Understanding Agile Global Software Development (A-GSD)

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Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work, and has not been submitted as an exercise for a degree at this or any other university. I further declare that this research has been carried out in full compliance with the ethical research requirements of the School of Computer Science and Statistics.

Signed: _____

Sohrab Farzaneh Candón

1st September 2015

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I agree that the School of Computer Science and Statistics, Trinity College may lend or copy this dissertation upon request.

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Sohrab Farzaneh Candón

1st September 2015

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"A mí ya se me olvida todo, pero de ti me acuerdo mucho hijo"

Abstract

This research aims to provide a deep understanding of how the how Agile Methodologies are applied to a Global Software Development environment. In addition, it tries to understand the advantages, disadvantages and solutions of Agile Global Software Development (AGSD) practices. In order to do so an embedded single case study was conducted gathering qualitative data with participatory observation and semi-structured interviews. The case studied the development phase of an implementation project driven by the service and support organization of one of the 10 largest software companies in the world. Two very large companies, located in three different regions (AMER, EMEA, APJ), with four time zones, implemented the project. The study discovered the usage of two new practices applied to AGSD: Sprint Kick-off meetings and Sprint Wrap-up meetings.

Keywords: SCRUM, Agile Methodologies, Global Software Development, Case Study, large organization, implementation project

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Abbreviations

AGSD: Agile Global Software Development

BA: Business Analyst

CustCo: Customer of the project under study

DSD: Distributed Software Development

GSD: Global Software Development

ImpCo: Implementation Company of the project under study

OPR: Observer Participant Report

PMO: Project Management Office

QA: Quality Assurance

QM: Quality Management

TL: Track Lead

US: United States of America

1. Chapter 1: Introduction

The world of software development has been evolving since the creation of the first computing machines. Nowadays, thanks to the Internet and the improvement on the communication infrastructures, software development can be distributed among distant locations around the world.

Distributed or Global Software Development (GSD) can team-up professionals in different parts of the world and provide access to large pools of skilled professionals. GSD projects can also present an increased management complexity due to factors such as cultural differences, geographical distance and different time zones (Agerfalk et al., 2008).

In order to mitigate some of the risks associated with Global Software Development, some companies have used Agile Methods (Estler et al., 2014). Since the consolidation of Agile Methods in 2001, these projects are commonly associated to small, co-located projects and claim to provide flexibility in the features to be implemented (Patel et. al, 2011).

This study analyses how an implementation project uses Agile Methodologies to overcome some of the challenges presented by Global Software Development in the support organization of one of the 10 largest software companies in the world.

1.1. Context & Background

Dharmadas (2008) defined Global Software Development as the process of developing software with teams located in different parts of the world working together to deliver an application according to the customer's requirements. Agerfalk and others (2008) stated that the geographical distance was not the only one applicable to Global Software Development, temporal and socio-cultural distance also affects distributed development teams working on a global environment. Ozawa & Zhang (2013) studied how a Japanese software company used Agile Methods in a Global Software Development environment to mitigate the socio-cultural distance among the different locations collaborating in the project (Ozawa & Zhang, 2013).

The aim of this research is to understand how an implementation project uses the Agile Methods to mitigate the risks present when working on a Global Software Development environment. Moreover, this study aims to provide new insights and hypothesis for future research. The first objective of this dissertation is to provide more information about how Agile Methods are combined with Global Software Development in an industrial situation on a project delivered by a large company. The second objective of the study is to identify the perceived benefits and challenges of using Agile Methods in Global Software Development projects.

1.2. Research Question

In order to understand how Agile Global Software Development (A-GSD) is used in the industry, this dissertation will try to answer the following research questions:

- How are Agile Methods used in a Global Software Development implementation project delivered by a large company?
    - What are the advantages and challenges of Agile Methods and GSD practices in a project?
    - How are the challenges addressed in an A-GSD project?

1.3. Scope of the Study

The aim of this study is to identify new hypothesis for future research, therefore the research method used will be a single embedded case study. The data gathered will be analysed using qualitative methods. Using qualitative techniques will provide a deeper understanding on how the project to study combined Agile Methods and Global Software Development practices.

Several studies have been carried out in order to understand the combination of Agile Methods and Global Software Development. Sureshchandra and Shrinivasavadhani (2008) analysed the adoption of those techniques by small and medium-sized organizations. Kussmaul, Jack and Sponsler (2004) studied the combination of Agile Methods with Distributed Software Development and Paasivaara, Durasiewicz and Lassenius (2009), studied the usage of SCRUM in Global Software Development on three different small and medium-sized companies based in Finland and Russia. Nevertheless, the number of publications in the area of Agile Global Software Development is very limited and commonly belonging to a few authors, including Lassenius, Paasivaara, Agerfalk, Kumar, Kumar Bhatia or Nerur, among some others. The most commonly used method used by the previous authors is case studies on these different small and medium sized companies. The industry is applying and combining agile techniques at a faster pace that the academic research (Dingsoyr et al, 2012), and Therefore, some of the previously mentioned authors claim for more case studies to understand how these methods are combined.

> *"The total number of publications shows that agile development has received interest from the academic community; however, most of the research is inspired by practices emerging in industry."*
>
> *- (Dingsoyr et al, 2012)*

Therefore, for this research, a case study has been selected. Due to the specific project to study, a single embedded case will be studied. This research will focus on the first implementation project driven by Irish subsidiary of one of the 10 largest software companies in the world. In order to preserve anonymity, this document will refer to the company under study as *ImpCo* and the customer's company as *CustCo.* The project under study comprises three different locations and four different time zones, and

incorporates members of ImpCo and the CustCo. The members of the ImpCo are located in Ireland and US, CustCo's members are based in the US and India.

The distribution across different locations is not the only determining factor for the selection of a single embedded case study. The following factors are important to understand the uniqueness of the project under study:

- The product to be implemented was recently acquired by CustCo, Therefore the acquired company was not completely integrated
- To align with recent strategic changes in ImpCo the project was implemented by its Service and Support Organization, which had a wide experience with customer interactions, but limited implementation experience.
- The ImpCo's team in Ireland was composed by an 80% of graduates with 1 year of experience or less. Nonetheless, most of the members of the Irish team focused, exclusively, on the product to be implemented in the project. The ImpCo's team based on the US were mostly senior members, with over 5 years experience, but did not work on an implementation of the product before.
- The CustCo's business team was familiar with the functionality provided by the product to implement, but the CustCo's IT team did not have any experience in the product to implement.

Based on the unique characteristics described above, this study will focus on understanding the Agile Global Software Development practices followed during the project's development phase. Additionally this research will try to understand the problems encountered by using such techniques and the solutions proposed. The study will include a participatory observation during the development phase, and a set of semi-structured interviews to different members of the implementation team after the end of the development phase.

1.4. Chapter Structure

This dissertation is organized in 5 chapters, each of them containing the details of a specific activity of the research. Chapter 1 contains an introduction to the topic and the research question and sub-questions. A literature review on agile methodologies and global software development practices is stated on Chapter 2. Chapter 3 describes the research method followed and the reasons for its adoption based on the research question. The research results and analysis method are explained on Chapter 4 and Chapter 5 contains the conclusions lessons learned and future work after this research.

2. Chapter 2: Literature Review

2.1. Introduction

This chapter presents a review of the relevant literature for the topic on this research. It defines briefly agile methodologies and different points of view regarding its advantages and disadvantages while applying agile methodologies to distributed teams and complex projects, then it provides more details on the practices used in SCRUM in distributed projects and the main global software development practices that have are used in the industry.

A significant amount of literature was found regarding agile methodologies and its implementation but significantly less amount of literature was found in the combination of agile methodologies and global software development, several authors suggested that additional case studies are required to understand how the industry combines agile methodologies and global software development.

2.2. Agile Methodologies

In 2001 seventeen professionals of the software industry signed the manifesto for agile development where they proposed twelve principles for improving software development based on four principles (Beck et al., 2001)

> *"**Individuals and interactions** over processes and tools*
> ***Working software** over comprehensive documentation*
> ***Customer collaboration** over contract negotiation*
> ***Responding to change** over following a plan"*
>
> *-Beck et al., 2001*

Several advantages have been attributed to the usage of agile methodologies on software development, especially on environments were the requirements are unstable or subject to change due to factors such as time to market.

Different studies have been carried out in order to understand the combination of Agile Methods and Global Software Development. Sureshchandra and Shrinivasavadhani (2008) analysed the adoption of those techniques by small and medium-sized organizations. Kussmaul, Jack and Sponsler (2004) studied the combination of Agile

Methods with Distributed Software Development and Paasivaara, Durasiewicz and Lassenius (2009), studied the usage of SCRUM in Global Software Development on three different small and medium-sized companies based in Finland and Russia

Kumar & Kumar Bhatia (2013) relates the success of agile methodologies with the flexibility on the design, the requirements gathering and the usage of techniques such as Test Driven Development, while Duka (2013) states that the main benefit of implementing agile on Ericson was the ability to identify activities that do no produce any value (Duka, 2013).

Agile methodologies in software development are typically associated with small co-located projects. Flora & Chande (2014) defend that agile methodologies are not suitable for complex and large projects and Kumar & Kumar Bhatia (2013) state on their paper *Impact of agile methodologies on software development process* that

> *"[An Agile Method] Does not scale well to large projects, as numerous iterations are needed to complete the desired functionality"*
>
> *- Kumar & Kumar Bhatia, 2013*

Mishra & Mishra (2011), on their work *Complex software project development: agile methods adoption* argue the previous statement regarding the unsuitability of agile methodologies on complex projects, but recommend to adapt the agile methodologies by creating a stable architectural design upfront.

A series of drawbacks have also been associated with agile methodologies. Waters, states that agile methodologies have a series of drawbacks including the required involvement of customers and the risk of scope creep on the project leading to ever-lasting projects (Waters, 2007). Flora & Chande (2014) also state that agile methodologies are suitable only for experienced developers, or novices assisted by experience developers and culturally similar and co-located teams, but in some cases video-conferencing tools are used to try to overcome these problems.

In the case study presented by Mishra & Mishra (2011), the team was co-located in the same office, but due to the recent practices of code outsourcing and offshoring companies look to relocate software development due to the benefits associated with this practice, especially cost reduction and access to specialized skills or resources

(Kussmaul, Jack & Sponsler, 2004) in addition agile is being adopted in those projects to overcome requirements volatility and required time to market (Sureshchandra & Shrinivasavadhani, 2008)(Fowler, 2006).

Due to the lack of documentation on agile projects and specifically on large distributed software development project, Mishra & Mishra (2011) claim that further industry cases studies are required

2.3. Agile Development Practices

Together with XP, SCRUM is one of the most widely used agile methodologies. Defined in 1996 by Ken Schwaber (1996), SCRUM is a management lightweight framework that has been widely used on product development. Scrum is composed by a set of immutable roles, events, artefacts and rules. The SCRUM lifecycle is divided in three phases: pre-sprint planning, sprint and post-sprint meetings (Cohen, Lindvall and Costa, 2004).

The pre-sprint or *pre-game* phase includes the planning and definition of a high-level architecture and design, the sprint phase or *game* phase is the engineering phase where concurrent engineering is done through several sprints through “develop – wrap – review – adjust”, the post-sprint phase or *post-game* includes the closure activities of the project including integration, system testing and documentation activities (Schwaber, 1996).

2.3.1. Roles

Ken Schwaber and Jeff Sutherland (2013) define three main roles in SCRUM: Scrum Master, Product Owner and Development Team.

- Scrum Master. The Scrum Master is the responsible for guiding the team through the SCRUM theory, practices and rules and deals with the blockers faced by the development team. It is also in charge of the interaction outside the scrum team.
- Product Owner. The Product Owner is in charge of maximizing the value of the product and is the sole responsible for the product backlog.
- Development Team. The Development Team is a cross-functional and self-organized team in charge of delivering the items on the product backlog

In addition to the roles defined for SCRUM by Schwaber & Sutherland (2013), Mishra & Mishra (2011) propose an additional role for large complex project development:

- Architect. The Architect is responsible for ensuring and guiding the business and technical teams towards a good architectural design. The architect should be able to adapt the architectural design while maintaining the focus on the core architecture.

2.3.2. Artefacts

As an agile method the main deliverable of SCRUM is working software that is delivered incrementally and iteratively in different sprint cycles, the deliverable is SCRUM are flexible and can change at any time based on market intelligence, customer contact or skills of the developers (Schwaber, 1996). In order to finalise the required deliverables SCRUM has a Product Backlog and Sprint Backlogs as dynamic artefacts.

