THE CHALLENGES OF APPLYING DISTRIBUTED AGILE SOFTWARE DEVELOPMENT: A SYSTEMATIC REVIEW

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ABSTRACT

With the increasing use of distributed software development, there has been growing interest in the application of different methods of software development. The software development industry is investigating the use of Agile software development methods with the distributed development instead of the traditional heavyweight methods in order to improve the development efficiency and quality. However, research has shown that combining Agile and distributed development could pose significant challenges, regarding to the contradiction between Agile values and the distributed development environment. This systematic review intends to identify the challenges of applying this approach. The various challenges have been classified into five categories: lack of communication and collaboration, lack of management and control, cultural differences, time zones differences, and lack of Agile skills. The outcome of the paper has enabled the creation of a systematic map that shows the current stage of knowledge about this development approach. A major conclusion of this study is that there is a lack of empirical research and a dire need for further investigation in order to identify the expected challenges and benefits of this combinatory approach.

KEYWORDS: *Distributed Agile, Global Agile, Global Software Engineering, Agile Software Development &Systematic Literature Review.*

I. INTRODUCTION

Increased globalization has led to greater competition between software developments companies around the world. The software development industry is seeing a shift from co-located software development to GSD, which involves multiple distributed development teams from different locations [1]. GSD facilitates competitive software development prices by using teams from countries that have an abundance of IT developers available at relatively low cost. Datamonitor estimates the value for the global software market is increasing and is set to reach $299.1 billion in 2014 [2]. In addition, research has shown that software companies are interested in applying Agile Software Development (ASD) to develop the software by global teams to have the combined advantages of ASD and GSD [3], [4]. The combination of Agile development methods and GSD is known as Distributed Agile Software Development (DASD). Venkatesh defined Distributed Agile Development as: "Distributed Agile, as the name implies, is a model in which projects execute an Agile Methodology with teams that are distributed across multiple geographies" [5]. This combination has shown signs of providing IT companies with the ability to meet the critical success factors of the software industry, such as quality, time, and cost. Sutherland et al. [6] reported their experience of applying a distributed Scrum approach and reported several advantages such as the high increase of team productivity, increase in the transparency, better building of trust, and increased the project visibility [6].

However, research has shown that software companies are encountering significant challenges by applying this approach. Developers are not always able to apply the Agile practices successfully due to the global development environment [7], [8]. The lack of communication and differences in culture and time zones create significant challenges for Agile methods [[12]], [10].

There are several relevant systematic studies that have been published about Agile development. For example, Hossain et al. [7] conducted another systematic review regarding the use of the Agile method known as Scrum in GSD. This review highlighted the challenges of adopting the Scrum method as well as the strategies to deal with these challenges. They conclude that there is a need to modify Scrum practices in order to adopt it within the GSD setting. Their study also pointed to the growing interest and the lack of empirical research in this area. Moreover, Dybå and Dingsøyr [11] have published a systematic review regarding Agile software development in which they indentify around 26 pre-studies. Their review compared and contrasted various Agile development methods and discussed the benefits and limitations of Agile development. It ended with reporting the need to conduct more research such as action research to manage the partnership between industry and research community in this field. Another systematic review has been published by Jalali and Wohlin [12] for global software engineering and Agile practices. It indentified 81 papers published between (1999 and 2009). This study focused on Agile practices and the sufficient conditions required making it work successfully with the GSD. The results reported that most of the studies within this area are experience reports, and there is need for more empirical research and comprehensive framework to address DASD approach.

Apart the above studies which look at specific aspects of the development and investigate particular Agile development method, there is no current and up to date systematic review that provides comprehensive background about DASD and investigates the use of the main Agile methods such as Scrum, XP, and Lean within the GSD environment. Therefore, this paper will explore the current knowledge of the DASD through analyzing and classifying the related studies in this field. The aim is to provide researchers and ASD communities with a detailed overview of what is already known about DASD. Finally, it will further investigate the main challenges of applying the DASD approach in order to provide a basis for the improvement to this kind of development.

This rest of this paper is structured as follows: Section 2 summarizes the review methodology and describes the review process. Section 3 details the review results by providing answers to the review questions. Finally, the conclusions of the review will be addressed within Section 4.

II. REVIEW METHOD AND CONDUCT

3.1. Review Strategy "Review protocol"

The present study has been developed in accordance with Kitchenham systematic review guideline [13]. The review protocol can be summarized as follows:

I. Identify the study scope and questions.
II. Identify the data sources and search strategy.
III. Collect the related papers by applying the selection process.
IV. Apply a quality assessment test.
V. Extract data from the selected papers.
VI. Analyze the contents of those papers.
VII. Answer the questions of the review.

3.2. *Research questions and data extraction*

This review aims to answer the following two research questions.

RQ1: What is currently known about Distributed Agile Software Development?

This question was chosen to address the general aim of this literature review, which is to provide a thorough statistical overview of what is known about the DASD approach. During the review information was extracted from a range of papers including details on the Agile methodologies employed, data sources, year of publication, and some classifications based on the contents of the selected studies. In addition, the so-called HOT perspectives were used to classify the selected paper (HOT stands for Human, Organizational, and Technical perspectives [14]). This technique has been used to show that Agile approach is not just about management and technical perspective, but also the human and organizational perspectives. Hazza and Dunbinsky [14] explain how the Agile manifesto and practices cover these three perspectives and also allude to how these perspectives are vital for the

success of software engineering. Table 1 shows the characteristics of each aspect of the HOT perspectives.

Table1. The HOT perspectives.

Human perspective	Organizational perspective	Technical perspective
— Social aspects — Collaboration and communication between customers and development team — Knowledge sharing	— Management and organization culture aspects — Software project management — Control	— Designing — Testing — Coding — Delivering — Maintenance

RQ2: What are the main challenges of Distributed Agile Software Development?
This question has been chosen to address the main objective for this review, which is to highlight the challenges and obstacles of applying the DASD approach. To answer this question the reported challenges of distributed Agile were collected, analyzed, and listed within the results section.

