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Toward improvements of teamwork in globally distributed agile teams

Bachelor of Science Thesis in Software Engineering and Management

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Abstract – Working geographically distributed in agile teams becomes more common and the challenges encountered, do largely alternate compared to normal agile challenges. This paper presents previous research, regarding both challenges and improvements of geographically distributed agile teams, and supplements it with interview data. Interview and questionnaire were conducted with employees of a multinational company, in order to explore the area of concern. The eight challenges discovered were: communication and collaboration, cultural, documentation, knowledge management, management, risk management, time zone and tools. Results from the literature review then used to produce improvement suggestions, regarding the common challenges.

Keywords – agile, challenges, geographically distributed, improvements, solutions, traditional

1. Introduction

Agile development processes (ADP) have, over the last years, become more popular as they encourage and handle change in a better way than plan driven development processes (Highsmith and Cockburn, 2001; Shrivastava and Date, 2010). Simultaneously during this change, the technology developed further and several companies started to collaborate more geographically distributed (Pichler, Rumetshofer and Wahler, 2006; Korkala and Abrahamsson, 2007; Sutherland, et al., 2007; Holmström, et al., 2006; Prikladnicki, Audy and Evaristo, 2003a). Hence, challenges of geographically distributed agile software development (GDASD) arise (Therrien, 2008; Shrivastava and Date, 2010; Alqahtani, et al., 2013; Jimeenez, Piattini and Vizcanio, 2009; Hossain, Babar and Paik, 2009; Prikladnicki, Audy and

Evaristo, 2003b), which differs from the common agile challenges.

Therefore the aim of this research is to bring a deeper understanding of the challenges, which arise in geographically distributed agile teams as well as to provide improvement suggestions. In order to answer the research questions, a literature review of previous research has been conducted. The outcome of the literature review was complemented with data from interview and questionnaire data, resulting in a list of challenges as well as improvement suggestions. The geographically distributed agile company, MediLog Technologies, agreed to the conduction of interview and questionnaire with their employees. The results of this study will be used by the investigated company to improve their development process. This research paper is essential since more companies are working distributed and agile. Hence, the information on how to solve the challenges must be collected and together analyzed in order to help new corporations in order to work distributed. The research questions that were created to investigate this phenomenon are:

Q_1	What challenges arise in geographically distributed agile teams?
Q_2	How can the challenges, which arise in geographically distributed teams, be solved in an improved way?

Research in this area has partly been done before; therefore it will be validated with a company which has GDASD teams. The information in this area is rather spread due to that most of the previous research were case studies. This research will not

go into detail in agile or traditional software development methodologies, instead it will just outline the differences. The questions' emphasis is on distributed agile teams, in other words no specific software development methodology challenges will be in the scope of this research. Furthermore, it will not include the many benefits which are generated through working in geographically distributed agile teams (Shrivastava and Date, 2010). This research will have the perspective of a software development team and will exclude challenges which are not related to the team. Instead focus will be on challenges which GDASD teams encounter and improvements regarding these.

The rest of the paper is outlined as follows, Section 2 presents related research and background to the area of concern. Next section describes and explains different methods used to conduct this research, followed by Section 4 where the results are presented. Section 5 contains the discussion of the result of all data sources, which also includes a validity discussion. Next Section is the conclusion, followed by the last sections on future work and acknowledgements.

2. Theoretical Background

To be able to interpret and understand the document, some background knowledge about the different types of software development methods, also known as software development life-cycle (SDLC), are essential. Therefore, a comparison between the different types of SDLC, Traditional- and Agile software development methods is required. Furthermore, emphasis will be on previous research which considers challenges and improvements of GSGD.

2.1 Traditional vs. Agile Development Processes

Traditional methodologies, also known as the heavyweight methodologies, are built upon certain steps that are needed to be followed strictly (Awad, 2005). Therefore these kinds of methodologies (e.g. Waterfall, Spiral Model and Unified Process) lack the flexibility to handle changes in requirements (Nerur, Mahapatra and

Mangalaraj, 2005). As Dybå and Dingsøyr (2008) states, the fundamental assumptions of the traditional software development methodologies are predictable systems through extensive planning.

Some characteristics of traditional methodologies were stated by Awad (2005:6-7), and they are: predictive approach, comprehensive documentation, process oriented and tool oriented. ADP is based upon continuous and rapid feedback and change (Dybå and Dingsøyr, 2008).

Agile key challenges mentioned by Conboy, et al., (2010) were:

1. Fear, caused by transparency of skill deficiencies for the developers
2. Developers need to be "master of all trades"
3. Increased reliance on social skills
4. Lack of business knowledge among developers
5. The need to understand and learn the values and principles of agile, not just the practices
6. Lack of developer motivation to use agile methods
7. Implications of devolved decision-making
8. The need for agile-compliant performance evaluation
9. Lack of agile-specific recruitment policies and suitably trained IT graduates

2.2 Geographically Distributed Agile Teams

To not confuse the connotation of distributed software development with other project infrastructure, the criteria is as expressed by Prikladnicki, Audy and Evaristo (2003a:2):

"[Distributed software development] distance of the actors, Distribution of the project team, Development outsourcing, Cultural differences and Project size."

Working in GDASD teams will create both challenges and benefits, although benefits will not be considered in this study. The following two subsections describe challenges and improvements of GDASD teams.