- Product Backlog. The Product Backlog gathers the set of requirements know at a time. The product backlog is a dynamic and living artefact that evolves over time based on business decisions, market conditions and technology. The Product Owner is the main responsible of the product backlog although the development team is the ultimate responsible for any estimate that is done in any of the items of the product backlog.

- Sprint Backlog. The Sprint Backlog is a set of Product Backlog items that are planned to be delivered during a Sprint phase, the Development Team is responsible for assigning the items to the sprint backlog based on their capacity and the priority of the requirements, the Product Owner can also have his input on the Sprint Backlog definition by prioritizing items of the Product Backlog. The Development Team is the only one that can modify the Sprint Backlog during a Sprint. (Schwaber & Sutherland, 2013).

Flora & Chande (2014) include two additional artefacts in their analysis of SCRUM.

- Burn down Chart. The Burn down Chart is updated everyday, typically by the SCRUM Master and represents the remaining work in the Sprint required to achieve the Sprint Goal.

- Release Backlog. The Release Backlog specifies the items pulled from the Product Backlog and have been identified and prioritized for a future release.

2.3.3. Events

In addition to the roles, rules and artefacts, SCRUM is composed by a set of events to improve the efficiency of the communications on SCRUM teams.

> *"Prescribed events are used in Scrum to create regularity and to minimize the need for meetings not defined in Scrum"*
>
> *-Schwaber & Sutherland, 2013*

The main event of SCRUM is the Sprint. A Sprint is an iteration phase where a releasable element is created. As Cohen, Lindvall and Costa (2004) define, Schwaber originally specified the length of a Sprint in 6 weeks, but a period between 2 and 4 weeks is more commonly used (Cohen, Lindvall and Costa, 2004). The definition of the length of a Sprint depends on the circumstances of the product to be developed and can be decided before a Sprint commences, as per Schwaber and Sutherland's definition of a Sprint once the Sprint has began the length has to remain stable in the duration of that Sprint (Schwaber & Sutherland, 2013).

Besides the Sprint, Schwaber & Sutherland (2013) define four events on SCRUM: Sprint Planning, Daily Scrums, Sprint Review and Sprint Retrospective.

- Sprint Planning. The Sprint Planning is a preparative activity for the upcoming Sprint where the activities to be performed are decided. The entire SCRUM team should participate in this meeting. The Sprint Planning meeting should answer the questions of
    - "What can be delivered in the Increment resulting from the upcoming Sprint?"
    - "How will the work needed to deliver the Increment be achieved?"
- Daily Scrums. The Daily Scrums is a 15-minute meeting whose objective is to synchronize the team activities and prepare a plan for the following 24 hours. Only Development Team members should participate on the Daily Scrum Meetings. The Daily Scrum meeting aims to answer the following questions
    - "What did I do yesterday that helped the Development Team meet the Sprint Goal?"
    - "What will I do today to help the Development Team meet the Sprint Goal?"

- "Do I see any impediment that prevents me or the Development Team from meeting the Sprint Goal?"

- Sprint Review. The Sprint Review, also referred as functional demo, is a meeting between the Scrum Team and the Stakeholders that occurs at the end of the Sprint where the functionality that has been delivered is discussed and showed to the stakeholders.

- Sprint Retrospective. The Sprint Retrospective is held after the Sprint has finished and serves as an opportunity to improve the process by analysing the previous Sprint. The objectives of the Sprint Retrospective has the objective of inspecting how did the last sprint go, identify potential areas of improvement and things that went well on the previous sprint, and create a plan for implementing improvements in future Sprints.

Cohen, Lindvall and Costa (2004) declared that the recommended size for a SCRUM team is seven people including developers, quality assurance engineers and documenters. But in the case of large or complex development a scrum team might not suffice to fulfil the requirements of the project. (Cohen, Lindvall and Costa, 2004) In order to improve the scalability of SCRUM Jeff Sutherland introduced a new event to allow multiple scrum teams collaborate together (Sutherland, 2001).

- Scrum of Scrums. The Scrum of Scrums or meta-Scrum, is a daily scrum meeting carried out by a designated ambassador from each of the Scrum Teams on the project, the objective of this meeting is to align between different Scrum Teams by answering the same questions as in the Daily Scrum meeting.

2.3.4. Challenges of Agile Methodologies for Global Software Development

In Agile Global Software Development where the teams are distributed the SCRUM events might represent a challenge since many of these meetings requires a big part of the team to attend. Flora & Chande (2014) state that some SCRUM is limited due to the high dependency on the cohesiveness of the team, that an offsite customer would make the collaboration not possible and that the scalability of teams would increase an extended coordination effort. Cohen, Lindvall and Costa (2004) by the other hand declared that even though Scrum does not provide specific support for distributed teams, it could easily escalate by having different Scrum teams working together.

Paasivaara, Durasiewicz and Lassenius (2009) summarized some of the solutions previously defined for overcoming the problems of Scrum and XP in Global Software Development, emphasising the usefulness of web conferencing tools for Daily Scrums, Scrum of Scrums and Sprint Reviews. They also described the usage of e-mail to answer the questions Scrum meeting in advance, to improve the efficiency, the participation only of development leads on Sprint Planning events due to time-difference challenges and the representation of a business or software analyst to interact with remote customers (Paasivaara, Durasiewicz & Lassenius, 2009).

2.4. Global Software Development

Global Software Development has been growing together with the improvement of the communication channels and globalization in the last years, the expansions of companies across the globe, the requirements of 24/7 availability and follow the sun approaches, and the access to large pools of qualified professionals have contributed to the expansion of Global Software Development in the recent years.

Carmel (199) described global distributed development projects as project based on teams from different locations towards reaching a common goal. Herbsleb & Mockus (2011) argument that some companies adopt Global Software Development techniques because of the promise of economic benefits like the difference of development cost and other companies are forced to adopt Global Software Development due to, for example, a lack of trained workforce or the necessity of getting closer to customers.

As well as the advantages and motivations of adoption for Global Software Development mentioned, Herbsleb & Moitra (2001) defined six dimensions of the problems of being physically distributed among different locations.

- **Strategic Issues**. The decision of how to divide the work among different teams becomes a problem, due to differences in knowledge, technologies, infrastructures, etc. Additionally an organizational resistance to GSD could appear due to management misalignment in different locations, and people might think their jobs are threatened by other locations.

- **Cultural Issues.** Different cultures involved on a project might differ drastically in things like their attitude towards hierarchies, communication stiles and trust to unknown individuals.

- **Inadequate Communications.** Informal communications among developers and members of the project might disappear between different locations, this sort of spontaneous communication helps people staying aware on what is going on the project and who has knowledge on different areas of the project. This lack of informal communications might lead to inefficient management of issues in the project.

- **Knowledge Management.** Required expertise might be not located properly even if the required expertise exists within the team in any of the locations. Lack of update documentation can cause inefficiency and duplication of work in different locations.

- **Project and Process Management Issues.** In GSD projects lack of synchronization among different sites can become critical, unstable specifications, unavailability of good tools supporting collaboration and the lack of informal communications can increase the risk of failure of distributed projects.

- **Technical Issues**. Networking, the usages of different software versions and data format incompatibilities among different locations are some examples of technical issues faced on GSD projects and can cause additional problems to a project. (Herbsleb & Moitra, 2001)

(Holmstrom et al., 2006) defined additionally tree distances that applies to Global Software Development:

- **Temporal Distance**. Temporal Distance is the dislocation in time caused by time zone difference or time shifting work patterns. Time distance reduces the opportunities for real-time collaboration.

- **Geographical Distance**. Geographical Distance increases the complexity of a GSD project by the problems for moving among different locations of a project. Instead of measuring geographical distance in Km it should be measured on ease of relocation. Transport connections and visas can be considered for measuring this distance.

- **Socio-Cultural Distance**. Socio-Cultural Distance treats the capacity of individuals to understand different values and normative practices. Socio-Cultural Distance involves language, politics, work ethics, personal motivation, national culture and organizational culture.

Paasivaara, Durasiewicz and Lassenius (2009) summarized the practices used to overcome the challenges on Global Software Development.

- Frequent Visits. Frequent visits are required to build trust and collaboration among different locations. Team members should rotate between sites to build a good relationship and maintain collaboration over time.

- Multiple Communication Models. Multiple Communication Models used in parallel should be available to maintain an efficient communication across sites, including telephone, videoconference, emails, instant messaging and wikis.

- Mirroring/ Balanced Sites. Mirroring or Balanced sites would reduce dependencies and improve communication if each role is represented in each site of the project.

- Ambassador/ Rotating Guru. Rotating Gurus are experienced engineers that are sent to other sites for prolonged periods of time. Ambassadors set future directions for the project and report the lessons learned.

- Synchronization of Working Hours. In order to minimize the Time Distance, different shifts can maximize the overlapping working hours improving the real-time communications between the different locations.

2.5. Literature Review Conclusions

This chapter has made an introduction to Agile Methodologies and its characteristics, and has described limitations and some of the proposed solutions. SCRUM method and practices were described and the challenges of Agile Global Distributed Development were specified. Additionally, the challenges and advantages of Global Software Development have been illustrated.

Paasivaara, Durasiewicz & Lassenius (2009) on his work "*Using Scrum in Distributed Agile Development: A Multiple Case*" present a multiple case study on how Agile Methodologies were applied to Global Software Development by three small companies using SCRUM. Based on their work they claim for additional future work on understanding how Agile Global Software Development is applied other companies (Paasivaara, Durasiewicz & Lassenius, 2009).

Misra & Misra (2011), after their study on the adoption of agile methodologies on Complex and Large projects, have also specified that it would be beneficial to have further case studies on agile methodologies used in complex projects.

Based on the literature reviewed for this dissertation, additional case studies are required to understand how the industry is using Agile Methodologies in Global Software Development so as to provide a more ample scope, and which of the practices described in the literature solve the different challenges of Agile and Global Software Development.

3. Chapter 3: Research Methods

3.1. Introduction

The aims of the research are to understand how projects use Agile Methodologies on Global Software Development (GSD) and, potentially, provide new insights and hypothesis for future research. The main objectives are providing more information about how agile methodologies are combined with global software development in an Agile Global Software Development project (A-GSD) in a project on large company and identifying the perceived benefits and challenges of using agile methodologies in global software development projects. This chapter highlights the research methods followed in order to answer the research question and fulfil the objectives of the research.

> *"I recommend that a general framework be adopted to provide guidance about all facets of the study"*
>
> *-Yin, 2005*

3.2. Research Method

Peffer et al. state that the research method is a working framework providing a set of principles, practices and procedures applied to a specific branch of knowledge (Peffer et al., 2008). Saunders, Lewis & Thornhill (2009) add a clarification and define the difference between research methodology and research method by defining research methodology as the theory of how research should be undertaken and research methods as the techniques and procedures used to obtain and analyse data (Saunders, Lewis & Thornhill, 2009).

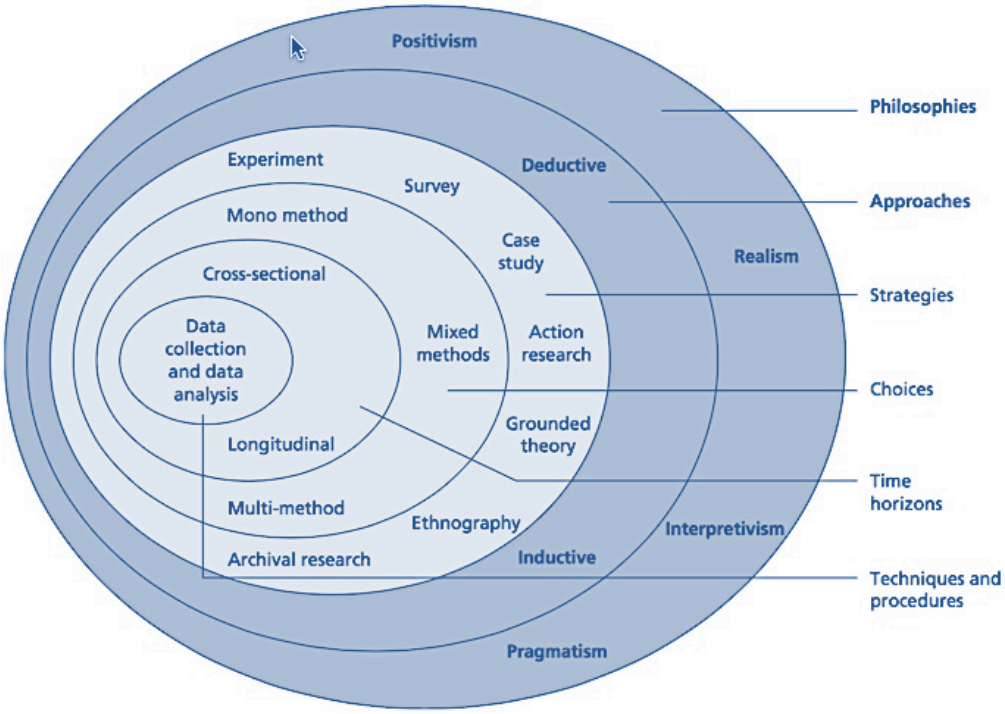

FIGURE 3.1 - Research Onion (Saunders, Lewis & Thornhill, 2008)

3.2.1. Research Philosophies

Saunders, Lewis & Thornhill (2008) the research 'onion' to define the different layers that defines a research methodology (FIGURE 3.1 - Research Onion (Saunders, Lewis & Thornhill, 2008)). Additionally a researcher should understand the epistemology, ontology and axiology of the research to be conducted in order to clearly define the view of the researcher about how the research will be conducted.