3.3. Data Sources and keywords

The review used five available digital libraries containing peer-reviewed work. These libraries represent the most relevant well-known journals in software engineering and provide a diverse selection of data sources:

I. IEEE Xplore.
II. Science Direct, Elsevier.
III. Wiley InterScience "Information Systems Journal".
IV. SpringerLink.
V. ACM Digital library.

When searching the data sources the written language was assigned to "English", and the publication data was set from 2005 to May-2012. In the search, the following keywords were employed:

Table 2. Search keywords

Research words category	
Category	**Keywords**
Agile Software Development (ASD)	Agile; Global Agile; Distributed Agile; Agile software development; Agile development methods; Agile practices; Scrum; Extreme programming XP; Feature driven development; Lean development
Global Software Development (GSD)	Global software development; Dispersed software development; Distributed software development; Distributed team; Distributed development; Outsourcing software development; Off shoring software development; Global software engineering; Virtual team

3.4. Selection process

During the selection process, studies were selected using four key stages. Table 3 below shows the selection process as well as the number of studies identified at each stage.

Table 3. The primary papers selection process

Selection stage	Number of papers
First stage: Searching for the related papers using the search words and search terms, and select related papers based on their titles.	707
Second stage: Reading the abstracts of the selected papers from the previous stage, to decide whether or not these papers are related.	231
Third stage: Reading the contents of the selected papers, and selecting the main related papers.	112
Final stage: Applying a quality assessment to identify the final set of the main related papers.	76
Update stage: Updating the search result by May 2012.	81

The first stage involved searching for related papers using the keywords, whilst related papers were also selected based on their titles. Before commencing with the second stage, a short pilot test was undertaken for a random set with 30 papers. Each one of the authors worked separately to evaluate the set and extract the critical data. The aim of the pilot test was to provide the authors with a good understanding of the kind of data that need be extracted and the kind of information that need to be extracted during the paper selection. The pilot test also aimed to identify the selection process within this study. The second stage involved reading the abstracts of the papers selected in stage one. For papers lacking a clear abstract the main contents and sub-titles were briefly scanned. The third stage consisted of reading the contents of the selected papers. Critical data was extracted during this stage such as the research type, the Agile method, the type of development (local or global), the HOT perspectives, and so on. The final stage involved the application of a quality assessment to identify the final set of the main related papers. The quality assessment for this review has nine critical factors in the form of questions with which to access the quality of the selected papers. They are:

(1). Research aim (Yes, No).
Does the paper communicate its aim/s clearly?
(2). Research design (Yes, No).
Does the paper explain its research methodologies with regards to addressing the research's aims?
(3). Data collection (Yes, No).
Does the paper provide an explanation of its data collection methodologies?
(4). Sample (Yes, No).
Does the paper provide sufficient information about the sample such as sample size, the type of participants, and how the sample size is suited to the project?
(5). Value of research (Yes, No).
Do the authors show how their paper adds value to the previous knowledge of their research area?
(6). Data analysis (Yes, No).
Do the authors explain the data analysis process?
(7). Research finding (Yes, No).
Do the authors state the research findings clearly?
(8). Agile development (Yes, No).
Does the paper relate to Agile software development?
(9). Global software development (Yes, No).
Does the paper relate to global software development?

Those factors have been used to evaluate the selected papers. Any paper with a total score less than 5 from 9 was discarded. The Appendix 1 is showing the list of selected studies with their quality assessment result.

III. RESULTS AND DISCUSSION

4.1. Results of the systematic review

To answer RQ1 a plethora of information was extracted to provide a thorough statistical overview with regards to what is currently known about this kind of software development. This section will discuss the extracted information and will provide statistical data in order to illustrate the current level of knowledge within the field.

Figure 1 below shows the number of related studies based on the year of publication and the data source. The number of selected publications in this area ranges from 2 studies in 2005 to the highest number of studies by 2008 and 2011 with 19 papers. The review also collected 5 papers published so far within May 2012. The increase in the number of studies shows the increased interest of Agile methods from IT companies and developers.

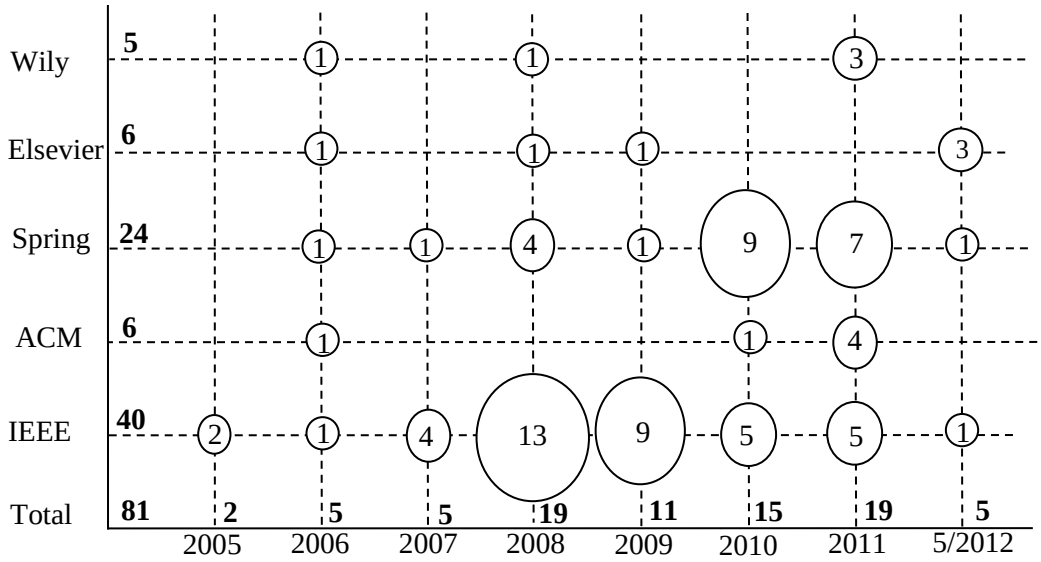

Figure 1. Visual map showing the number of studies by each year for each data source.