Non-distributed ADP challenges	GDASD challenges
Developer fear, caused by transparency of skill deficiencies (Conboy, et al., 2010)	Communication and collaboration challenges (Alqahtani, et al., 2013)
Developer need to be "master of all trades" (Conboy, et al., 2010)	Cultural challenges (Jimeenez, Piattini and Vizcanio, 2009)
Increased reliance on social skills (Conboy, et al., 2010)	Documentation challenges (Shrivastava and Date, 2010)
Lack of business knowledge among developers (Conboy, et al., 2010)	Knowledge management challenges (Shrivastava and Date, 2010)
The need to understand and learn values and principles of agile (Conboy, et al., 2010)	Management challenges (Shrivastava and Date, 2010)
Lack of developer motivation to use agile methods (Conboy, et al., 2010)	Risk management challenges (Jimeenez, Piattini and Vizcanio, 2009)
Implications of devolved decision-making (Conboy, et al., 2010)	Time zone challenges (Alqahtani, et al., 2013)
The need for agile-compliant performance evaluation (Conboy, et al., 2010)	Challenges related to Tools (Hossain, Babar and Paik, 2009)
Lack of agile-specific recruitment policies and suitably trained IT graduates (Conboy, et al., 2010)	

Table 1: Challenges of non-distributed ADP and GDASD (challenges do not have any specific order)

2.2.1 Challenges

The combination between ADP and working geographically distributed creates new challenges (Shrivastava and Date, 2010). The main reason behind this is that agile methods usually build upon close daily communication in the teams (Shrivastava and Date, 2010), to build trust between stakeholders (Alqahtani, et al., 2013). Therefore, the common challenges in non-distributed ADP and GDASD differ a lot (see Table 1).

The main challenges of GDASD teams and their descriptions are:

Communication and collaboration – Communication between stakeholders is a common challenge and is a crucial project component (Alqahtani, et al., 2013) which roughly every GDSAD-team will encounter (Hossain, Babar and Paik, 2009). Due to complex infrastructure in GDASD teams, the communication will decrease in both frequency and quality and directly affect the teams' productivity (Shrivastava and Date, 2010). This is also dependent upon the language skills of the team-members (Alqahtani, et al., 2013; Jimeenez, Piattini and Vizcanio, 2009).

Culture – Cultural challenges between stakeholders has been mentioned by many authors (Jimeenez, Piattini and Vizcanio, 2009; Alqahtani, et al., 2013; Therrien, 2008; Shrivastava and Date, 2010; Prikladnicki, Audy and Evaristo, 2003b; Prikladnicki, Audy and Evaristo, 2003b), and are considered to be one of the main challenges of GDASD. Collaboration with individuals, which have different cultural backgrounds, is required in GDASD (Shrivastava and Date, 1020).

Documentation – Documentation can suffer because of insufficient communication in GDASD-teams (Shrivastava and Date, 2010; Prikladnicki, Audy and Evaristo, 2003b).

Knowledge management – To avoid redundant work and reducing avoidable costs, the employees need to: share experience, decisions, methods and skills to the team during the development (Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009).

Management – The management becomes a challenge in geographically distributed agile teams due to the high organizational complexity, scheduling, task assignment and cost estimation (Shrivastava and Date, 2010). Time zone differences lead to lack of synchronization across the team. This may result in overhead in order to gain coordination and control throughout the projects (Prikladnicki, Audy and Evaristo, 2003b).

Risk management – Working geographically distributed generates different risks, compared to not working distributed. Hence, risk management is a critical project management activity (Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009).

Time zone – Time zone can differ a lot in GDASD, which creates barriers in agile development (Alqahtani, et al., 2013). Time zone is a common challenge in geographically distributed agile teams (Shrivastava and Date, 2010; Therrien, 2008; Alqahtani, et al., 2013; Prikladnicki, Audy and Evaristo, 2003b; Shrivastava and Date, 2010) and many agile software development methods build upon synchronization of working hours between the employees and other stakeholders (Shrivastava and Date, 2010; Alqahtani, et al., 2013).

Tools – Agile methodologies usually rely on the team being in the same room. Therefore, it is important that tools support the features (burndown charts, backlogs etc.) of agile methodologies, to be shared between every employee (Shrivastava and Date, 2010).

2.2.2 Improvements

In order to explore the benefits of geographically distributed software development in agile teams, companies need to deal with the challenges of GDASD (Shrivastava and Date, 2010). Suggestions for improving these challenges are as follows:

Communication and collaboration – The key to have a successful geographically distributed teamwork is to improve the generally bad communication (Alqahtani, et al., 2013; Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009). This can for example partly be improved by good collaboration tools, different work hours and a team–representative (Alqahtani, et al., 2013; Jimeenez, Piattini and Vizcanio, 2009; Hossain, Babar and Paik, 2009; Shrivastava and Date, 2010).

Documentation – According to Shrivastava and Date (2010) it is important to maintain valuable documentation, due to the fact that it may improve the collaboration process for the geographically distributed agile teams. It is also important to use a good project management tool since it aids to maintain documentation and provides a good transparency (Shrivastava and Date, 2010).

Knowledge management – To facilitate knowledge sharing in GDASD environments, the content needs to be shared through internet-based tools (Shrivastava and Date, 2010; Prikladnicki, Audy and Evaristo, 2003b; Jimeenez, Piattini and Vizcanio, 2009).

Management – Challenges related to management which may be encountered are: to control the overall development process, distribution of work, commonly defined milestones, taking into account the possible impact of different cultures, improving the process during the enactment and reduce any factors that may influence badly on the productivity (Shrivastava and Date, 2010).

Risk management – A greater effort is in need regarding risk management activities, due to GDASD with agile teams and defect control must be adapted to fit the environment (Jimeenez, Piattini and Vizcanio, 2009; Shrivastava and Date, 2010).

Time zone – The aim of time zone improvements is to help the team adjust to new methods and to minimize the misunderstandings between stakeholders (Alqahtani, et al., 2013). This can be solved by consideration of planning, which can differ between companies, due to the individual team-members' geographical positions (Shrivastava and Date, 2010).