The ontology of the research represents how the researcher understands the world. The researcher could understand that reality exist independently of the social or external actors determining an objectivist ontology or could adopt a subjectivist approach by interpreting that the reality is created by the perceptions and actions of social actors.

The epistemology of a research defines what is the acceptable knowledge on a particular field of study and what is the researcher's perspective towards the valid data and resources. Positivism is the traditional perspective on natural sciences, a positivist research prefer observable and measurable facts as the source of reliable data. Realism relates to scientific enquiry and positions the research based on the belief that senses shows the reality as the truth (direct realism) or that the real world is experienced as

sensations and images of the things in the real world (critical realism). Idealism is a philosophical position, opposed to realism, stating that the content of the mind are the only one existing. Interpretivism, as opposed to positivism, argues that the world is too complex to be defined by laws as in the natural sciences and the human interactions need to be understood taking into account the roles of the different social actors (Saunders, Lewis & Thornhill, 2009).

The axiology of the research represents the values in which the research is funded and serves the grounding for judgment.

> *"Axiology is the study of value in general, embracing ethics, but also aesthetics, economics and other fields"*
>
> *- Heron 1996*

Additionally to the more rigid philosophical positions described, Morgan (2007) proposed a different approach towards defining a research philosophy, he proposed "pragmatic approach" as an alternative to the previous paradigms. The pragmatic approach specifies that the research philosophy should be determined by the research question and can be a combination of epistemologies, ontologies and axiology if it is required by the research question (Morgan, 2007).

3.2.1. Research Approaches

As Saunders, Lewis & Thornhill (2009) describe, here are two main approaches that can be followed when performing a research deduction and induction. A deductive approach tries to validate a theory by deducing hypothesis and performing a rigorous test against the hypothesis postulated, deductive approaches tend to be closer to positivist philosophies and rely more heavily in quantitative data analysis. An inductive approach tries to formulate theories based on the data gathered, more commonly conforming to interpretivist philosophies and the usage of qualitative data analysis.

Deduction emphases on scientific principles moving from theory to data and the need to explain causal relationships between variables while an inductive approach tries to understand the social actors by gaining a closer understanding of the research context, commonly and inductive approach is not able to establish causality between variables but can define relations. Deductive and inductive research can be combined combining multiple research methods (Saunders, Lewis & Thornhill, 2009).

3.2.2. Purpose of a Research

At the time of selecting a research question the researcher should understand the purpose of the research, a research can explanatory, descriptive or explanatory and descriptive. If the purpose of the research is explanatory the main objective of the research is to establish causal relationships between variables with an emphasis on studying a situation or problem. In the case of a descriptive study the objective is to understand accurately the profile and context of situations, persons or events, descriptive research requires to have a clear picture of the phenomena to study before the data collection phase. Descriptive and explanatory or exploratory studies aims to understand the precise nature of a problem by looking for new insights to a particular problem (Saunders, Lewis & Thornhill, 2009).

3.2.3. Research Strategies

Saunders, Lewis & Thornhill (2009) State that a research strategy can be understood as a guide to answer the research question and meet the research objectives, Saunders, Lewis and Thornhill identify seven main research strategies: experiments, surveys, case studies, action researches, grounded theories, ethnographies and archival researches.

> *"Your choice of research strategy will be guided by your research question(s) and objectives, the extent of existing knowledge, the amount of time and other resources you have available, as well as your own philosophical underpinnings"*
>
> *-Saunders, Lewis and Thornhill, 2009*

Experiments are a form of research that aims to study causal relations between variables. Experiments are based on two groups for the research: an experimental group that will be exposed to a controlled manipulation; and a control group that will not be affected by such manipulation. By contrasting the results between the control and experimental groups a correlation may be established based on the variable under study. In order for experimentation to work the variables under study need to be isolated from the rest of possible variable making hard to ensure the external validity of the results. Experiments tend to require laboratory research leading to a Major complexity to

reproduce the results on 'real world' social interactions and organizations. To ensure the internal validity of an experiment the members of the control and experimental groups should be randomly selected to minimize the bias caused by the researcher's selection.

Surveys are a form of qualitative research commonly associated with the deductive approach. The survey strategy relies on gathering data from a sizeable population and using statistical methods to analyse the data gathered. Surveys are a common research strategy due to the simplicity to explain and understand the mechanism of the research and the reduced cost to perform such research. Among the methods used on the survey strategy are questionnaires, structured observation and structured interviews. The biggest challenge of using the survey strategy is a poorly designed questionnaire, interview or observation structure and the limit on the number of questions that can be asked in order not to bother respondents (Saunders, Lewis & Thornhill, 2009).

Case studies are research strategies where a phenomenon is studied in depth within its real context. Commonly case studies use a combination of techniques and triangulation to contrast the results and to validate the correctness of the assumptions made by the researcher Yin identified that the six most commonly used sources of evidence for case studies are, interviews, active observation, participatory observation, documentary analysis, archival records and physical artefacts. Yin (2005) identified four case study strategies that can be followed: single case study, multiple case study, holistic case studies and embedded case studies. Single case studies are based on a concrete case usually of special relevance or a unique case in contrast with similar cases. Multiple case studies represent different cases and aims to validate the assumptions and conclusions between the different cases under study by comparing the results of each of them. Holistic cases studies represent a case study within an organization as a whole, in contrast embedded case studies research on specific logical sub-units within the organization. (Yin, 2005) (Saunders, Lewis & Thornhill, 2009)

Saunders, Lewis & Thornhill, (2009) clarify that action research is different from other types of research mainly in the fact that the researcher is directly involved in a change. Action research focuses on four main themes: Emphasizing the purpose of the research by performing an action instead of merely observing an action and change together with the ones experiencing the change; Increasing the involvement of researchers in a collaborative partnership with the practitioners; Emphasizing in the

iterative process of diagnosis, panning, acting and evaluating; Ensure the implications of the research beyond the context under study. Action research help practitioners gaining the skill to diagnose and fix organizational problems while the research is taking place.

Grounded theory research aims to build a theory based on a combination of induction and deduction it is especially useful to explain behaviours. Grounded research does not require an initial framework and theory is developed from the data gathered based on observation. Grounded theory requires researchers to develop tacit knowledge from the gathered data.

Ethnographic research tries to describe and explain the social world. In order to perform ethnographic research the researcher needs to become part of the social world being researched in order to understand the world in the same way as the subjects under study. The research process need to be flexible and responsive and requires a long time to perform.

Archival research uses administrative documents and records as the primary source of data. Archival research focuses on understanding the past and changing over time. The research might be biased by the archival information that might be incomplete, inaccurate or have missing parts of information (Saunders, Lewis & Thornhill, 2009).

3.2.4. Data Collection Techniques

The previously defined Research Strategies can rely on one or multiple data collection techniques. Two types of data collection methods can be identified based on the nature of the data collected: Quantitative and qualitative techniques. Quantitative techniques are focused on numerical data; examples of quantitative date could be questionnaires or data analysis procedures. Qualitative techniques are focused on non-numerical data; examples of qualitative data would be interviews of data analysis procedures such as data categorizations, pictures, videos and audio are also considered qualitative data.

A research could use only one or a combination of data collection techniques. If only one data collection method is used the method is defined as “mono method”. A data collection technique is considered to be using multiple methods of data collection if more than one collection method is used, in that case the method could be multi-method if the different methods used are all of the same type, either qualitative or quantitative, and it

would be considered a mixed-method data collection technique if both qualitative and quantitative methods are used. Triangulation is defined as the combination of qualitative and quantitative data collection techniques to corroborate some findings. (Saunders, Lewis & Thornhill, 2009).

3.2.5. Time horizons

An important consideration that has to be clarified is the intended time horizon of the research. A research could be longitudinal or cross sectional. A Longitudinal study requires a long-term research that would allow studying the change on a specific situation and its development. A cross-sectional study aims to understand a particular phenomenon on a determined point of time (Saunders, Lewis & Thornhill, 2009).

3.3. Selected Research Methods

The aim of this research is to understand how A-GSD is used. In order to achieve the aim of this research and solve the research question a case study will be conducted. A case study will help solving the main research question by analysing one specific A-GSD project on a large company on its own context, therefore the context of the case under study will have to be analysed and understood (Creswell, 2003)(Yin, 2005).

As specified by Yin (2005) the benefit of the case study would be maximized by using a longitudinal study and several methods to validate the data and establish solid correlation among the data analysed (Yin, 2005), but due to the time limitations of this research the study time horizon will be cross-sectional and the methods used will be observation, semi-structured interviews and secondary data analysis of documents and project resources.

In order to provide a contextual background for the case to study this research will assume the word is understood from the point of view of the social actors of the research, there for this study will consider a subjective interpretation. An interpretivist approach will be followed to solve the research question by participatory observation and using qualitative data analysis of semi-structured interviews and project documentation. (Holden & Lynch, 2004)

The objective of this study is to understand how A-GSD is being implemented, meaning that it will be an descriptive research and no hypothesis will be made

beforehand, in order to accomplish the objective of the study a exploratory approach will be used and the research question will be used to group and compare the data (Holden & Lynch, 2004) (Nigatu, 2009).

Once the data is gathered from semi-structured interviews and documents it will be classified using qualitative analysis by categorizing the information in different topics. The study aims to understand A-GSD in a particular project Therefore the information in this analysis will try to understand how the most common practices of agile and GSD are being used in the case to study.

Paasivaara, Durasiewicz and Lassenius identify the main practices for A-GSD projects. Those practices will be used in this research as the starting point for the classification of data in the qualitative analysis. TABLE 3-1 - Agile & Global Software Development practices below shows the identified topics divided in Agile Software Development and Global Software Development practices (Paasivaara, Durasiewicz and Lassenius, 2009).

TABLE 3-1 - Agile & Global Software Development practices

Agile Software Development	Global Software Development
Distributed Daily Scrums	Frequent Visits
Sprint Planning Meeting	Multiple Communication Models
Review Meeting	Mirroring/Balanced Sites
Demonstrations of Working Functionality	Ambassador/Rotating Guru
Remote Customer	Synchronization of Working Hours
Distributed Scrum-of-Scrums	

The data gathered with interview and observation will be categorized using the previous topics, new categories may be identified during the data-gathering phase.

In order to answer the research questions the data will be categorized using the matrix shown in TABLE 3-2 - Sample Coding Matrix (Agile Practices) and TABLE 3-3 - Sample Coding Matrix below. Additional information will be gathered to understand how are agile and global software development techniques combined in the project under study

TABLE 3-2 - Sample Coding Matrix (Agile Practices)

Agile Software Development Practices						
	Daily Scrum	Sprint Planning	Review Meeting	Functional Demo	Remote Customer	Scrum of Scrums
Description						
Challenges						
Advantages						
Solutions						

TABLE 3-3 - Sample Coding Matrix (GSD Practices)

Global Software Development Practices					
	Frequent visits	Communication Models	Mirroring Sites	Ambassador /Rotating Guru	Synched. Hours
Description					
Challenges					
Advantages					
Solutions					

In order to answer the research question and to ensure the validity of the study using interviews, the participants in the research will be clustered based on their role in the project, and based on the roles specified by the SCRUM method. An additional architecture role included for large projects has also been taken into account (Mishra & Mishra, 2011).