Out of the selected group of studies, IEEE published most with 40 papers, which represents about 49% of the selected work. Springer-Link came second with 24 papers (30% of the total selected work).

Figure 2 provides a breakdown of the reported software development methods. Most papers came under the Agile class which includes the papers regarding Agile practices in general, and the papers detailing hybrid methods. This class came first with 37 papers. The Scrum method is the most popular Agile method with 27 studies. There are 8 non-Agile papers were selected because they are related to GSD.

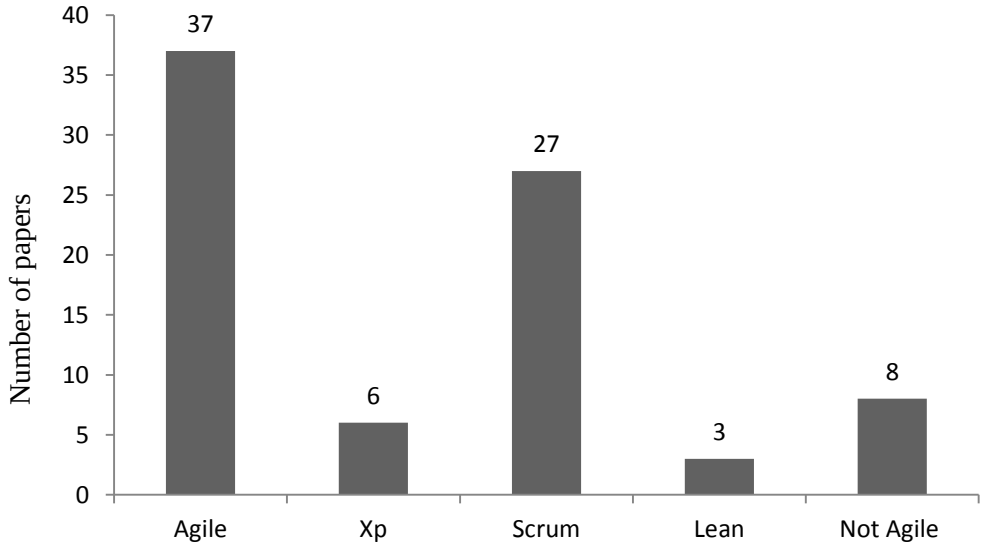

Figure 2. The number of selected papers for each development Agile methods.

Figure 3 shows a classification for the selected studies based on their particular focus. The first class which has 18 articles is "Case Study and Lessons Learned". The papers of this class discuss the experience of applying the Agile approach and reported some lessons learned. The category of Challenges and Risks Management has the most papers (20 papers). The Agile Adoption class collected 17 studies. The papers of Agile Adoption included a description and map road to start effectively applying Agile methods with global and local development. The Analysis and Explanation class has 13 papers which explain and analyze some phenomena regarding the application of Agile methods and practices such as increased team productivity. In addition, 5 selected

papers evaluated and compared Agile methods to identify the differences between them and determine the most efficient method.

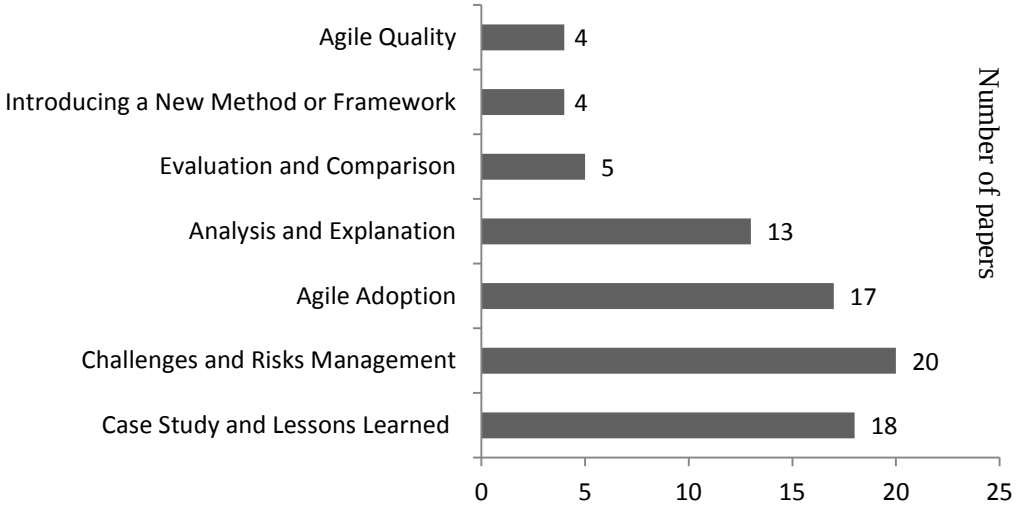

Figure 3. The number of selected papers for each class based on their contents.

The percentage of distributed Agile articles from the selected set is 78%. While, 28% are not Agile or not global. Moreover, the presence of global software development articles from the total selected papers is 87%, and about 13% are about local development. More than 75% of the related papers are not empirical studies.

More than 75% of the related papers are not empirical studies. Many researches have reported the lack of empirical studies issue [12], [15].. Figure 4 details the research methodology that was used in the collected papers. The most popular methods are case studies and experience reports which explains the lack of empirical studies within this field.