Tools – GDASD needs to be combined with management commitment, in order to provide the agile team with the tools for maximization of the communication (Shrivastava and Date, 2010) .

2.2.2 Context of the study

MediLog Technologies is a rather new company which works geographically distributed. The different nations, which the employees live in, are: Sweden, Singapore, Malta and Sri Lanka. In Sri Lanka the company has a sub-team, which primarily works on various in-house projects.

The corporation has, at the moment, four ongoing projects, which differ a lot from each other, according to an interviewee. As mentioned above, the company has their own and three other projects which are similar to consultancy projects, where a single employee or two work on a specific task. Therefore, the focus is on the challenges related to their own project.

For communication and collaboration the company uses the tools: Skype, email, GitHub, Google Drive and partially Pivotal Tracker (PT). Skype and email are mainly for communication between team-members and stakeholders. GitHub is a powerful collaboration tool used for code management of both open source- and private projects (GitHub, Inc, 2013). Google Drive is a tool with the purpose of sharing, collaborating and storing files, although the corporation mainly uses it for documentation such as description of fundamental requirements and other reports (Google, inc, 2013). PT is an agile management tool and it is mainly used for its functionality to keep track of backlogs. According to a interviewee, this is a new tool which was chosen by the management department. Deployed use and evaluation by the development department, however, found that the tool did not fit their needs as initially anticipated, and have discontinued its use.

MediLog Technologies does not, at the moment, have a defined development process. Despite that, they a feature list (backlog) which gets updated with either new or modified features, according to a project manager. The project teams have weekly meetings/conferences, and the sub-team in Sri Lanka has additionally face-to-face meetings during each week.

3. Method

This study was conducted using action research where data was collected through an interview, questionnaire and a literature review. The data was then analyzed by thematic analysis.

3.1 Research Approach

Action research (McKay and Marshall, 2001) was selected in order to investigate and possibly improve the current software process of a corporation, which works with geographically distributed agile teams.

As seen in Figure 1, an action research is an iterative process for implementing problem solving activities (as seen in Figure 1). The iteration stops when the outcome of the improvements has reached a satisfactory level.
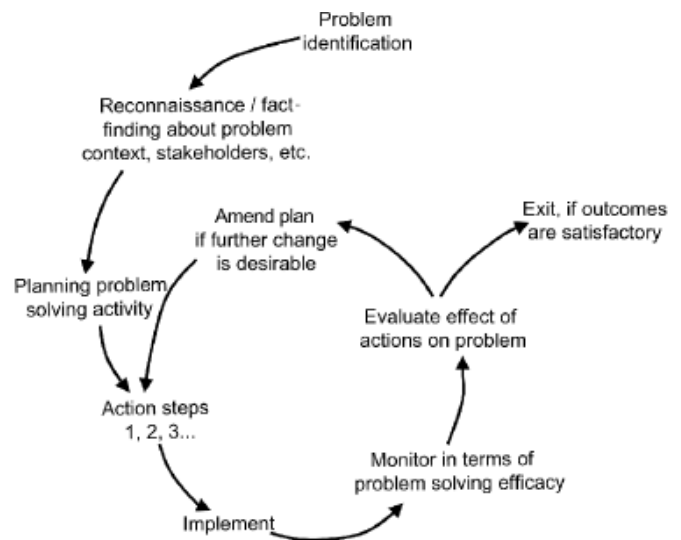

Figure 1: The problem solving interest in action research (McKay and Marshall, 2001:50)

This study will include the first three steps: problem identification, reconnaissance/fact-finding about the problem context and planning a problem solving activity. They are followed by the iterative phases, implementation and to measure if the outcomes of the improvement are satisfactory. Otherwise, it is planned again and the process iterates one more time. The last steps of the action research were not included in this research due to time constraints. The company will most probably implement the improvements, but information on this will not be available for this research.

3.2 Data Collection

The data collection was divided into two subsections, one containing information about the literature review and the other containing interview and questionnaire.

3.2.1 Literature Review

To answer the research questions, a literature research was conducted in order to get deeper

background knowledge of different kind of processes, to be able to conduct efficient a questionnaire. To find literature, a search strategy was created, as well as a criteria for selection of documents.

3.2.1.1 Search Strategy

The databases were used to discover relevant documents (see Table 2) using the keywords: agile, challenges, geographically distributed, improvements, solutions and traditional.

Databases
Chans
Libris
Chalmer Library
ProQuest
Google Scholar
Scirus
IEEE Explore

Table 2: Used databases for literature review

The search terms were created both by individual keywords, as well as the combinations:

- Agile
- Challenges
- Geographically distributed
- Improvements
- Solutions
- Traditional
- Geographically distributed agile
- Geographically distributed agile solutions
- Geographically distributed agile challenges
- Geographically distributed agile improvements
- Geographically distributed improvements
- Geographically distributed improvements
- Geographically distributed solutions
- Agile challenges
- Traditional and agile

The exclusion criterion concerned the following documents: produced before 2000, from other databases (than those mentioned in Table 2) and found without using the keywords.

3.2.1.2 Study Selection Criteria

The process for finding data sources consisted of a literature review and a creation of a review protocol. The review protocol included both criterion for inclusion and exclusion. Other exclusion criterion, regarding the content of the literature, were done in two iterations before the final analysis. The articles were rated on a scale of one to five upon both relevancy and reliability, and the data was then stored to create a good overview of the literature. In the first iteration, documents were decided upon based on the abstract and overlook of headings. The second iteration consisted of a full review of the documents and a possible extraction of the relevant data. Documents that were not directly relevant to background, challenges or improvements, were discarded. The relevancy and reliability needed both to be at least over two and the sum had to be over five.