TABLE 3-4 - Interview Participant Categorization

Interview Participant Categories (roles)	Headcount	Intended to Interview
Developer Team Members	20	5
Scrum Masters / Track Leads	5	2
Business Analysts	3	1
Architects (introduced for GSD)	5	2

In order to ensure a complete understanding of the project, at least one participant of each role was interviewed. This provided a full understanding of the usage of A-GSD in all the development aspects of the project. The participants were selected among the participants of the project within the company under study. CustCo's members of the team were excluded from the selection.

The selection of the participants will be determined by a randomizer algorithm. The algorithm will run within each of the clustered categories, 30% of the members of each category were invited to perform the semi-structured interviews. A weighted distribution was made to invite participants from the different locations of the project, 70% of the members of the project are based in Ireland and 30% are based in US. Therefore, the same amount of invites has been sent as shown in TABLE 3-5 - US/IE Interview Invitations. The participants and location of the members changed along the project, the FIGUREs shown in

TABLE 3-4 - Interview Participant Categorization and TABLE 3-5 - US/IE Interview Invitations corresponds with the moment where the invites where sent. One of the developers based in Ireland spent the full length of the project on the US. He has therefore been considered as a US member of the team.

TABLE 3-5 - US/IE Interview Invitations

Interview Participant Categories (roles)	US	US Invites	IE	IE Invites
Developer Team Members	5	2	15	3
Scrum Masters / Track Leads	2	1	3	1
Business Analysts	0	0	3	1
Architects (introduced for GSD)	3	0	2	2

3.4. Research Reliability & Limitations

In order to ensure the validity of the qualitative analysis and in this case, the research itself, that the principle of authenticity will be taken into account when reflection on the five questions mentioned by Shutt (2011):

> - *"Do they illuminate the phenomenon as lived experience? In other words, do the materials bring the setting alive in terms of the people in that setting?*
> - *Are they based on thickly contextualized materials? We should expect thick descriptions that encompass the social setting studied.*
> - *Are they historically and relationally grounded? There must be a sense of the passage of time between events and the presence of relationships between social actors.*
> - *Are they processual and interactional? The researcher must have described the research process and his or her interactions within the setting.*
> - *Do they engulf what is known about the phenomenon? This includes situating the analysis in the context of prior research and also acknowledging the researcher's own orientation on first starting the investigation. "*
>
> *- Schutt, 2011*

As Boden, Nett & Wulf (2008) specify on their paper "*Researching into Global Software Development*", some of the bigger challenges to conduct a research on Global Software Development are the difficulty of finding collaborators on a research on the area, based on this fact and due to the time constraints and limitation of resources in this research an opportunistic approach will be used to select the case to study (Boden, Nett and Wulf, 2008). The case to study will be a global project in a large company using A-GSD techniques.

In the case of this research, a single embedded case study was performed due to the singularities of the project under research. Therefore, the results might not be suitable to provide a generalized understanding of the situation under study, but it will no doubt serve as starting point for future research. The complete set of particularities of the project

are specified in the context definition in chapter 4 of this document, but as a summary the project under study is case study of a big company in the suffering a structural organizational change. The project under study is the first implementation on an acquired company in collaboration between Ireland and the United States and the method applied would serve a starting point for future projects and iterations.

As explained by Yin (2005), conducting participatory observation has additional limitations that could produce a potential bias in the project:

- The researcher might have less ability to work as an external observer
- The researcher is likely to become a supporter of the group under study
- The participant role might require too much time
- The researcher might find to be difficult to be in the right place at the right moment.

This research has been performed taking into account the previously mentioned limitations. In order to mitigate the possible limitations of a participatory observation, a set of interviews was performed and compared against the observations in order to provide a way of ensuring the veracity of the research. Additional ways of data triangulation and analyses would have also been beneficial, but could not be performed due to time constraints (Yin, 2005).

Based on the proposed research methodologies, methods, and approach, this research will also have some limitations inherited from the research method itself. Only correlations between variables will be able to be identified and causality will not be able to be inferred from this study. The control over the study will be very limited, many factors can influence on the case to study or people to interview that could influence the result of the study (Fisk, 2004). The case study will not use all the recommended methods to find facts through converge of evidences (Yin, 2005).

The research should, on the other hand, be able to provide new insights and hypothesis for future works that could validate the study by extending the method used on this research (Fisk, 2004).

3.5. Conclusions

TABLE 3-6 - Method Summary summarizes the research methods selected for this study using the layered approach mentioned previously on section 3.2 Research Method.

TABLE 3-6 - Method Summary

Layer	Selected Method
Research Philosophy	Interpretivism
Research Approach	Inductive
Research Strategy	Single Embedded Case Study
Research choice	Qualitative Multi-method
Time horizon	Cross-Sectional
Data Collection Methods	Semi-Structured Interviews Participatory Observation Documentation

4. Chapter 4: Data Analysis

4.1. Introduction

This chapter will describe the gathering process and the way in which data was analysed during this research. The aim of this chapter is to transform the data gathered into relevant information in order to understand how Agile and GSD practices were applied in the project under study. Based on Yin (2005), a single embedded case study requires a deep contextualization to provide a complete understanding of the factors that can influence the case studied. In the case of this research, the factors affecting the project are divided into internal and external factors. The internal factors are the variables affecting the project that can be modified or influenced by the members of the project studied. An example of internal factor could be the meetings scheduled during each of the Sprints of the project. On the other hand, external factors refer to variables outside of the control of the members participating in the project, for example, the experience of the team assigned to the project or global organizational changes.

4.2. Data Analysis Process

In order to provide a frame of understanding of the project and the way in which AGSD was applied to it, two data gathering methods were applied: participatory observation and semi-structured interviews. The participatory observation provided the required information to understand and describe in detail the context of the project under study. The semi-structured interviews, conversely, provided a deep insight into the understanding of how AGSD practices were applied to the project under study. This research was conducted during the development phase of the project. The participatory observation was carried out from the beginning of the development phase, while the semi-structured interviews were scheduled at the end of it. FIGURE 4.1 - Research Period represents the section of the project where the research was conducted.

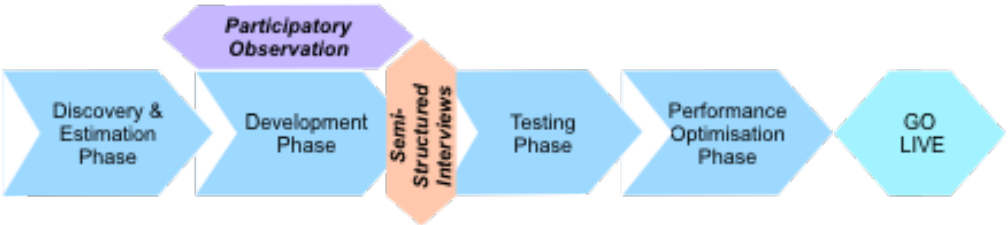

FIGURE 4.1 - Research Period

The development phase of the project was divided in five different Sprints of three weeks each. At the end of the development phase, 94% of the user stories were completed based on the final scope of the project. The scope was increased on a 6% during the project. Even though the project was completed by the time this study was performed, and based on the user stories completed, the development phase of the project can be considered as a success.

4.2.1. Participatory Observation

The project was observed during the complete 15 weeks of the development phases. The participatory observation is detailed in the Observer Participant Report (OPR) attached in Appendix 2: Observer Participant Report. The Observer Participant Report clarifies the participatory observation performed during the development phase of the project under study. It provides a detailed explanation of the Observer Participant's background and implication on the project under study, and a complete description of the context influencing this project. Additionally the OPR documents the observed risks for the project and the solutions applied to mitigate different risks influenced by the external factors that were described in this report.

4.2.2. Semi-structured Interviews

Participatory observation provided the research with the relevant information to contextualise the project. However, that observation by itself does not provide enough information on how Agile and Global Software Development practices were implemented in the project under study. Semi-structured interviews were conducted in order to obtain that information. During the last week of the development phase 10 members of the development team were invited to participate in those semi-structure interviews. Only 10 invitations were sent due the limitations in time, space, and resources for this research. The invitations were sent to members of ImpCo in Ireland and the US. Members of CustCo were not invited to participate in the research due to issues with confidentiality. During the following two weeks six semi-structured interviews were conducted, lasting between 30-45 minutes each. During the following week, due to the lack of responses, another two invitations were sent. The last two participants were selected in an opportunistic manner due to time restrictions of this research. TABLE 4-1 - Semi-Structured Interview Participants presents the invitations sent and the interviews conducted.

TABLE 4-1 - Semi-Structured Interview Participants

Interview Participant Role	US			IE		
	Total	Invited	Participants	Total	Invited	Participants
Architects	3	0	0	2	2	1
Track Leads	2	1	0	3	1	1
Business Analysts	0	0	0	3	1	1
Developers	5	2	0	15	3 + 2	3 + 2

As presented in TABLE 4-1 - Semi-Structured Interview Participants, none of ImpCo's members based on the US responded to the invitations sent. Therefore, only members of ImpCo's Irish team were interviewed, presenting a possible bias that has been impossible to avoid in the analysis. After the participants were interviewed, the interview recordings were sent to a professional linguist so as to provide a transcription.

4.2.3. Codification Process

Once the interviews were stored in a text format, each interview was classified and coded using a computer based qualitative analysis tool (NVivo). Each Interview was classified considering the characteristics and roles of the participant. TABLE 4-2 - represents the classifications used for each of the interviews analysed.

TABLE 4-2 - Participant Attributes

Attributes	Type	Values
Role	Enumeration	Architect / Track Lead / BA / Developer
Gender	Enumeration	Male / Female
Track	Text	Name of the track
Did Rotation	Boolean	YES / NO
Had Agile Training	Boolean	YES / NO
General Experience	Decimal	Number of years
Product Experience	Decimal	Number of years
Agile Experience	Decimal	Number of years

The classification of the participants provides the context for the analysis of the interviews. The responses of each participant might be affected by their personal circumstances, knowledge or experience. Therefore, the previous participant classification aims to provide a base for comparison among the different participants. Originally, a location attribute was included in participant classifications, but finally all participants were based on the same location.

Once the participants were classified, the content of each interview was coded based on the codification nodes described on TABLE 4-3 - Practices Codification Nodes. Originally the codification nodes were selected based on the ones defined by Paasivaara, Durasiewicz & Lassenius (2009). This would allow comparing the result of the current study with the one previously conducted by them. During the analysis, some of the codification nodes were modified because the practices used in the project under study differed from the ones described by Paasivaara, Durasiewicz & Lassenius.

TABLE 4-3 - Practices Codification Nodes

Agile Software Development	Global Software Development
Scrum Meeting	Frequent Visits
Sprint Planning	Communication Models
Review Meeting	Mirroring Sites
Functional Demo	Rotating Guru
Kick-off Meeting	Synchronised Hours
Wrap-up Meeting	Remote Customer
Ad-Hoc Meetings	Project Locations

During the analysis, in addition to the codification nodes representing the Agile and GSD practices, additional classification nodes were attributed to the coded sections of the interviews. Those codification nodes were added to understand the valuation done about a certain topic by the interview participant. The characteristics attributed to the nodes were classified considering if the participant was describing the practice, mentioning the challenges of the practice, specifying its advantages or providing the solutions applied to the practice that he was mentioning. TABLE 4-4 - Characteristics

Codification Nodes, specify the codification nodes defined for understanding the valuation made by the interview participant about a certain topic.

TABLE 4-4 - Characteristics Codification Nodes

Characteristics
Description
Challenges
Advantages
Solutions

After the codification of all the interviews including the practices and characteristics codification nodes, result matrixes were created with help of the NVivo tool. The results matrixes represent the number of times that each participant mentions a description, challenge, advantage or solution for an Agile or GSD practice. The results of the interviews analysis were compared with the work of Paasivaara, Durasiewicz & Lassenius (2009) and the Observer Participant's insights of the project.

4.3. Qualitative Analysis

This section describes the most important AGSD practices used in the project based on the answers obtained from the interview participants. The most relevant AGSD practices were selected based on the total number of mentions of each of the practices applied in the project. FIGURE 4.2 - AGSD Practices: Total Mentions, outline the total number of mentions of each of the practices used in the project.