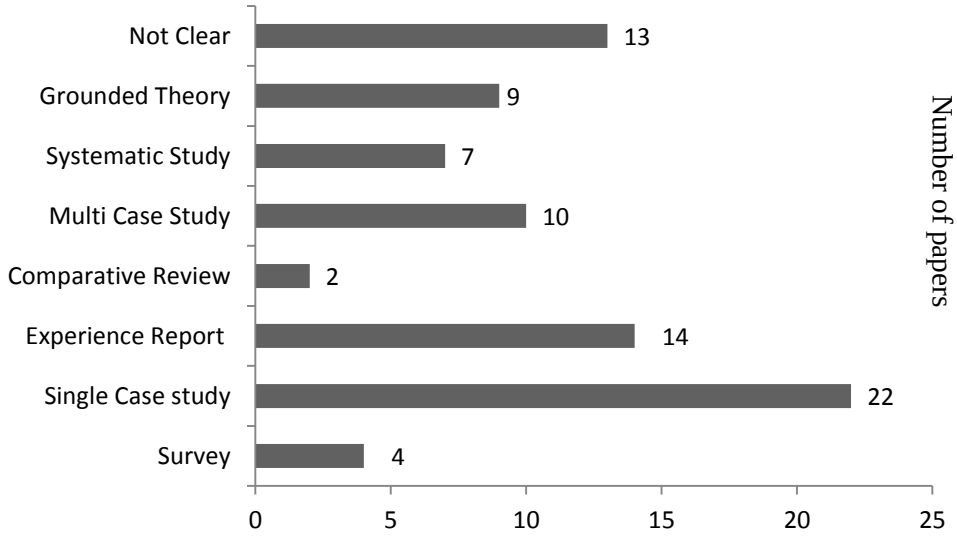

Figure 4. The number of selected papers based on the applied research methodology.

Figure 5 analyses the content of the collected papers based on the HOT perspectives. Using this kind of classification, this review aims to explore the lack of research in the distributed Agile field by presenting the number of papers for each perspective. This was a difficult task, as a number of papers were reported under two or three perspectives. Figure 5 reports that most of the papers cover the technical perspective while there is a lack of coverage when it comes to the human perspective. The losing attention of the human perspective within the DASD studies is conflicting with first value from the Agile manifesto is "Individuals and interactions over process and tools" [16]. Losing this Agile main value could decrease the Agility level and make the development similar to the structured

traditional methods and directly linked to the main challenges with this development, such as cultural differences and lack of Agility. The human perspective need to immediately search to explore the effect of the cultural differences on the relationship between the stakeholders and the development process. The next section will discuss some development challenges related to this issue such as cultural difficulties and lack of Agility.

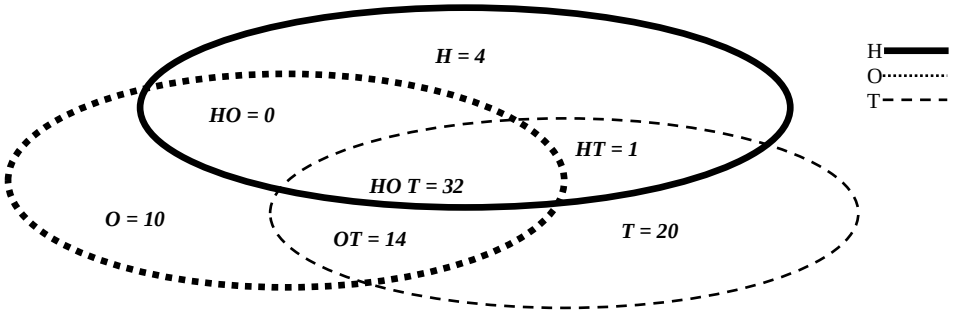

Figure 5. HOT analysis, classifying the collected papers based on Human, Organizational, and Technical perspectives.

4.2. The main challenges with Distributed Agile Software Development

To answer the review's second question (RQ2) an analysis of the published studies and reports was undertaken in order to extract the kinds of challenges encountered with distributed Agile development. This review found 33 studies outlining the challenges of this development model. This section classifies the challenges into the following groups: communication and collaboration, management and control, cultural differences, time zones differences, and Agile skills. In each subsection an outline of the main issues reported will be provided.

4.2.1 Communication and Collaboration Challenges

Communication and collaboration between project stakeholders is crucial for Agile methodologies. However, in GSD, the distance between the development teams can create many difficulties in synchronizing communications. Agile development requires a high level of synchronized communications between the stakeholders and any weakness of the communications could create a misunderstanding of the requirements, reduce the team productivity, or decrease the collaboration level [7]. Asynchronous online communications methods (such as email or project management software) have been used to address the problems of synchronized communication between teams working in different time zones. However, it has still not been enough to compensate. The lack of synchronization and direct communication contradicts Agile values and principles [17]. The lack of communication could create barriers for customers when they follow the progress of development and could make it difficult for developers to keep in touch with customers. Therefore, this could decrease visibility of development [18].

Providing a good quality communications channel could be expensive and add substantial cost to the project. Sometimes the development teams, especially those offshore face technical issues such as poor internet connections, or poor infrastructure. Due to this, the communications cost must be increased [19], [10].

In most cases, the English language is not the mother tongue of the offshore team members. The lack of proficiency in the English language could create a big challenge between the development teams, as it could cause some misunderstandings of the requirements and issues with communications and collaboration [15].

In brief, Agile methods require interactive daily communication between stakeholders. That is difficult to provide within the global environment. Improving communications is important in decreasing the distances between teams. Most of the others challenges of DASD are linked to communication barriers, in some way. Table 5 lists the communication challenges identified in the systematic review and shows the count and the percentages for each one of them.

Table 5. Lack of communication and collaboration challenges with the DASD

Communication challenges	Count (Frequency)
There is a lack of communication and collaboration during all the development stages	25 (75%)
There is a lack of English Language skills within project team members that minimizes the communication levels	5 (18%)
There is a lack of communication between the developers and the product owners "misunderstanding of the requirements"	6 (18%)
There is an increase of the communication and coordination costs to address the communication barriers	6 (18%)
Lack of shared knowledge and information	4 (12%)
The increased distance between Agile developers minimizes the level of communication and collaboration.	4 (12%)
Some development teams have issues with poor infrastructures	3 (9%)
The visibility level of the development progress is low	2 (6%)
The total	29 (88%)

4.2.2. Culture Differences Challenges

The first value from the Agile manifesto is "Individuals and interactions over process and tools" [16]. This means the Agile approach is not just about the process, it takes care of people over the process. Agile methodologies focus on creating a relationship between developers and customers, sharing a culture and building trust between team stockholders. Agile principles also believe that the developers and customers need to work side by side during the development. Working together with different people and sharing the work environment can be an easy task with local development. However, with global development, it is a bigger challenge. The stakeholders with global development are from different counties and areas around the world, combining different cultures, different values, different backgrounds, and different religions. Consequently, applying Agile methodologies within the global environment confronts some cultural barriers [15].