Reliability, in the first iteration, was based upon the authors' experience and why it was written. In the second iteration, the value of reliability was updated based on the content of the literature. In areas such as: how soon after the event the document was written and if the author had a certain point of view. Standpoints of the author also go hand in hand with if there are competing versions of the source.

After the first iteration, 28 articles were chosen dependent upon title, year of publication and abstract. After the second iteration ten documents were not considered to be relevant enough, which resulted in 18 documents in total.

3.2.2 Interview and Questionnaire

This research was based upon an interview with employees of MediLog Technologies to understand the individuals and the cultural contexts, which influence their current process. Firstly, a face to face interview was conducted, and then four questionnaires were sent out. Out of all questionnaires sent, three were returned.

The first interview was with a project manager from MediLog Technologies. It was held to understand the environment and the current SDLC.

The interview was a semi-standardized interview, which means no strict questions in advance and interview guide were based upon themes the interviewer found important (Bergquist, 2013). Some of these topics were discovered from before based on literature review, to not miss important themes. A semi-standardized interview, together with open questions, was chosen since it generally produces a great amount of data (Bergquist, 2013). The interview was recorded, then transcribed and finally summarized to bullet list form. This was done to not miss important data and to easily analyze the interview with other data sources.

An email questionnaire to the developers of the company was sent out as well, and the questions were based upon the literature review and the face-to-face interview with the project manager of MediLog Technologies (see Appendix C). The reason behind this choice was in order to collect data from all the developers despite the time constraints, but also for the reason that the employees are geographically distributed.

3.4 Data Analysis
The data analysis was divided into two different sections, one for analysis of the literature review and one for the interview and responses of the questionnaire. After the analysis of each data source the information were analyzed together by thematic analysis (Braun and Clarke 2006) to compare findings.

3.4.1   Literature Review
The data collected from the literature review was analyzed by thematic analysis (Braun and Clarke 2006). Thematic analysis builds upon six steps and this research followed them accordingly (Braun and Clarke 2006):

1   Prepared the coding for thematic analysis – document to handle the coding was created.
2   Generated initial codes – consists of the creation of keywords for a certain type of data (in this case mostly challenges and improvements).
3   Searched for themes – started when the data was coded, to see patterns of keywords

4   Reviewed and refined themes – this is done to be able to group themes, although no refinement was in order.
5   Produced thematic map – by this an overview was created with a clear perception of the most common challenges and their relations.
6   Produced the final report – also consisted of final analysis and final selection of literature.

3.4.2   Interview and Questionnaire
The abovementioned six steps of thematic analysis (Braun and Clarke 2006) were also used to analyze interview and the responses of the questionnaire. Although, keywords of thematic analysis was more easily created due to the background obtained from the literature review. The interview and the responses of the questionnaire were analyzed and compared to each other, because they consisted of similar questions about the challenges which GDASD teams encounter. This was with ease possible due to the transcription and summarization of the face to face interview, which generated data which were easy to compare with the responses of the questionnaire.

4   Results
In this section, the result of challenges and the suggestions of improvements, are presented.

4.1   Current Challenges

Area of challenges in GDASD	Literature review	Interview/ questionnaire
Communication and collaboration	X	X
Culture	X	X
Documentation	X	
Knowledge management	X	
Management	X	X
Risk management	X	
Time zone	X	X
Tools	X	

Table 3: Comparison of the findings in the literature review and interview/questionnaire

The challenges discovered from all data sources were categorized into themes. In Table 3 it is

visible which data source identified the respective challenge.

The themes of the challenges are the following:

Communication and collaboration – The interviewee and the participants of the questionnaire mentioned communication and collaboration challenges which have been encountered. Alqahtani et al., (2013) mentioned that the decrease in communication frequency and quality is caused by the complex infrastructure of GDASD. Hossain, Babar and Paik (2009) even state that roughly every GDASD-team will encounter this challenge. Therefore, it is considered to be one of the main challenges in GDASD. Also one of the participants of the questionnaire stated:

"*When it comes to delivering a product or module, communication is the most important factor.*"

The challenge is not only the communication within the team, it is also the communication between teams as one of the participants of the questionnaire stated. Inter-team chemistry was as well mentioned in the response of the questionnaire, where he/she also interacts with the teammates on a personal basis. Hence, it becomes tougher to relate to other teammates, which are geographically distributed.

During meetings, offshore members are usually quiet until they are asked to speak, compared to onshore members who are direct, loud and honest (Alqahtani, et al., 2013). At the same time, the offshore members are most likely to hide their development issues and simply mention the "good news" (Alqahtani, et al., 2013). Furthermore, the offshore members commonly do not want to take part of the discussion or appear to possess a lower level of skills and not being able to understand the problems (Alqahtani, et al., 2013; Jimeenez, Piattini and Vizcanio, 2009). This can depend on the personality and cultural background of the employees. Yet, a participant of the questionnaire stated:

"*[Interact with the teammates on a personal basis] Sitting in geographically distributed offices does not make this possible to the degree I would like to,*

and I often find it difficult to relate to my programmers for this reason."

The communication gap is even greater when the team-members are new and have not gotten familiar with the process and the team (Shrivastava and Date, 2010). Language skills were mentioned both by employees and literature, and will alternate in GDASD (Alqahtani, et al., 2013; Jimeenez, Piattini and Vizcanio, 2009). Language differences may lead to additional misunderstandings, for example mistakes in messages and translation errors (Alqahtani, et al., 2013; Jimeenez, Piattini and Vizcanio, 2009).

Communication and collaboration challenges may lead to a lack of trust and team awareness, which would influence the company's productivity badly, causing e.g. misunderstanding of the requirements (Alqahtani, et al., 2013; Prikladnicki, Audy and Evaristo, 2003b). It could also be the source of a communication barrier to the customer, which would result in decreased visibility of the development (Alqahtani, et al., 2013). In order to maintain good communication quality the company needs to provide good Internet connections, especially for their offshore team members (Alqahtani, et al., 2013).