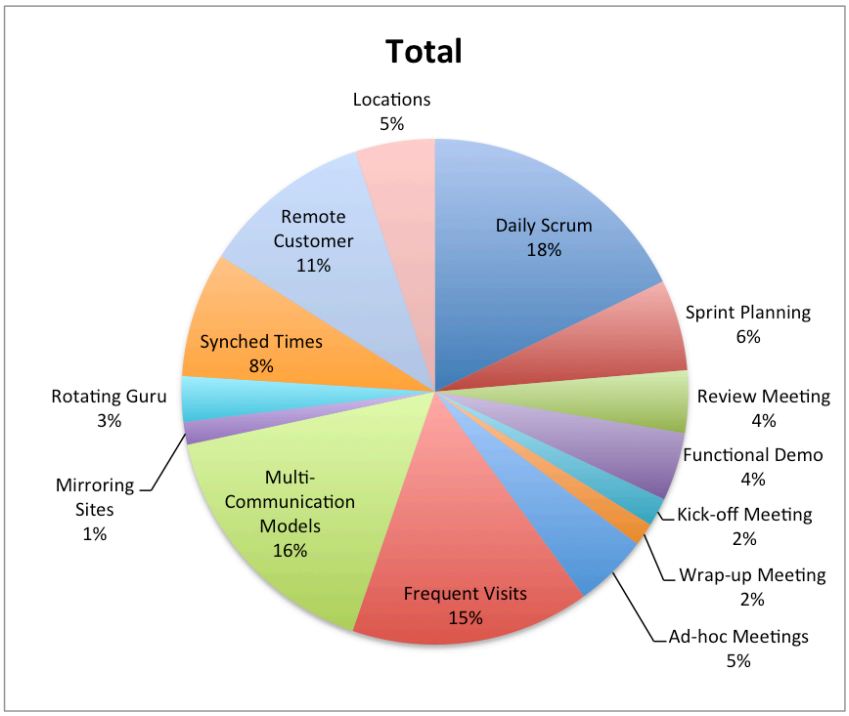

FIGURE 4.2 - AGSD Practices: Total Mentions

4.3.1. Scrum Meetings

> *"[Scrum meetings are] Basically, meeting up with people everyday and discussing what has been done and what we will do."*
>
> *-Interwiewed Developer*

Scrum meetings are short daily meetings aiming to update the members of a track about the state of the development during a Sprint. Due to the distributed nature of the Tracks, in the current project scrum meetings were carried out via phone or Lync call. The scrum meeting was synchronized among locations. Against the agile principles, in some locations, Scrum meetings were not scheduled at the beginning of the working day.

The main challenge described by the interview participants for the Scrum meetings was the difficulty of some developers of summarizing their activities, leading to longer sessions including technical descriptions. One of the development team members mentioned that in his track the scrum was not scheduled daily, leading to a lack of information on what other members of track were doing. The solutions proposed by the participants were related to providing more information about the mechanics of the Scrum meeting in order to reduce the technical discussions during the meetings.

All interview participants, except one, declared that the Scrum meeting was one of the most advantageous practices for a Global Software Development project. The Scrum meeting provides a daily synchronization event across locations and maintains all the members of the track updated about the progress. It also helps to identify the dependencies and blockers early in the project. One of the development team members interviewed declared that the scrum meeting was redundant and not necessary for his daily work. This declaration might be influenced by the size of the track he was working on, composed by three members of ImpCo and one member of CustCo.

4.3.2. Communication Models

In order to ensure the communication between the different locations of the project, different communication methods were used in the project under study. The interview participants considered email the most frequent method of communication, as well as phone, conference calls and instant messaging tools such as Lync, which were used frequently during the development phase of the project. Also a task managing board tool, Jira, was used as a communication tool via comments and uploading relevant documentation.

The challenges mentioned in the communication tools were mainly related to reaching members of the team in remote locations. Some times emails were not replied, or members in other locations were not reachable due to different time zones. The solutions proposed for the communication were on the line of providing knowledge transfer session and workshops to have a common understanding of the problems that arise. This would allow informing the relevant people about dependencies on a timely manner, and improve the communication between regions. Jira was claimed as one of the most useful communication models, as it served as a central place for communications between companies and locations.

4.3.3. Frequent Visits

> *"the visit to the customer was hugely advantageous because you get a lot of feedback and it's engaging and getting instant replies as well".*
>
> – *Interviewed BA*

During the development phase of the project, several visits were organised among the different locations of the project. ImpCo's Irish development team was relocated to the US during the first two sprints of the development phase and CustCo's implementation team was located in Ireland during the forth Sprint. The BAs visited the customer site at the beginning and at the end of the development phase. Senior architects were rotating between the customer's site and the development locations. All the interview participants identified the early rotations as one of the keys to success in the project. The relocation of the team allowed the organization of different workshops and knowledge transfer sessions that enabled the team to start the more complex phases of the development quickly enough.

> *"we tried to do the same [knowledge transfer sessions] for the Indian colleague, but there was still a lot of blank spaces in between and it's only one day that he came over to Ireland."*
>
> *–Interviewed Track Lead*

The main disadvantage associated to the rotations was the high cost of traveling and the impact on work-life balance of the members of the team. One of the proposed solutions proposed by the architect to reduce traveling was to record knowledge transfer sessions that would help enablement across different locations.

4.3.4. Remote Customer

> *"due to the change of requirements, I think it is good that the customer is involved with us"*
>
> – *Interviewed Developer*

In the project under study the customer is located in the US and India while the ImpCo's team is distributed between the US and Ireland. On a daily bases the members

of both companies meet on the Scrum meeting. While developers mentioned that they did not have any other relation with the customer, the observed practices suggest the opposite. It has been observed that ImpCo's development team members had meeting in certain occasions with CustCo's IT, architects and business members. Those meetings were not very frequent and its main purpose was to align on dependent tasks. Besides those meetings all the communications between the customer and the development team members were carried out by the BAs. Several challenges were mentioned regarding the remote customers during the interview sessions. Firstly, the different environments between ImpCo and CustCo caused issues in different tools, such as instant messaging systems, due to the different corporate networks. Secondly, CustCo's IT members were not familiar with the product to be implemented, and due to the distance between ImpCo's and CustCo's implementation team, it took a long time for them to ramp-up. The solutions applied for the project included: the elaboration of a semi-automatic process for transporting the deliverables though the different corporate networks, and a series of knowledge transfer sessions to enable CustCo's implementation team.

4.3.5. Synchronised Working Times

> *"it [Synchronised hours] is more than useful, it is necessary."*
>
> – *Interviewed Developer*

ImpCo's Irish implementation team worked on a late shift during the third sprint in order to synchronise with the US team members. After the third Sprint, only some of the members worked in US shift based on the levels of collaboration required with the US members of the team. All the interview participants changed their normal schedule at some point to synchronise with another location. The main challenges associated with the time synchronization are the over cost for the project and the impact that it has on the work-life balance, especially if the shift is changed for long periods of time. The interviewed team members mentioned that the possibility to reach remote members of the team is one of the biggest advantages of synchronised working times.

4.4. Quantitative Analysis

With the codification of the interviews and the help of NVivo a set of quantitative data was created. The quantitative data obtained represented the number of times that each AGSD practice was mentioned by the interview participants. FIGURE 4.2 - AGSD Practices: Total Mentions above represents the total number of times that each practice was mentioned by all the interview participants. That information is useful to understand the most commonly cited practices, but it is insufficient to answer the research question proposed in this study.

In order to understand the most relevant AGSD practices used in the project, a higher level of classification was required. Additionally, it is important to understand the valuation given by each participant on the AGSD practices used in the project. Therefore the characteristic classifications were used to understand the value given to each of the AGSD practices. The figures presented in the Appendix 3: Quantitative Analysis Charts in Section 8.1 AGSD Practices by Characteristic represent the distribution of references of each of the AGSD applied in the project. The figures are based on the number of times each practice was described, or a challenge, solution or advantage was mentioned regarding it.

4.4.1. AGSD Practices Described

The first figure, FIGURE 8.1 - AGSD Practices: Description, suggests that some of the practices were widely used in the project, since a large number of descriptions were provided. The most described practices were “Scrum Meetings”, “Frequent Visits”, “Remote Customers” and “Multiple Communication Methods”. The most unknown practices were “Wrap-up” and “Kick-off” meetings. In this case the results align with the literature. Scrum meetings are considered in the literature the most important practice of AGSD projects. Additionally, “Wrap-up” and “Kick-off” meetings are not mentioned in the literature as AGSD practices.

The Kick-off meeting can be understood as a high level Sprint Planning meeting. It is scheduled before every sprint to decide which elements of the backlog will be assigned to each track for the following Sprint. In the Sprint Wrap-up meeting, each Track Lead present the results of previous sprint to the project Stakeholders. The Sprint Wrap-

up is scheduled at the end of each Sprint. Only Track Leads, Architects and Members of the PMO take part in these meetings.

The fact that only Track Leads and Architects assist to those meetings is an important factor to take into account. The fact that only one Architect and one Track Lead participated in the interview could have influenced the results in respect to these practices.

4.4.2. Challenges of AGSD

The second figure presented in the Appendix 3: Quantitative Analysis Charts, FIGURE 8.3 - AGSD Practices: Solutions, represents the number challenges cited for each of the AGSD practices mentioned in the project. Based on the results, the most challenging practices would be use of different communication models, and the Scrum meetings. The number of developers interviewed might bias these results. Based on the results the most widely know practice is the Scrum meeting. Therefore it is possible that the higher number of challenges mentioned about the Scrum meeting, higher because more people know about it. In fact, despite the high number of challenges mentioned, the qualitative analysis reflects that most of the challenges cited represent, exclusively, the long duration of the meetings. In regards of the multiple communication models, the majority of problems represent the problems in communication between different locations, rather than the usage of multiple communication models.

4.4.3. Solutions Proposed

FIGURE 8.4 - AGSD Practices: Advantages represent the solutions that were proposed for the challenges encountered in the practices used in the project. In this case, the quantitative analysis provides less information that in other cases. In most of the cases there are a greater number of solutions mentioned for a practice that has presented more challenges. Nevertheless, there are two significant singularities while comparing the challenges and solutions proposed. The number of solutions proposed for Frequent Visits and Ad-Hoc meeting are higher than the times the challenges were mentioned. This can be better understood with the qualitative data analysis. Sometimes, the solutions mentioned in the interview, present a solution for Global Software Development instead of the solution to a specific challenge. In the case of Frequent Visits, some participants

mention that the frequent visits are the solutions to mitigate communication problems in later stages of the project.

Ad-hoc meetings were used in the project to synchronize in dependent topics between different tracks. In the case of Ad-hoc meetings, one of the development members thought that the ad-hoc meetings were one of the more important practices of AGSD. This assertion collides with the observations on the project. While ad-hoc meetings were important during the development phase, they were not very frequent, and did not seem to provide Major advantages in the communication process compared with other practices. It is important to mention that the only participant emphasizing in the important of the Ad-hoc meetings was the only one that did not visit the US location at the begging of the project.

4.4.4. Advantages of AGSD practices

Based on the data reflected in FIGURE 8.4 - AGSD Practices: Advantages, the practices bringing the highest number of advantages are Frequent Visits, Scrum Meetings, Multiple Communication Models and Synchronized Working Hours. These results are in line with the literature and the observation.

4.5. Findings

The previous sections analysed the data gathered with interviews emphasizing the most relevant topics for the current research. While comparing the practices applied in the project and the ones described in the literature, this research has discovered that two additional practices are in use in the industry: Sprint Kick-off and Sprint Wrap-up. The literature mentions high-level meetings scheduled periodically during the Sprint, the Scrum-of-Scrums. The Scrum-of-Scrums is scheduled between members of each scrum team in a large project. The Scrum-of-Scrums aims to map the concept of Scrum meeting to a higher level, in order to align between different scrum teams. In the project under study, the most similar practice was the Ad-hoc meetings organised between tracks. Sprint Kick-off and Sprint Wrap-up meeting are also high-level meetings aiming to align between tracks. However, instead of mapping the Scrum meeting their objective is to map the Sprint Planning and the Sprint Review meetings. These meetings are scheduled before and after the Sprint instead of in the Sprint time.

In addition to the usage of new high-level practices, this research has demonstrated that Agile Global Software Development is not used exclusively for product development. The current study presents a fully contextualized case study of an implementation project working in a global environment and using AGSD practices. The literature often recommends the implementation of agile methods only if the development team count with wide experience. In the case of this project, agile practices were successfully used with a team composed by 80% graduate and junior developers.

4.6. Discussion

The codification of the interviews helped creating a set of quantitative data that could be compared and analysed. The data obtained represented the number of times that each participant cited Agile or GSD practices and the valuation that the participant gave to that citation. The codification process is open to interpretation Therefore this analysis is limited by the codification perfumed on the data. Another researcher could arrive to different result with the same dataset. In order to limit the possible bias due to subjective interpretation, the OPR includes a full profile of the Observer Participant.