The differences of cultures between the stakeholders could create a lack of understanding of the team responsibility. In some cultures, organizations' members do not pay attention to the upper level management. They are used to working within a "command and control" environment. Managers from this kind of culture do not share the vision and goals of their organization with their employees. This could create a lack of understanding of the teams' responsibility and decrease team moral. Developers with Agile methodologies need to work as a team, share their ideas, discuss their goals and tack their responsibility to their team. Some papers stated that the offshore members usually stay quiet and cautious during the agile meetings until someone asks them to speak, as to do otherwise is considered rude in their culture. In contrast, the onshore members are direct, loud, honest, and open to discussion [15], [10].

In addition, the cultural differences may cause a lack of transparency and honesty. The members of the offshore team usually hide the development issues, especially in the beginning of the project. They pass the good news to the onshore team and avoid talking about any kind of negative staff. The offshore team looks to the onshore team as their managers, so they may not have the courage to discuss any negative things with them. The offshore team members usually try to avoid any discussion with onshore team because they do not want them to think they do not understand the problems [15].

The cultural differences also could create misunderstanding between team members and lead to lack of trust and team awareness. That could decrease the team productivity [20]. Table 6 summarizes the reported cultural differences challenges with DASD.

Table 6. The cultural differences challenges with the DASD

Cultural challenges	Count (Frequency)
The cultural differences between project/s stockholders can lead to lack of awareness	18 (55%)
There is a lack of trust between team members	10 (30%)
There is a lack of understanding of authority with some team participants	4 (12%)
The differences in culture can reduce the team responsibility and moral	4 (12%)

There is a lack of transparency from some members regarding cultural differences	3 (9%)
The cultural differences reduce the developers' productivity	2 (6%)
The total	24(73%)

4.2.3. Management and Control Challenges

Managing two teams or more around the world is a difficult task. Managing them to develop the software by Agile methods, where the manager is a facilitator more than manager, is a huge challenge when based within the environment of global development [18]. Project managers need to manage and control the development under Agile values and principles and they have to adapt to different regulations from different countries, such as working systems or immigration policies [12]. The lack of management could cause despondency between the development teams. Other management barriers will be reported within Table 7 below.

Table 7. Lack of management challenges with the DASD

Management and control challenges	**Count (Frequency)**
There is lack of team management "configuration management"	14 (42%)
The development team has estimation difficulties with the development cost, scope, and development schedule	4 (12%)
The differences of the development countries make barriers to adapt within different local regulations	2 (6%)
There is a security risk according to the distances between teams. "Some information could be lost during the communication"	2 (6%)
Increasing the number of sites creates difficulties for team control and management	2 (6%)
The total	15 (45%)

4.2.4. Time Zones Differences Challenges

The differences of the time zones between the project stakeholders in global development could reach around 10 to 12 hours. That creates many barriers in Agile development. Many of the Agile practices require synchronization of the working hours between the offshore teams, onshore team, and other stakeholders. For instance, the Agile team will have issues with applying pair programming practice or holding the Scrum meeting. The time zone difference makes combining the Agile and distributed development with smaller projects not worth it [20].

Furthermore, the differences of the countries and regions create differences with the public holidays and weekends between the development members [15]. For example, the weekend in western countries is on Saturday and Sunday. In some other regions they have Thursday and Friday as the weekend holiday, and some countries only have one day as a break. The seasons for vacations are different between countries. This problem could minimize the chances of the development teams working together.

Table 7. Time zones differences challenges with the DASD

Time zone differences challenges	**Count (Frequency)**
Time differences between teams reduce the available time for synchronous communication	4 (12%)
Different holiday schedules make it difficult for teams to synchronize work	1 (3%)
The total	5 (15%)

4.2.4. Lack of Agility Challenges

Lack of agility refers to the conflict with Agile values and principles during project development. Global development conditions make it difficult to apply some Agile practices and reduce their values. For example, offshore members stay silent most of the meeting because of language barriers and cultural differences. In addition, the time zone difference limits the available time to meet. The increase of the project stakeholders will also be a challenge in using some Agile practices [15].

Another barrier is that the stakeholders may not have enough skills and experiences with Agile methods. It has been noticed by a few papers that the offshore team members usually have a weakness with agile skills. Some of the meeting's participants have a problem with reported information that they need to share during agile meetings [21]. On the other hand, customers could be new to Agile methodologies, so they will have a misunderstanding in their roles as product owners [6].
In addition, the distributed Agile challenges, such as lack of communication and language barriers, could increase the shared documents between the development stakeholders [15]. For example, participants share detailed documents about product requirements, meetings and project plans in order to solve the communication barriers. However, using heavy documentation instead of synchronized communications is contrary to agile principles and values. On the other hand, there is a lack of formal documents and standardized requirement documentations that could cause a misunderstanding of the task or increase documentation [22]. Table 8 below shows the issues with Agility within global development.

Table 8. Lack of agility challenges with the DASD

Lack of agility challenges	**Count (Frequency)**
Some stockholders have a lack of Agile skills	5 (15%)
Global development settings can lead to insufficient development meetings	3 (9%)
Lack of formal documents "no standards"	3 (9%)
There is an increase of documentations during development	2 (6%)
The large number of team members creates difficulties in applying some of the Agile practices	2 (6%)
Some technical issues with GSD can lead to insufficient applications for some Agile practices and methods	4 (12%)
The total	12 (37%)

Those five groups of challenges summarize the main reported barriers within the DASD from the literature. All the five reported categories of challenges are closely related, and each one having an impact on the other groups. For instance, the lack of management may decrease the communication and collaboration between team members. These challenges should be studied together as one set of challenges. To minimize or address one there is a need to minimize the effects of the others. Ignoring those challenges could minimize the Agile development advantages, and will make the development approach more structured (i.e. Traditional software development).