Culture – Collaboration with individuals who have different cultural backgrounds is required in GDASD (Shrivastava and Date, 1020). The cultural background differs in many different areas such as national, professional, ethic, organization, technical and team culture (Shrivastava and Date, 2010).

The national differences may include different holidays (for example some regions have Thursday and Friday as weekends), which affect the teams' possibility to communicate (Alqahtani, et al., 2013). Organizational differences can, for example, mean that some team members may be used to a "command and control" environment, and are therefore not open-minded to self-organizing teams (Alqahtani, et al., 2013). Another challenge stated by Alqahtani, et al., (2013) and Prikladnicki, Audy and Evaristo (2003b) was language barriers, which may have been included by Shrivastava and Date (2010) in the professional dimension.

Alqahtani, et al., (2013) also mentioned the religion dimension, which differs more for individuals in GDASD compared to local ADP. These differences can both be positive and negative, since they may lead to misunderstandings. For example, sending certain information by email can by some cultures be considered as abrupt and rude (Prikladnicki, Audy and Evaristo, 2003b). Therefore, the effect of these differences results in challenges in communication and collaboration (Shrivastava and Date, 2010; Alqahtani, et al., 2013).

The cultural challenges mentioned by employees were related to Shrivastava and Date (2010) sub-challenges - professional and organizational. The challenges the company faced were employment of women, language skills, fundamental theist employees and employees accustomed to "command and control". In one case, the employment of women in one onshore team lead to their father desired to be in the office during workdays. Employees which are theists have a desire to go and pray during working hours, which require additional planning to not interfere with meetings. "Command and control" is in some cultures a habit of the population and this requires a strict and good project manager, in order to stay in control. All these encountered challenges mentioned by the employees, are partly related to management as well.

Documentation – Insufficient communication in GDASD-teams can influence the project documentation badly (Shrivastava and Date, 2010; Prikladnicki, Audy and Evaristo, 2003b). Hence, understanding may suffer about details in the project, which results in a lack of information in the story cards for a complete understanding for every team member (Shrivastava and Date, 2010). The documentation is very important to clarify assumptions and at the same time support the maintainability (Prikladnicki, Audy and Evaristo, 2003b).

Knowledge management – Knowledge management is an important project component. Without this it is not possible to exploit the real benefits of GSD-projects (Shrivastava and Date, 2010; Prikladnicki, Audy and Evaristo, 2003b). The main purpose of knowledge management is to

reduce costs by sharing: experience, decisions, methods and skills to the team, during the development (Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009).

Management – Challenges related to management are caused by high organizational complexity, scheduling, task assignment and cost estimation (Shrivastava and Date, 2010). The task assignment becomes difficult due to the assignment on a one-user story (not system component) to the whole development team, regardless of the team members' geographical location (Shrivastava and Date, 2010). This may result in gaps in the functionality between system components (Shrivastava and Date, 2010). Differences in time zone lead to lack of synchronization across the team (Prikladnicki, Audy and Evaristo, 2003b). The employees mentioned synchronization from the different sub-challenges above. However, they also encountered challenges related to "command and control", employment of women and theist employees, which are partly related to management challenges as well. Another challenge related to management is planning, according to one project manager that was interviewed.

These challenges arise because of the development environment, which consists of changes of specifications, cultural diversity, a lack of informal communication and volatile requirements (Shrivastava and Date, 2010).

Risk Management – Risk management is an important and critical project activity in GDASD teams, which generate different risks compared to local ADP (Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009). The risks that geographically distributed agile teams generate are: coordination, evolving requirements, problem resolution, knowledge-sharing and risk identification (Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009). In addition, software defects most probably increase due to an increased complexity caused by communication problems and a lack of group awareness (Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009). Sometimes, the risk management does not take into account the effects that diverse cultures, dispersion, attitudes and time difference,

which GDASD may encounter (Prikladnicki, Audy and Evaristo, 2003b). Despite this, the company has, according to an interviewee, not conducted any risk management at the moment. The reason behind that choice was unclear.

Time zone – Challenges regarding time zones can create barriers in ADP (Alqahtani, et al., 2013), because ADP relies on synchronization of working hours between the employees and other stakeholders (Shrivastava and Date, 2010; Alqahtani, et al., 2013).

The time zone between Sweden, Singapore, Malta and Sri Lanka is a challenge for the team. Although the maximum time difference between the four countries is 6 hours, one of the participants of the questionnaire stated:

"The b*iggest challenge for our team is communication and time zone*"

This challenge also includes the differences between countries' holidays, which affect the amount of time the team can work together (Alqahtani, et al., 2013). Meetings are one project component that become directly affected by the different time zones and the various holidays in different nations (Shrivastava and Date, 2010).

Tools – Geographically distributed agile teams need various tools to maximize communication and project support (Shrivastava and Date, 2010; Hossain, Babar and Paik, 2009). This becomes a challenge, because most ADP relies on local collaboration. Therefore, it is important that tools support the features (burndown charts, backlogs etc.) of agile methodologies to be shared between every employee (Shrivastava and Date, 2010).

The company uses GitHub, PT, Skype, instant messages which seems to be enough for the employees. Although, when reading between the lines of some statements by the interviewee and the participants of the questionnaire, it is possible to notice a lack of tool support:

"[Why PT is not needed] because GitHub has all the basic necessary project management & tracking tools needed for a developer"

"[PT] As a developer it doesn't support me. I think if it could be integrated with GitHub it would be great."