It is important to note that the figures analysed in Section 0

Quantitative Analysis include the responses of all of the participants. The data analysed is influenced by the difference in the number of interview participants. Five developers were interviewed, while only one Architect, one BA and one Track Lead participated in the research. The information presented in the quantitative data analysis was broken down in order to reduce the possible bias. The charts representing the answers divided by roles are attached in Appendix 3: Quantitative Analysis Charts.

The practices mentioned above were the most widely mentioned during the interviews. It can represent that some of the practices were unknown for certain members of the team, or that some members of the team mentioned one topic several times during his interview. In order to be able to draw conclusions about the relevance of AGSD practices of the project, it is important to understand the figures presented in Appendix 3: Quantitative Analysis Charts.

Additional discussion can be done regarding the semi-structured interview questions. The first interview did not provide very detailed insights on the AGSD practices applied to the project, since the participant did not share the same vocabulary. None of the interviewed participants were familiar with the term Global Software Development. Therefore and introduction to the topic was required to obtain relevant information during the interviews. This practice could be discussed as leading questions, since some of the GSD practices were mentioned during the introduction to the topic. However, that led to an enrichment of the data acquired.

5. Chapter 5: Conclusions and Future Work

5.1. Introduction

This document has presented a review of the existing literature relative to Agile Methodologies, Global Software Development and the combination of both. It has summarized the state of the art in Research Methods and defined a single embedded case study as research method using participatory observation and semi-structured interviews as data gathering techniques. The participatory observation helped in the case study contextualization and the researcher profile in the OPR, while the semi-structured interviews provided a set of qualitative data. After the data codification, it that served as a basis for the qualitative and quantitative analysis performed in Chapter 4. Finally, this chapter will summarize the findings and verify that the research questions proposed in Chapter 1 was answered.

5.2. Research Question

The aim of this research, as mentioned in Chapter 1, is to understand how the implementation project under study combines Agile and Global Software Development practices.

> *"If agile is meant to be a river flowing, it could be building dams every day, if you're distributed"*
>
> *– Interviewed BA*

The analogy presented by one of the interview participants represents the problems that distributed development can bring to a project using agile methodologies. This research has analysed how different Agile and Global software development techniques were used in the project under study and has described the challenges and advantages of those practices by triangulating the information gathered via semi-structured interview, the findings in the literature and the participant observation.

The OPR provides a contextualised description of the project under study, while semi-structured interviews provided a deep insight into the understanding of AGSD practices applied in the project. The perspective of developers, Business Analysts, Track Leads, Architects and the Observer Participant were taken into account. The qualitative analysis performed on the data gathered with semi-structured interviews provided a

detailed description of the advantages and challenges encountered in the most important AGSD practices. Additionally the quantitative analysis helped identify the practices that were observed to have more challenges and the ones that brought more advantages to the project. Together with the analysis of the advantages and challenges of the AGSD practices used in the studied project, the solutions applied were clarified. Additionally some of the interviewed participants proposed solutions that had not yet been applied to the project under study.

These observations answer all the formulated research questions for the project under study.

- *How are Agile Methods used in a Global Software Development implementation project delivered by a large company?*
    - *What are the advantages and challenges of Agile Methods and GSD practices in a project?*
    - *How are the challenges addressed in an A-GSD project?*

5.3. Findings

This study provides a contextualised embedded case study of an implementation project in a very large software company. The majority of case studies appearing in the literature researching about AGSD are cases studying projects in Small or Medium Companies. Commonly the studied team is involved in product development activities.

This case provides new insights on how Agile Global Software Development has been applied in an implementation project in the service and support organization of one of the 10 largest software companies in the world. As a result, two new practices have been identified applied to AGSD: Sprint Kick-off meetings and Sprint Wrap-up meetings.

In addition to the newly identified AGSD practices, the project studied was influenced by a series of external factors including a recent company acquisition, a strategic change in the organisation's responsibilities and an implementation team composed by an 80% of graduate and junior developers without Subject Matter Experts in the team. This last fact contradicts one of the recommended practices for agile methodologies: encouraging experienced teams.

Even though by the time of writing this dissertation the project was not completed, the development phase of the project can be considered to be a success if we take into account the percentage of user stories completed: 94% of the user stories were completed based on the final scope of the project.

5.4. Limitations of Research

The performed research was primarily limited by the research method selected to conduct this research. Since the research philosophy was interpretivist, the research result might be hard to replicate by another researcher. In addition, the codification of interview materials might have a subjective connotation. In order to limit the bias caused by the possible subjectivity of the research process the OPR includes a section that details the observer participant/researcher profile.

Another important limitation in the research conducted is the limited amount of interviews conducted. A greater number of interviews, especially in Track Lead, BA and Architect roles would have provided a deeper insight in what each of the roles of the project consider important. As presented in FIGURE 8.7 - Agile Practices: Track Lead located in the Appendix 3: Quantitative Analysis Charts, the interviewed Track Lead provided a very detail description of agile practices used in the project, but did not provide any valuation in the practices that were used.

In addition to the lack of participants of different roles, the lack of participants of different locations has had an important impact on the results of the study. The current study can only take into account the results provided by one of the locations. Therefore only geographical and temporal distances can be attributed to the results. Even though the interviewed participants came from six different nationalities, all of them were based on the same working environment. Therefore Cultural difference cannot be applied to this study.

5.5. Future Research

As a continuation of this study it would be very interesting to repeat this research on the same team in another implementation project in a period of three years and compare the results to understand the changes implemented in that time and the reason behind this changes.

More studies in the combinations of Agile and Global Software Development would be required comparing product development projects and implementation projects. This could provide new insights on how to adapt AGSD practices to each project based on its nature.

Two new practices have been introduced to AGSD in this study, as a future research it would be interesting to understand more deeply how this practices that affect different projects would find a benefit on their implementation.

Finally, more research in the success factors of young teams using agile methodologies is required, since this might challenge some theories and assumptions regarding agile methodologies.

5.6. Summary

This document has presented a review of the existing literature relative to Agile Methodologies, Global Software Development and the combination of both. It has summarized the state of the art in Research Methods and defined a single embedded case study as research method using participatory observation and semi-structured interviews as data gathering techniques. The participatory observation helped in the case study contextualization and the researcher profile in the OPR, while the semi-structured interviews provided a set of qualitative data. After the data codification, it that served as a basis for the qualitative and quantitative analysis performed in Chapter 4. Finally, this chapter will summarize the findings and verify that the research questions proposed in Chapter 1 have been answered.

6. Appendix 1: Interview Questions

6.1. Overview

The primary focus of the interview questions are to identify the practices used in the project under study regarding agile and global software development and develop an understanding on how such practices can be combined and used on a software development project and the challenges and advantages that might arise of the usage of the practices involved on these techniques. This will involve semi-structured interview and the data collected from the interview will undergo qualitative analysis. This will pull the common threads of interviews together to formulate key research findings, recommendations and lessons learned.

6.2. Agile Software Development

This section will explore the usage of agile software development on the project under study and will build an understanding on the challenges of the techniques identified on the literature.

1) How would you describe your current understanding of agile software development?
2) Based on your knowledge, could you describe the agile techniques used or not used on the current project?
3) Can you describe your participation in the agile activities mentioned to be used on the current project?
4) Based on your knowledge, which of the mentioned techniques can bring an advantage to the current project?
5) Based on your experience in the project, have you encounter any challenge with the agile practices used in the project?
    a) If so can you describe those challenges?
    b) Based on your knowledge have any measures been established to overcome those challenges in the current project?
6) Can you describe your interactions with the customer in the current project?
7) Are you familiar with the term SCRUM-OF-SCRUMS?
    a) If so could you describe it based on your knowledge?
    b) Have you participated in any SCRUM-OF-SCRUMS meeting during your involvement of the current project? If so can you describe your participation?

6.3. Global Software Development

This section will explore the usage of global software development practices and their usage in the project under study. This section additionally will gather an understanding on how these techniques are affected by agile software development.

1) How would you describe your current understanding of global software development (also known as distributed software development)?
2) Based on your knowledge, could you describe the global software development techniques used or not used on the current project?
3) Based on your knowledge, could you describe how the development is organized among the different locations within the current project?
4) Based on your knowledge, could you describe which measures have been taken implemented in the current project to enable remote work?
5) Based on your knowledge in the current project, have you identified any challenge with the global software development techniques used in this project?
   a) If so can you describe them?
   b) Based on you knowledge, have any measures been established to overcome those challenges?
6) Based on your experience, which of the mentioned techniques can bring an advantage to the current project?
7) Could you describe your interaction with remote locations working in the current project?
8) Have you been on a remote location during the development of the current project?
   a) If so could how long and how many times have you been on a remote location?

6.4. Agile and Global Software Development

Additionally to the previous sections, this section will gather additional information on how the combinations of the previous techniques present challenges or advantages when they are combined.

1) Base on your knowledge, could you describe how are agile software development and global software development practices are combined in the current project?
2) Based on you knowledge with are the challenges of combining agile software development and global software development practices?
3) Based on you knowledge with are the advantages of combining agile software development and global software development practice

7. Appendix 2: Observer Participant Report

The Observer Participant Report has been attached after the Bibliography section at the end of this document. It was moved to avoid confusions with the page numbering and due the independent nature of the OPR.