IV. CONCLUSIONS AND FUTURE WORK

In conclusion, this review demonstrates the nature of the current literature regarding the DASD. It has also listed the potential challenges within this kind of development. The lack of communication is seen as the biggest challenge by 88%, whilst the cultural differences are a close second with 73%.
This review finds that 75% of the related studies in this area are not empirical studies. It also showed that there is no standard approach for applying Agile methods within global development. On the other hand, there is increasing interest about applying this approach. Therefore, there is a need for empirical comprehensive studies, which describe the challenges and strategies for combining the Agile methods with the global development.
Future work will involve further investigation to examine these challenges and develop a better understanding of applying Agile practices within global settings.

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David Harrison is currently the Chair of the Higher Degrees Committee of Glasgow Caledonian University. He is also the Subject Group Leader for Mechanical & Manufacturing. He has spent his working career in manufacturing industry or industry facing academia. A graduate of UMIST, he has also worked within the Department of Mechanical Engineering, where he was a consultant to many blue chip manufacturing companies. He joined Glasgow Caledonian University in 1994 where he has had a variety of roles. For the past 4 years he has led the "Howden Academy" which is a global engineering programme developed specifically to meet the needs of the Howden Group of Companies. He has delivered MSc Modules on "Project Planning and Management" "Manufacturing Management" and "Professional Practice" for the past 18 years and this has been

available via Distance Learning mode for the past 6 years. He is the Secretary of the Engineering Professors' Council and the Immediate Past President of the Institution of Engineers & Shipbuilders in Scotland.

Bruce Wood is a qualified Designer with 17 years' experience in industry on a national and international scale. Founder of the CCI at GCU in 2002, he has created Masters programmes in Product Design and Development, Digital Media and more recently, Design Practice and Management. In 2009 He completed his PhD entitled Design as an Economic Development Enabler. Throughout this time Bruce directed and managed over 200 new products which established over 50 new companies and won over 30 international design awards.

David Moore is an Audio Technology Lecturer in the School of Engineering and Built Environment at Glasgow Caledonian University. He commenced this post in 2009 after completing his PhD thesis at the University of Huddersfield. He has a strong interest in the application of HPC technologies for audio processing and acoustic modelling tasks and has recent research in spatial audio, sound synthesis, environmental noise, and novel controllers for audio interaction. In addition, to the above David is a committee member for the Audio Engineering Society Scottish Section and a member of the local steering committee for Archie-West - a research council funded supercomputer for the West of Scotland.

Abdullah Alqahtani is a lecturer at the University of Dammam since 2002. He received his Master degree from the University of New England – Australia. He is currently doing his PhD at Glasgow Caledonian University. And his field of interest includes Distributed Agile Development, Agile methods, Information Systems, and Knowledge Management

APPENDIX 1- THE QUALITY ASSESSMENT FOR THE SELECTED STUDIES

N	List of selected Studies (Authors, Title, Year of publish)	Aim	Research design	Data Collection	Sample	Value of Research	Data Analysis	Finding	Agile	Global	Total
1	ABBATTISTA, F., CALEFATO, F., GENDARMI, D. AND LANUBILE, F. Incorporating social software into distributed agile development. (2008)	1	1	0	0	1	1	1	1	1	7
2	ABRAHAMSSON, P., OZA, N. AND SIPONEN, M.T. Agile software development methods: A comparative Review. (2010)	1	1	0	0	1	1	1	1	0	6
3	ANGIONI, M., CARBONI, D., PINNA, S., SANNA, R., SERRA, N. AND SORO, A. Integrating XP project management in development environments. (2006)	1	0	0	0	0	1	1	1	1	5
4	AVRITZER, A., BRONSARD, F., AND MATO, G. Improving global development using Agile: How Agile processes can improve productivity in large distributed projects. (2010)	1	1	1	1	1	0	1	1	1	8
5	BANNERMAN, P.L., HOSSAIN, E. AND JEFFERY, R. Scrum practice mitigation of global software development coordination challenges: A distinctive advantage? (2012)	1	0	1	1	1	1	1	1	1	8
6	BERCZUK, S. Back to basics: The role of agile principles in success with a distributed scrum team. (2007)	1	0	0	0	1	0	1	1	1	5
7	BOEHM, B. Some future software engineering opportunities and challenges. (2011)	1	1	0	0	1	0	0	1	1	5
8	CANNIZZO, F., MARCIONETTI, G. AND MOSER, P. Evolution of the tools and practices of a large distributed agile team. (2008)	1	0	1	1	1	0	1	1	1	7
9	COWAN, C.L. When the VP is a scrum master, you hit the ground running. (2011)	1	0	1	0	0	1	1	1	1	6
10	CRISTAL, M., WILDT, D. AND PRIKLADNICKI, R. Usage of scrum practices within a global company. (2008)	1	1	1	1	0	1	1	1	1	8
11	DAJDA, J. AND DOBROWOLSKI, G. Experiment-driven approach to building support for distributed agile teams. (2007)	1	0	0	0	1	1	1	1	1	6
12	DINGSOYR, T., NERUR, S., BALIJEPALLY, V.G. AND MOE, N.B.A decade of agile methodologies: Towards explaining agile software development. (2012)	1	1	1	1	1	1	1	1	0	8
13	DORAIRAJ, S., NOBLE, J. AND MALIK, P. Bridging cultural differences: A grounded theory perspective. (2011)	1	1	1	1	1	0	1	1	1	8
14	DORAIRAJ, S., NOBLE, J. AND MALIK, P. Effective communication in distributed agile software development teams. (2011)	1	1	1	1	1	1	1	1	1	9