"[PT] *I think it is an excellent tool, which greatly helps teams track how progress is going and who is doing what."*

The first and second statements say that the tool is not needed, because it does not support the developers. In contradiction, the third statement is answered by the viewpoint of the team, therefore it becomes necessary for the interviewee.

4.2 Possible Improvements of Challenges

In this section suggested improvements, which can be made to improve geographically distributed agile teams, is presented based on the literature. The improvements are as follows:

Communication and collaboration – In order to compare the literature, some authors (Alqahtani, et al., 2013; Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009) agreed that the key to improve the generally bad communication is communication itself. Although, agile team members normally communicate informally, this becomes formal nonverbal communication when regarding GDASD- teams (Shrivastava and Date, 2010). A great way to minimize this challenge according to Shrivastava and Date, (2010) is to set up, if possible, video conferences which are a much better option compared to voice conferencing. In order to enable the team members to work remotely, the company can supply Web cameras, headsets and the right tool/tools for sharing software (Shrivastava and Date, 2010). Additional solutions to enhance communication, and even to combine with conference calls, are instant messenger (synchronous communication) and email (asynchronous communication) (Alqahtani, et al., 2013; Hossain, Babar and Paik, 2009; Shrivastava and Date, 2010). These communication methods will help to overcome the challenge of different time zones, if they are not overlapped (Shrivastava and Date, 2010; Prikladnicki, Audy and Evaristo, 2003b). It can also be done by adjusting working hours to have overlap in the communication, for example by having some

members working from home during the meeting (Hossain, Babar and Paik, 2009). Another solution may be selection of a representative in the team, which can write and send out reports to non-available team members about meeting discussions and outcomes (Shrivastava and Date, 2010). Additionally, conducting sub-meetings for only team members who are directly affected to an issue will save time, compared by conducting a meeting with the entire team (Shrivastava and Date, 2010). A functional and user-friendly management tool improves the collaboration as well (Jimeenez, Piattini and Vizcanio, 2009; Shrivastava and Date, 2010). Also, having requirements/user stories clear and commonly defined will reduce communication problems (Jimeenez, Piattini and Vizcanio, 2009; Shrivastava and Date, 2010). This as well relies on the individual skills of the team members to be able to work with several tools (Jimeenez, Piattini and Vizcanio, 2009). Shrivastava and Date (2010) mention the importance of training, to create a common knowledge of the tools. Distributed teams which are not co-located have to find different ways of training, creating common knowledge throughout the team (Shrivastava and Date, 2010).

Culture – No improvement were discovered, in the literature.

Documentation – By providing good illustration, it will: transcend all language barriers and are indispensable regarding the making of a proper design and action planning. Shrivastava and Date (2010) and Jimeenez, Piattini and Vizcanio (2009) also mentioned the importance of illustrations and how it will reduce misunderstanding and by that improve collaboration. An example of a suggestion for illustrating more was providing use case (UC) diagram with every user story (Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009). Shrivastava and Date (2010) states the importance of a good project management tool (e.g. issue tracker), because it aids maintaining documentation and provides a good transparency (Shrivastava and Date, 2010).

Knowledge management – To handle knowledge management challenges Shrivastava and Date,

(2010) and Prikladnicki, Audy and Evaristo (2003b) suggests sharing knowledge through an online tool. If knowledge sharing is improved it will be a lot easier for new team members to get experience by learning the knowledge stored in the knowledge management tool (Prikladnicki, Audy and Evaristo, 2003b). Therefore, the tools for improving the knowledge management need the following functions (Prikladnicki, Audy and Evaristo, 2003b):

- Traceability framework (identified by the key knowledge element)
- Supports the acquisition
- Integration
- Use of knowledge elements (allowing knowledge fragments to be stored in diverse environments to be integrated and used by different stakeholders)

The documentation must as well be continuously updated and structured to avoid assumptions and ambiguity, with the purpose of facilitating a common understanding (Prikladnicki, Audy and Evaristo, 2003b).

Management – One challenge for the management is not to distribute work according to the geographical location, and thinking in terms of completing user stories and not adding feature to components (Shrivastava and Date, 2010). The user stories should be distributed one at a time across the whole team, regardless of the geographical position of the team-members or skills (Shrivastava and Date, 2010). If user stories are broken down to tasks and then assigned dependent on the geography or skills, after a certain time this will construct knowledge silos by having new work that only can be done by one or two team members (Shrivastava and Date, 2010). Another important part of management is to have commonly defined milestones and clear entry and exit criteria for every task (Prikladnicki, Audy and Evaristo, 2003b; Shrivastava and Date, 2010). Tasks which involve transmission of critical information must be meticulously planned and executed (Shrivastava and Date, 2010), since networks differ in speed and reliability dependent on the geographic location (Shrivastava and Date, 2010). Other challenges that managers encounter are: to control the overall development process, taking

into account the possible impact of different cultures, improving the process during the enactment and reducing any factors that may influence badly on the productivity (Shrivastava and Date, 2010).

Risk Management – In GDASD teams, a greater effort is needed in risk management activities (Jimeenez, Piattini and Vizcanio, 2009; Shrivastava and Date, 2010). There have been attempts, according to Jimeenez, Piattini and Vizcanio (2009), in order to minimize these problems through: defining a process, specifying guidelines, roles, forms and templates, and adopting a re-engineered inspection process. The adoption of a re-engineered inspection process aims at minimizing synchronous activities and coordination problems (Jimeenez, Piattini and Vizcanio, 2009). Another way is the "WOOM" methodology, used to provide measurements and facilitate decision making (Jimeenez, Piattini and Vizcanio, 2009). The literature also states that increased communication problems and lack of group awareness may lead to more defects (Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009). A final statement by Jimeenez, Piattini and Vizcanio (2009:8) is that:

"Teams must be continuously controlled in order to detect problems and take corrective actions."