8. Appendix 3: Quantitative Analysis Charts

8.1. AGSD Practices by Characteristic

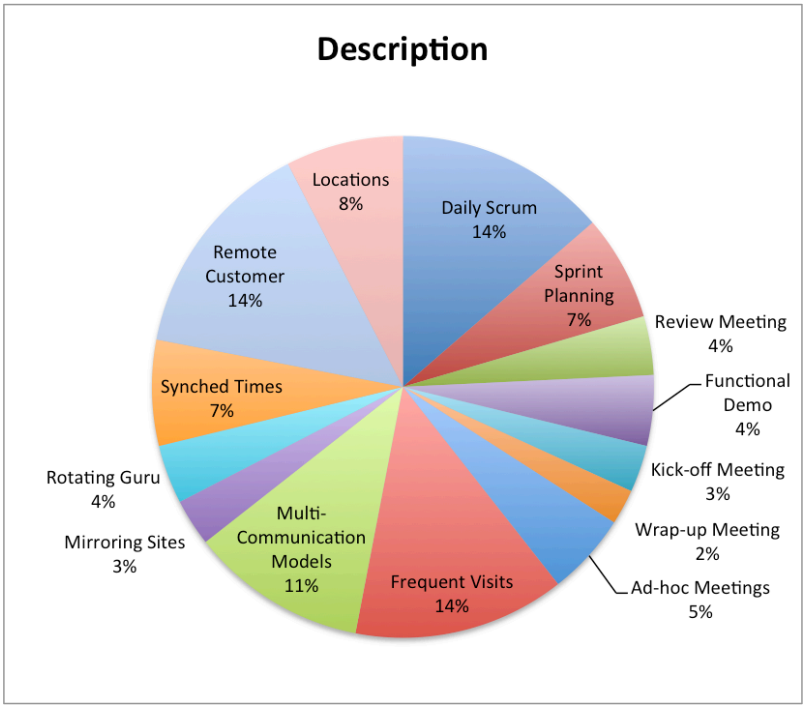

FIGURE 8.1 - AGSD Practices: Description

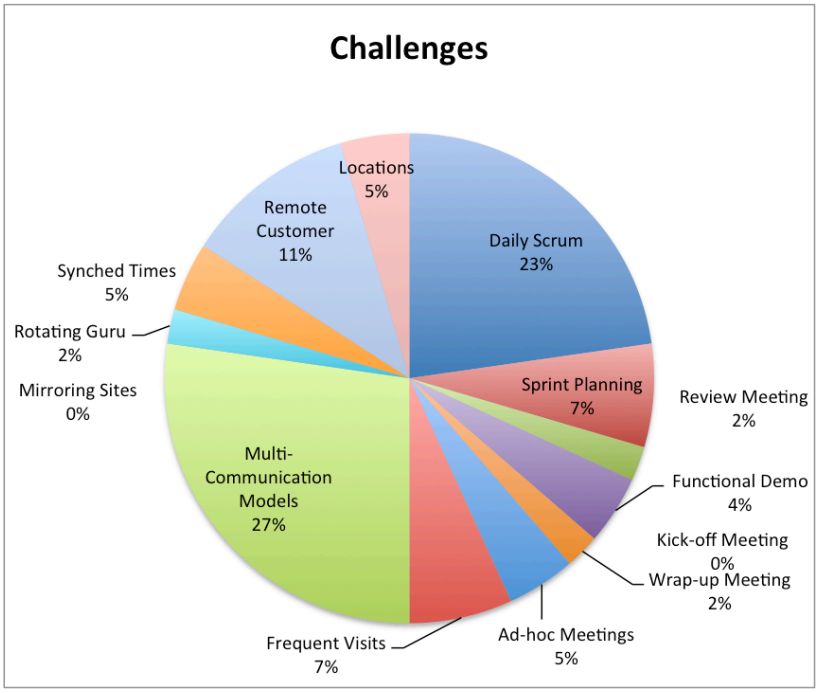

FIGURE 8.2 - AGSD Practices: Challenges

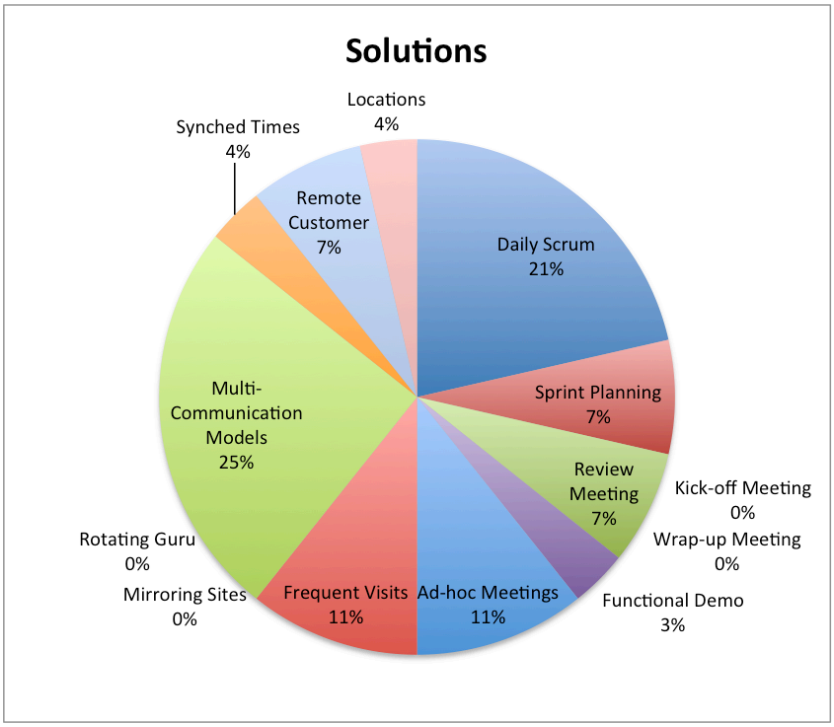

FIGURE 8.3 - AGSD Practices: Solutions

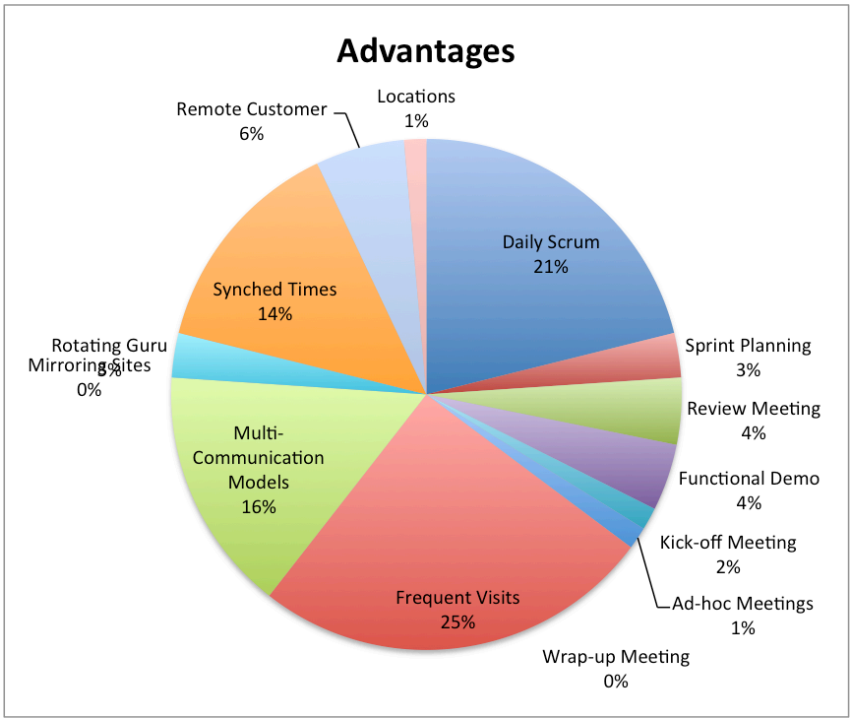

FIGURE 8.4 - AGSD Practices: Advantages

8.2. AGSD Practices by Role: Architect

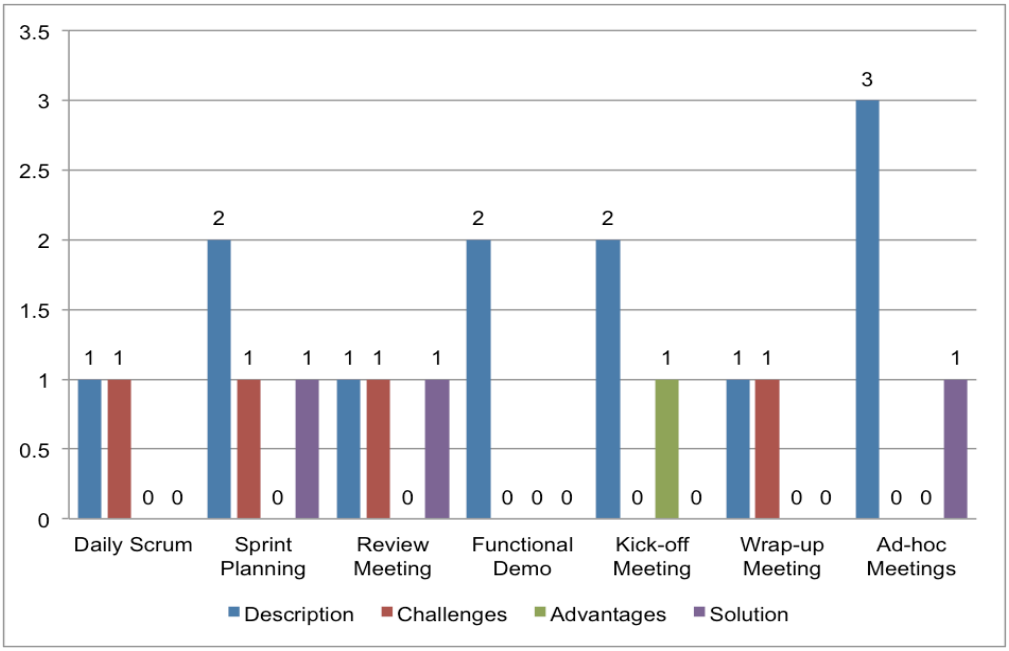

FIGURE 8.5 - Agile Practices: Architect

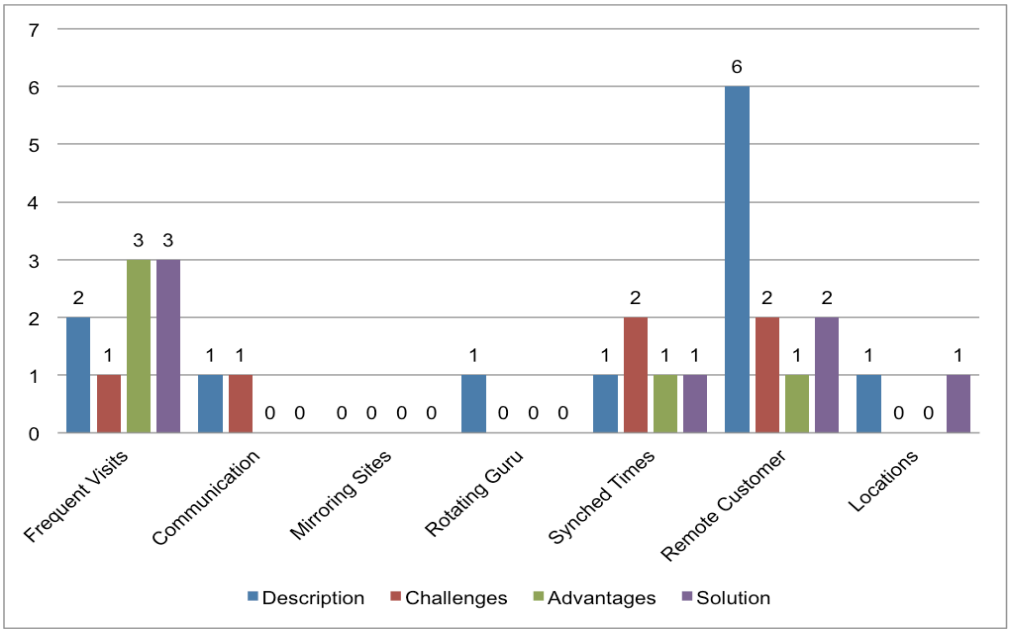

FIGURE 8.6 - GSD Practices: Architect

8.3. AGSD Practices by Role: Track Lead

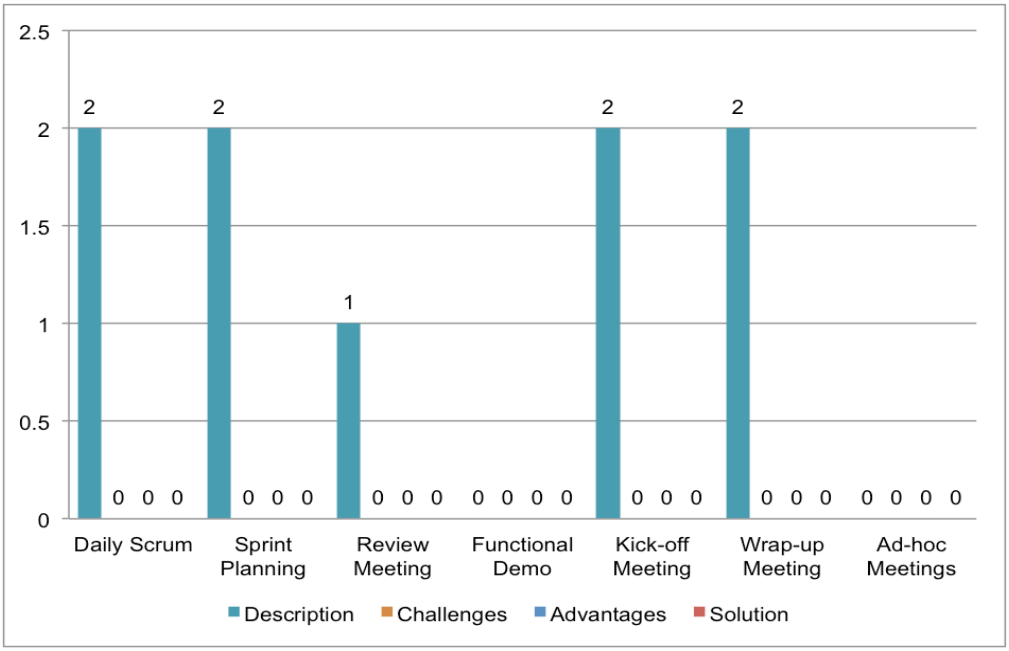

FIGURE 8.7 - Agile Practices: Track Lead

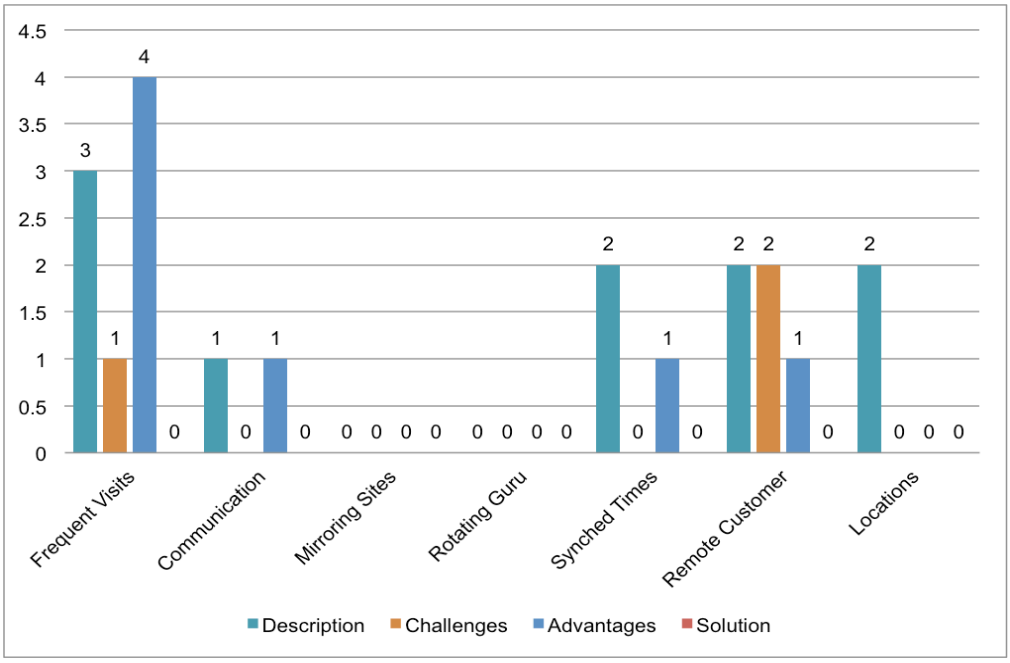

FIGURE 8.8 - GSD Practices: Track Lead

8.4. AGSD Practices by Role: Business Analyst

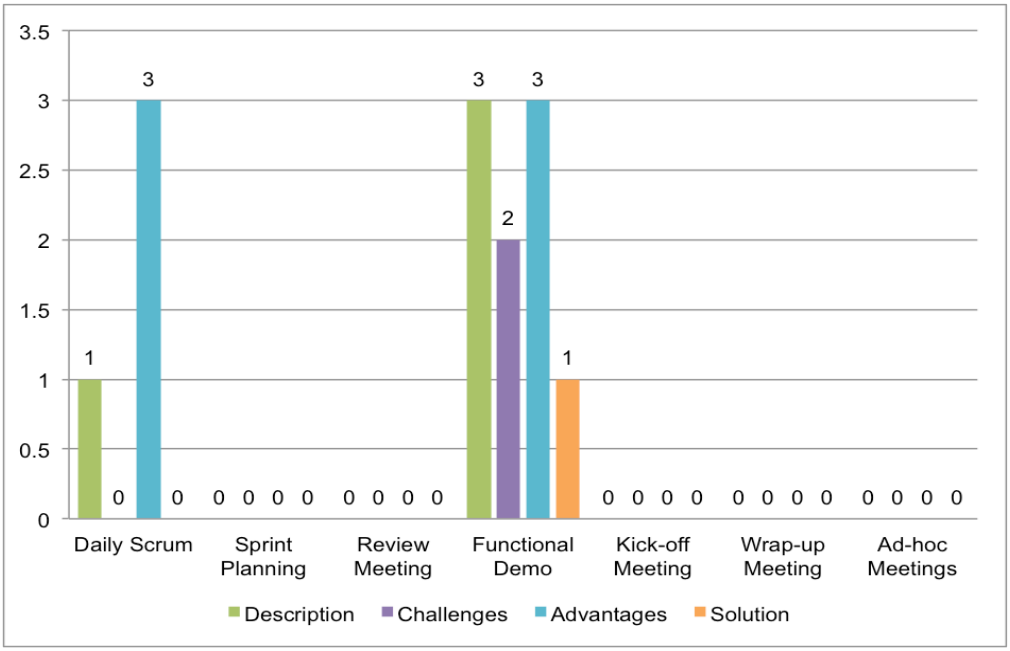

FIGURE 8.9 - Agile Practices: BA

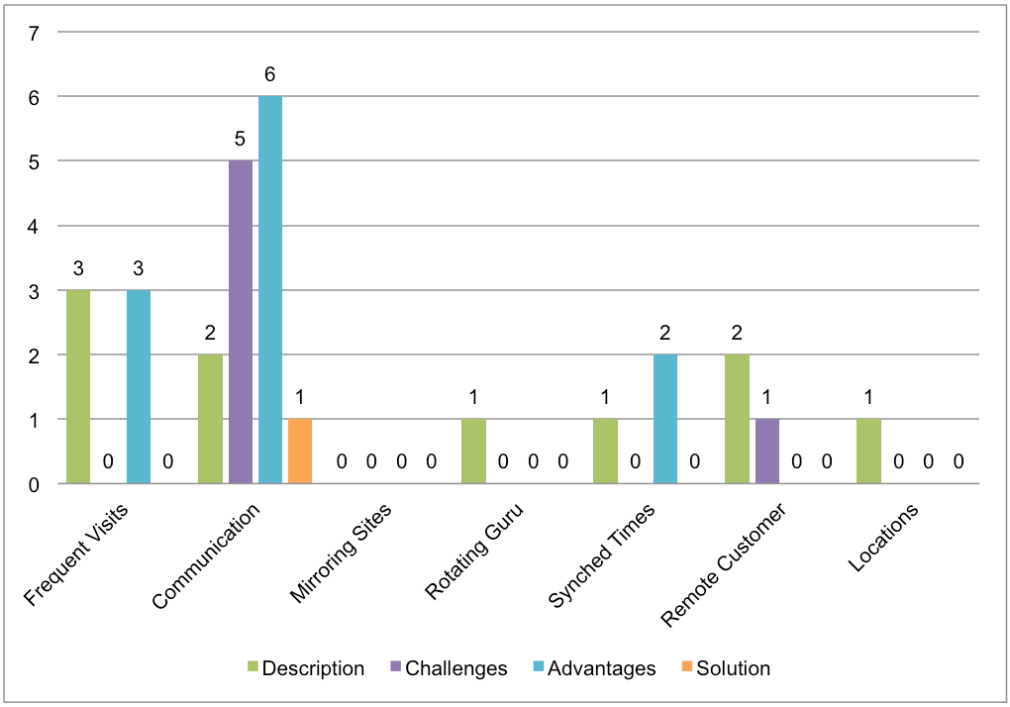

FIGURE 8.10 - GSD Practices: BA

8.5. AGSD Practices by Role: Developer

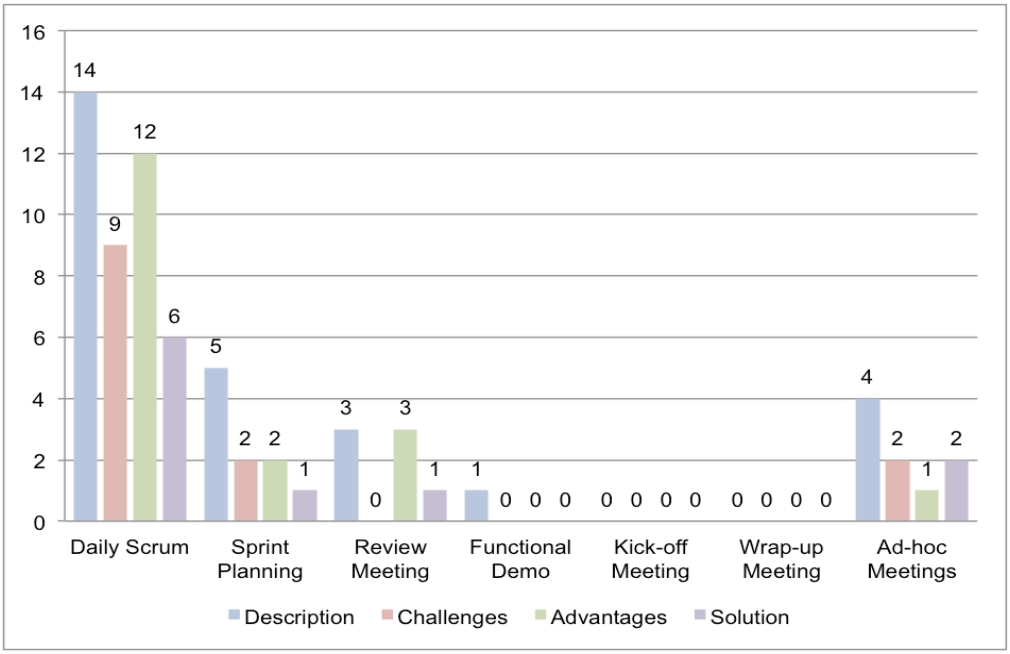

FIGURE 8.11 - Agile Practices: Developer

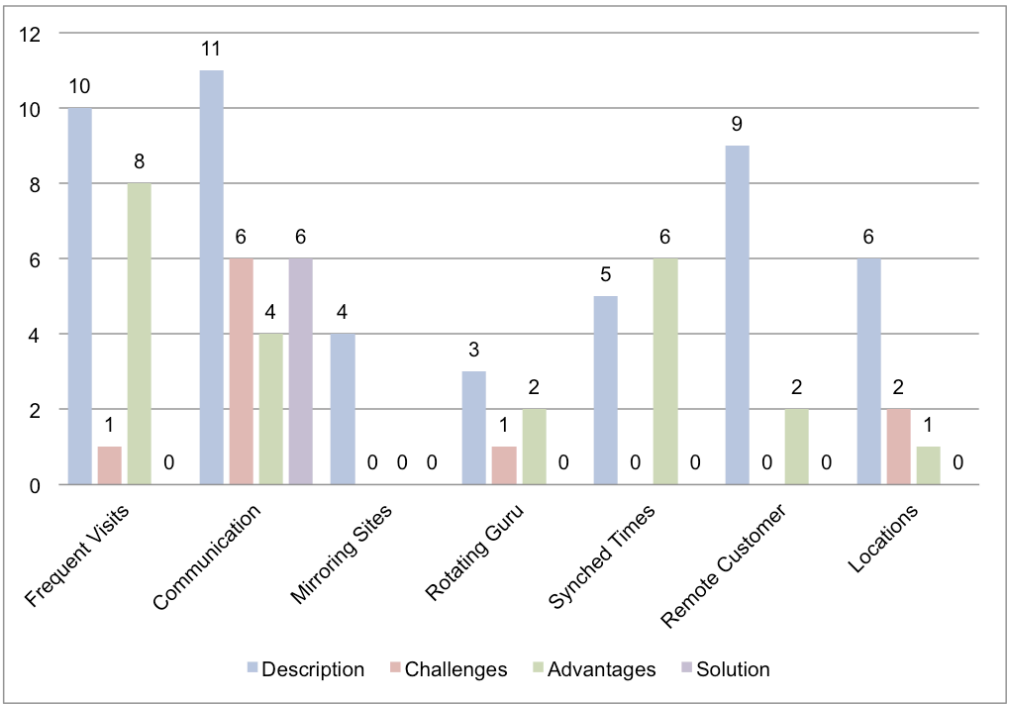

FIGURE 8.12 - GSD Practices Developer

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Understanding Agile Global Software Development (A-GSD)

OBSERVER PARTICIPANT REPORT

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Trinity College, University of Dublin

28st August 2015

Executive Summary

This report clarifies the participatory observation performed during the development phase of the project under study. It provides a detailed explanation of the Observer Participant's background and an implication on the project under study. Moreover, it will provide a complete description of the context influencing the project under study. Additionally, this report documents the observed risks for the project. It also provides the solutions applied to mitigate these risks, which were influenced by the external factors described in this report.

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Abbreviations

AGSD: Agile Global Software Development

BA: Business Analyst

CustCo: Customer of the project under study