15	DRUMMOND, B.S. AND UNSON, J. Yahoo! distributed agile: Notes from the world over. (2008)	1	0	1	0	0	1	1	1	1	6
16	DRURY, M., CONBOY, K. AND POWER, K. Obstacles to decision making in agile software development teams. (2012)	1	1	1	1	1	1	1	1	0	8
17	DULLEMOND, K., VAN GAMEREN, B. AND VAN SOLINGEN, R. How technological support can enable advantages of agile software development in a GSE setting. (2009)	1	1	0	0	1	1	1	1	1	7
18	DYBA, T. AND DINGSOYR, T. Empirical studies of agile software development: A systematic review. (2008)	1	1	1	0	1	1	1	1	0	7
19	ELSHAMY, A. AND ELSSAMADISY, A. Divide after you conquer: An agile software development practice for large projects. (2006)	1	0	0	0	1	1	1	1	0	5
20	FERNANDO, B.A.J., HALL, T. AND FITZPATRICK, A. The impact of media selection on stakeholder communication in agile global software development: A preliminary industrial case study. (2011)	1	1	1	1	1	1	1	1	1	9
21	HILDENBRAND, T., GEISSER, M., KUDE, T., BRUCH, D. AND ACKER, T. Agile methodologies for distributed collaborative development of enterprise applications. (2008)	1	0	0	0	1	0	1	1	1	5
22	HIRSCHFELD, R., STEINERT, B. AND LINCKE, J. Agile software development in virtual collaboration environments. (2011)	1	1	0	0	1	0	0	1	1	5
23	HOLE, S. AND MOE, N.B. A case study of coordination in distributed agile software development. (2008)	1	1	1	1	1	1	1	1	1	9
24	HOSSAIN, E., BABAR, M.A., PAIK, H. AND VERNER, J. Risk identification and mitigation processes for using scrum in global software development: A conceptual framework. (2009)	1	1	1	0	1	1	1	1	1	8
25	HOSSAIN, E., BABAR, M. AND PAIK, H. Using Scrum in Global Software Development: A Systematic Literature Review. (2009)	1	1	1	1	1	1	1	1	1	9
26	HOSSAIN, E., BANNERMAN, P. AND JEFFERY, D. Scrum practices in global software development: A research framework. (2011)	1	1	0	1	1	1	0	1	1	7
27	HOSSAIN, E., BANNERMAN, P.L. AND JEFFERY, R. Towards an understanding of tailoring scrum in global software development: A multi-case study. (2011)	1	1	1	1	1	1	1	1	1	9
28	IKOMA, M., OOSHIMA, M., TANIDA, T., OBA, M. AND SAKAI, S. Using a validation model to measure the agility of software development in a large software development organization. (2009)	1	1	1	0	1	1	1	1	0	7
29	JAGADISH SHRINIVASAVADHANI, J. AND PANICKER, V. Remote mentoring a distributed agile team. (2008)	1	0	1	0	0	1	1	1	1	6
30	JALALI, S AND WOHLIN, C. Agile Practices in Global Software Engineering – A Systematic Map. (2010)	1	1	1	0	1	1	1	1	1	8
31	JALALI, S. AND WOHLIN, C. Global Software Engineering and Agile Practices: A systematic review. (2011)	1	1	1	1	1	1	1	1	1	9
32	KAJKO-MATTSSON, M., AZIZYAN, G. AND MAGARIAN, M.K. Classes of distributed agile development problems. (2010)	1	1	1	1	1	1	1	1	1	9
33	KATAYAMA, E.T. AND GOLDMAN, A. From manufacture to software development: A comparative review. (2011)	1	1	1	0	1	1	1	1	0	7
34	KHAN, S.U., NIAZI, M. AND AHMAD, R. Critical success factors for offshore software development outsourcing vendors: A systematic literature review. (2009)	1	0	1	0	0	0	1	1	1	5
35	KORKALA, M. AND ABRAHAMSSON, P. Communication in distributed agile development: A case study. (2007)	1	1	1	1	1	1	1	0	1	8
36	KORKALA, M., PIKKARAINEN, M. AND CONBOY, K. Combining agile and traditional: Customer communication in distributed environment. (2010)	1	0	1	1	1	1	1	1	1	8
37	LANE, M.T. AND AGERFALK, P.J. Experiences in global software development-a framework-based analysis of distributed product development projects. (2009)	1	1	1	1	1	1	1	1	1	9
38	LANUBILE, F., EBERT, C., PRIKLADNICKI, R. AND VIZCAINO, A. Collaboration tools for global software engineering. (2010)	1	0	0	0	1	1	1	0	1	5
39	LEE, J.C., JUDGE, T.K. AND McCRICKARD, D.S. Evaluating eXtreme scenario-based design in a distributed agile team. (2011)	1	0	1	1	0	1	1	0	1	6
40	LEE, S. AND YONG, H.S. Distributed agile: Project management in a global environment. (2010)	1	1	0	0	1	0	0	1	1	5
41	MARCHESI, M., MANNARO, K., URAS, S. AND LOCCI, M. Distributed scrum in research project management. (2007)	1	1	1	1	1	1	1	1	1	9
42	MARUPING, L.M. Implementing extreme programming in distributed software project teams: Strategies and challenges. (2010)	1	0	1	0	1	1	1	1	1	7
43	McCAFFERY, F., SMITE, D., WILKIE, F. AND McFALL, D. A proposed way for European software industries to achieve growth within the global marketplace. (2006)	1	0	1	1	1	1	1	1	1	8
44	MEYER, S., KNAUSS, E. AND SCHNEIDER, K. Distributing a lean organization: Maintaining communication while staying agile. (2010)	1	0	0	0	1	1	1	0	1	5
45	MISHRA, D. AND MISHRA, A. Complex software project development: Agile methods adoption. (2011)	1	1	0	0		1	1	1	1	6
46	MISRA, S.C., KUMAR, V. AND KUMAR, U. Identifying some important success factors in adopting agile software development practices. (2009)	1	1	1	1	1	1	1	1	0	8
47	MONASOR, M.J., VIZCAINO, A. AND PIATTINI, M. Cultural and linguistic problems in GSD: A simulator to train engineers in these issues. (2011)	1	1	1	1	1	1	1	1	0	8
48	MUDUNBA, V. AND LEE, O.K. A new perspective on GDSD risk management:	1	1	0	0	1	1	1	1	1	7