Time zone – Bigger time zone differences can result in communication blackouts during which the team-members are not available, depending on the geographically difference their individuals in the team (Shrivastava and Date, 2010). GDASD teams need to plan the specific time for meetings in a way so that the time of the meetings is overlapped, but this is usually only possible for teams with less time difference (Therrien, 2008; Shrivastava and Date, 2010). If a team which is distributed offshore possesses a large time difference, a team representative who works with the remote team can write and send out reports (Shrivastava and Date, 2010). This team representative will attend the meetings and needs to be active in discussions and meetings with the team and in order to then pass the result on to the members who did not attend the meeting due to time zone differences (Shrivastava and Date,

2010). Shrivastava and Date (2010) states an alternative solution, which involves multilevel reporting and multiple meetings.

Tools – Consulting with other corporations and teams can be supportive when it comes to the discovery of good tools. In other words, finding out what other developers are working with and do a research about it. The suggested tools can, according to Shrivastava and Date (2010) and Hossain, Babar and Paik (2009), be categorized by their key purposes:

- Bug and tracking databases: Log where information about found bugs is stored.
- Collaborative development environments: tools which provide project workspaces and standardized work-sets, and are recommended as a solution for geographically distributed agile projects. Examples of that are project management tools and project repositories (this includes tools with the features of backlogs and burndown charts as well).
- Communication tools: Can for example be emails or instant messengers.
- Knowledge centers: tools for frequently asked question and technical references.
- Social networking tools: tools enabling group interaction, which furthermore contain communication tools, from email to tools for video conferences.
- Software configuration management tools: repositories and version controlling tools.

5 Discussion

This section discusses the findings of the interview and the responses of the questionnaire in comparison with the literature review. The data that concurs or diverges will be highlighted and discussed.

The challenges which arise in geographically distributed agile teams discovered both from the literature review and employees of MediLog Technologies matched. Although, the results of the interview and the questionnaire revealed four out of the eight known challenges, which were discovered by the previous research. The challenges mentioned by the employees were:

communication and collaboration, cultural, management and time zone. However, some challenges from interviewee and participants of the questionnaire were hard to fit into a single theme, since they were deemed essentially equally applicable to several themes. Some aspects regarding cultural challenges will directly affect both management and the communication and collaboration. Therefore planning to avoid cultural challenges becomes vital. The generally bad communication in GDASD together with formal meetings may go hand in hand with the lack of trust and team awareness (Alqahtani, et al., 2013; Prikladnicki, Audy and Evaristo, 2003b). The reason behind this can be that it is easier to trust a person you know.

To improve the bad communication and collaboration in GDASD-teams, the literature suggested improving the frequency of meetings and use of communication tool(s). Although, conducting daily meetings would improve the communication and create a better overview of the ongoing tasks. On the other hand, daily meetings can become very hard to organize if time zone differences are large. A functional and user-friendly project management tool would facilitate communication and reduce misunderstandings. To increase the communication even more, the team can also use instant messenger (synchronous communication) and email (asynchronous communication) (Alqahtani, et al., 2013; Hossain, Babar and Paik, 2009; Shrivastava and Date, 2010). This will partly help overcome the time zone challenges as well (Prikladnicki, Audy and Evaristo, 2003b).

Cultural challenges have six dimensions: national, professional, ethic, organizational, technical and team culture (Shrivastava and Date, 2010). It becomes hard to avoid or minimize cultural challenges, due to the fact they will always exist to some extent. As well as improvements of cultural challenges are directly dependent on personal communication and collaboration skills. However, cultural differences will also occur in local ADP, due to different backgrounds and personalities. Studies in improvement of cultural challenges can therefore exist in other researches related to ADP or other collaboration studies.

To avoid misunderstandings it is important to maintain valuable documentation (Shrivastava and Date, 2010). Documentation, together with illustrations, can overcome all language barriers that may exist. An example mentioned by Jimeenez, Piattini and Vizcanio (2009) was to provide a user story with every UC diagram.

Sharing experience on decisions, methods and skills, is a way to reduce unnecessary costs of a project (Shrivastava and Date, 2010; Jimeenez, Piattini and Vizcanio, 2009). In order to overcome knowledge management challenges, using an online tool for discussions has been proposed as a solution (Shrivastava and Date, 2010; Prikladnicki, Audy and Evaristo, 2003b; Jimeenez, Piattini and Vizcanio, 2009). The following functions have been suggested in this tool: traceability framework (identified by the key knowledge element), support for the acquisition, integration and use of knowledge elements, allow knowledge fragments to be stored in diverse environments, in order to be integrated and used by different stakeholders in creating a common understanding (Prikladnicki, Audy and Evaristo, 2003b). This challenge was mentioned neither by the interviewee nor the response of the questionnaire. The reason for that may be that the company uses GitHub wikis to share information. Because of this they have reached a good level of satisfaction in this area.

The challenges mentioned by an interviewee, were only two out of four sub-challenges: high organizational complexity and planning. Cost estimation and task assignment were the two other sub-challenges mentioned by Shrivastava and Date (2010). The reason why these were not discovered may have been because task assignment was included in the scheduling and cost estimation may not be considered in their own project. Another reason could be that they have a good process or tools which have made this challenge easier and therefore it was not considered.

Risk management of challenges is a critical project management activity (Jimeenez, Piattini and Vizcanio, 2009). The literature also states that the increased communication problems and lack of group awareness may lead to more defects

(Shrivastava and Date, 2010). Jimeenez, Piattini and Vizcanio (2009) suggests a way to minimize these problems by: defining a process, specifying guidelines, roles, forms and templates, and adopting a re-engineered inspection process.

