Global virtual project should be carefully prepared in advance.
Lesson 4: Software development process should be adapted for virtual software environment.
Lesson 5: Knowledge management plays important role in distributed work environment.
Lesson 6: Adaptive use of technology is crucial for global virtual team success

The paper focused on six areas which were most widely investigated in prior researches in study of global virtual team. They are strategies, team building, preparation, team process, knowledge management and use of technology. The areas that haven't included in the paper are behavioral factors, conflict management, cost evaluation of virtual team, use of specific development models in global software development (for example, pair programming), power and empowerment in virtual team. This paper makes several contributions to practical IT organizations and further researches. It further developed the theoretical of virtual software development team and its characteristics; identified major problems virtual software development teams face; presented summarized lessons learned found in literature and finally, provided overview of current study on global software virtual team. The above lessons provide specific strategies to organize and manage global virtual team, how to effectively use media for communication depending on different tasks, guidance on software development process, strategies on knowledge management, guidance on using tools and technology etc. These lessons are intended to help virtual team members and managers in practical organizations to improve effectiveness of their virtual teamwork and to help researchers to further develop the theoretical understanding of global virtual team and way to make them more successful.

In a practical field, experiences of using global virtual team growing and enriches the knowledge pool on successfully managing global software development. The most important thing is to make this knowledge pool to accessible and easily usable to those who need it. This paper advances the knowledge in global software development by investigating current researches have been done on what makes global virtual team successful and develop a theoretical guideline for practical IT organizations using literature review as research methodology. This study enabled a better understanding of global software development team, its problems and success factors.

Although study of global software development is being intensively progressing over the last years, improvements are still needed to fully exploit its advantages. From the research it can be seen that global software development is complex itself, thus selective utilization of strategies, patterns and models that are suitable for a certain situation are needed. In order to determine these certain conditions, understanding and definition of global software development, its constituents and attributes are need to be further developed. Based on this, more specific coping strategies are needed to be developed. Prikladnicki, Audy and Evaristo (2003) and several others emphasized need of well defined development process in virtual teamwork maturity model and discipline still need to be developed for global software organization. Cusumano's (2008) proposal of using Iterative approach mixed with Waterfall is need to be further investigated and proved in different types and scales of projects in practice.

Finally, global virtual teams face many barriers and problems due to global boundaries and communication barriers. But it is proven to have many advantages over traditional teams if lessons learned from previous studies and experiences properly applied into management of virtual teams in practice.

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