	Agile risk management. (2010)										
49	NISAT, M. AND HAMEED, T. Agile Methods handling Offshore Software Development Issues. (2005)	1	0	0	0	1	0	1	1	1	5
50	NOLL, J., BEECHAM, S. AND RICHARDSON, I. Global software development and collaboration: Barriers and solutions. (2010)	1	1	0	0	0	1	1	0	1	5
51	OLIVEIRA, M. AND DUIN, H. Agility in serious games development with distributed teams: A case study. (2008)	1	0	1	1	0	1	0	1	1	6
52	PAASIVAARA, M., DURASIEWICZ, S. AND LASSENIUS, C. Distributed Agile development: Using scrum in a large project. (2008)	1	1	1	1	1	1	1	1	1	9
53	PAASIVAARA, M., DURASIEWICZ, S. AND LASSENIUS, C. Using scrum in distributed agile development: A multiple case study. (2009)	1	1	1	1	1	1	1	1	1	9
54	PAASIVAARA, M., DURASIEWICZ, S. AND LASSENIUS, C. Using scrum in a globally distributed project: A case study. (2008)	1	1	1	1	1	1	1	1	1	9
55	PAASIVAARA, M. AND LASSENIUS, C. Could global software development benefit from agile methods? (2006)	1	0	0	0	1	0	1	1	1	5
56	PAASIVAARA, M. AND LASSENIUS, C. Using Scrum Practices in GSD Projects. (2010)	1	1	1	1	1	1	1	1	1	9
57	PHALNIKAR, R., DESHPANDE, V. AND JOSHI, S. Applying Agile principles for distributed software development. (2009)	1	0	0	0	1	0	1	1	1	5
58	PIETINEN, S., TENHUNEN, V. AND TUKIAINEN, M. Productivity of pair programming in a distributed Environment–Results from two controlled case studies. (2008)	1	0	0	0	1	1	1	0	1	5
59	PIKKARAINEN, M., HAIKARA, J., SALO, O., ABRAHAMSSON, P. The impact of agile practices on communication in software development. (2008)	1	1	1	1	0	1	1	1	1	8
60	PIKKARAINEN, M., SALO, O., KUUSELA, R. AND ABRAHAMSSON, P. Strengths and barriers behind the successful agile deployment—insights from the three software intensive companies in Finland. (2011)	1	1	1	1	1	1	1	1	0	8
61	PORTILLO-RODRAGUEZ, J., VIZCAANO, A., PIATTINI, M. AND BEECHAM, S. Tools used in global software engineering: A systematic mapping review. (2012)	1	1	1	1	1	1	1	1	1	9
62	PRIES-HEJE, L. AND PRIES-HEJE, J. Why scrum works: A case study from an agile distributed project in Denmark and India. (2011)	1	1	1	1	1	1	1	0	1	8
63	RICHARDSON, I., CASEY, V., BURTON, J. AND McCAFFERY, F. Global software engineering: A software process approach. (2010)	1	0	1	0	0	1	1	1	1	6
64	RINGSTAD, M.A., DINGSOYR, T. AND BREDE MOE, N. Agile process improvement: Diagnosis and planning to improve teamwork. (2011)	1	1	1	1	0	1	1	0	1	7
65	ROBARTS, J.M. Practical considerations for distributed agile projects. (2008)	1	0	1	1	0	0	0	1	1	5
66	SADUN, C. Scrum and global delivery: Pitfalls and lessons learned. (2010)	1	0	1	1	0	0	0	1	1	5
67	SCHARFF, C. Guiding global software development projects using scrum and agile with quality assurance. (2011)	1	0	1	1	1	1	1	1	1	8
68	SCHARFF, C., GOTEL, O. AND KULKARNI, V. Transitioning to distributed development in students' global software development projects: The role of Agile methodologies and end-to-end tooling. (2010)	1	1	1	1	0	1	0	1	1	7
69	SFETSOS, P. AND STAMELOS, I. Empirical studies on quality in agile practices: A systematic literature review. (2010)	1	1	1	1	1	1	1	1	0	8
70	SURESHCHANDRA, K. AND SHRINIVASAVADHANI, J. Adopting agile in distributed development. (2008)	1	0	0	1	1	0	1	1	1	6
71	SUTHERLAND, J., SCHOONHEIM, G., KUMAR, N., PANDEY, V. AND VISHAL, S. Fully distributed scrum: Linear scalability of production between San Francisco and India. (2009)	1	0	0	0	0	1	1	1	1	5
72	SUTHERLAND, J., SCHOONHEIM, G. AND RIJK, M. Fully distributed scrum: Replicating local productivity and quality with offshore teams. (2009)	1	1	1	0	1	1	1	1	1	8
73	SUTHERLAND, J., SCHOONHEIM, G., RUSTENBURG, E. AND RIJK, M. Fully distributed scrum: The secret sauce for hyper productive offshore development teams. (2008)	1	0	1	1	1	0	1	1	1	7
74	SUTHERLAND, J., VIKTOROV, A., BLOUNT, J. AND PUNTIKOV, N. Distributed scrum: Agile project management with outsourced development teams. (2007)	1	1	1	1	1	1	1	1	1	9
75	SZOKE, A. A feature partitioning method for distributed agile release planning. (2011)	1	1	0	0	1	1	1	1	1	7
76	SZOKE, A. Optimized feature distribution in distributed Agile environments. (2010)	1	1	1	1	1	1	0	1	1	8
77	TAYLOR, P.S., GREER, D., SAGE, P., COLEMAN, G., McDAID, K. AND KEENAN, F. Do agile GSD experience reports help the practitioner? (2006)	1	1	0	0	1	1	1	1	1	7
78	THERRIEN, E. Overcoming the challenges of building a distributed agile organization. (2008)	1	1	1	1	0	1	1	1	1	8
79	VALIMAKI, A. AND KAARIAINEN, J. Patterns for distributed Scrum—A case study. (2008)	1	0	1	0	1	1	1	1	1	7
80	VAX, M. AND MICHAUD, S. Distributed agile: Growing a practice together. (2008)	1	0	1	1	1	1	0	1	1	7
81	WANG, X. The combination of agile and lean in software development: An experience report analysis. (2011)	1	1	1	0	1	1	1	1	0	7