Meetings get directly affected by different time zones (Shrivastava and Date, 2010). With overlapped working hours, the meetings can be held to overlap as well. Otherwise, it was suggested by the literature (Therrien, 2008; Shrivastava and Date, 2010) to have different working hours. For example, two team-members can attend the meeting from home. The quality of the internet connection and the tool for communication becomes a direct potential issue. The company would be affected by the cost of arranging meetings on non-working hours. Another way would be to have a team representative send out meeting reports (Shrivastava and Date, 2010). The team representative needs to be active and alert during meetings in order to be able to pass on the results to unavailable employees (Hossain, Babar and Paik, 2009; Shrivastava and Date, 2010).

The challenge consisting of maximizing communication (Shrivastava and Date, 2010; Hossain, Babar and Paik, 2009) with tools, is the last challenge not mentioned directly by the interviewee nor the response of the questionnaire. This may be because they have good collaboration tools for the moment. However, reading between the lines, the teams seem to lack overview over the project and its ongoing tasks. In order to improve management challenges caused by lack of tool support, the team needs a large commitment from the management department (Shrivastava and Date, 2010).

5.1 Validity Discussion

The main strengths of this research are that more than half of the challenges were validated by an interview and questionnaire. The interview and the questionnaire were anonymous, which prompts more honest answers. Hence, the interviewees will not encounter consequences for their answers. Furthermore, data about challenges and improvements are perceptions of the employees and literature, and not facts. This increases as well the validity of the research. Additionally, previous research was concatenated for both the challenges and the improvements of GDASD-teams. The data acquired from the employees were also compared with previous literature. Previous literature in this area of concern had to be published no later than the year of 2000, which makes this research stronger and more accurate as it was based on new data sources. The process used for selection of literature disabled the author from declining the literature of his choosing. Following a review protocol will ensure the selection of literature follows a certain structure and therefore relevant data cannot be disallowed.

The selection criteria for choosing developers which were from the same company certainly affected the result. To obtain more reliable and objective result, there could have been interviews conducted with another geographically distributed company. Different nations and individuals may encounter different challenges and improvements when working with GDASD. But the largest limitation in this research was time/man-power, since there was only one researcher. Time constraints directly influenced the amount of data sources (for example the amount of interviews) and the possibility of implementation of the improvements. Another threat to the validity is the reply-rate of the questionnaire, 75% of developers hired in the company responded to the survey. Although, the reply rate of 75%, is still a respectable percentage of the questionnaire.

6 Conclusion

This paper investigates the challenges met by geographically distributed agile teams and their improvements. The areas of concern were investigated through a literature review, an interview and a questionnaire with employees from MediLog Technologies.

The conclusion was that geographically distributed agile teams might encounter eight common challenges. These are: communication and collaboration, cultural, documentation, knowledge management, management, risk management, time zone and tools. There were no new main challenges discovered by the employees of MediLog Technologies, compared to previous

studies. Instead, over half of the challenges were validated through the interview and the questionnaire. The improvements from the literature review were concatenated, as well as discussed. For all common challenges found, improvements to solve the challenges of concern were established. Although, differences in time zones, formal nonverbal communication and more comprehensive documentation will affect the ability to quickly respond to changes, which is the key purpose of ADP. Therefore, it becomes possible to question how agile the GDASD-teams actually are.

The main contribution of this research is the concatenation of literature, validation of challenges and summary of suggested improvements. The challenges were based upon the previous research in the field as well as an interview and a questionnaire. However, the improvements were based upon the literature. This research can be used by GDASD-companies to improve their productivity, although the challenges and improvements differ between teams and companies.

7 Future work

This paper contains valuable insight of challenges in GDASD-teams and how to improve these challenges. First, completing the rest of the steps in the action research loop would be gainful for GDASD-companies. In other words, to iterate stages of the action research such as implementing, obtaining feedback and to change according to feedback. This is done in order to generate, even more, enhanced improvements. Second, by conducting more interviews with another company, one would discover new challenges and improvements, which would broaden the perspective.

All this data produced by the two proposals above can be used to create better tools intended for geographically distributed agile teams.

8 Acknowledgements

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10 Appendix

Appendix A

Terms and abbreviations

Sequence Diagram	SD
Software Development Life-Cycle	SDLC
Use case	UC
Geographically Distributed Agile Software Development	GDASD
Pivotal Tracker	PT
Agile Development Processes	ADP

Appendix B

Face-to-face interview topics

Interviewer: Andreas Johansson
Interviewee: A project manager in MediLog Technologies
Interview setting: Semi-standardized interview

Date: 27-6-2013

- Communication
- Collaboration
- Cultural differences
- Documents
- Knowledge Management
- Language differences
- Main challenges
- Management/control
- Risk management
- Software development method
- Time zone
- Tools
- Work distribution

Appendix C

Questionnaire conducted by email

Interviewer: Andreas Johansson
Interviewee: The developers of MediLog Technologies
Interview setting: This was carried out through email correspondence.
Date: Answered: 12th of July 2013

Background Information

1. What is your current role in the company?
2. Which country do you currently live in?
3. What responsibilities and workloads does your role imply?

4. Could you please describe you experience in the field of software development?

Collaboration

5. What do you consider to be the main challenges of working in geographically distributed teams? Please elaborate your answer.
6. What would you consider to be the greatest in your collaboration? Please elaborate your answer.
7. Which software development method do you consider to be most similar to? Please elaborate your answer.
8. How good do you consider your current software development process (please rate on a scale of one to five)? Please elaborate your answer.
9. From a scale of one to five, how good overview do you have in each project? Please elaborate your answer.

Software Development Tools

10. How satisfied are you using GitHub on a scale one to five? Please elaborate your answer.
11. How satisfied are you with Pivotal Tracker? Please elaborate your answer.