ImpCo: Implementation Company of the project under study

IS: ImpCo's Service & Support organization

OP: Observer Participant

PMO: Project Management Office

ProdCo: Company owning the product to implement, acquired by ImpCo

QA: Quality Assurance

QM: Quality Management

US: United States of America

1. Introduction

This document describes a detailed report of my observations as a participant during the project under study. An “Observer Participant” (OP) will be referred, as a figurative individual, in order to distinguish the observational data obtained in the project from the data gathered by other means, such as semi-structured interviews. Based on the OP’s point of view, this document will aim to describe the project and the organizational context of the study.

This document is divided in four sections aiming to provide different insights of the project under study. The current section provides an introduction to the document. Section 2 describes the Observer Participant profile and his implication in the project. Section 3 aims to provide a detailed description of the context of the project, taking into account the different factors that could affect the project. Section 4 summarises the Observer Participant’s view and the context of the project.

2. Observer Participant Profile

This section describes the professional profile of the OP and the implication in the project under study. This will provide a full insight on the observer point of view. This aims to reduce the bias produced by the subjective aspects of the qualitative analysis performed by providing a detail explanation of the observer’s perspective and motivations.

As a participatory-observation research, the OP has taken part in the project under study during the development phase. The OP was assigned the role of developer and took part on the project as a SCRUM development team member in one of the tracks with the greatest amount of development required in the project. Additionally the OP was one of the members of the Quality Management (QM) group, in charge of ensuring the quality of the deliverables of the project and helping on the design of a testing infrastructure and process for the project. The combination of those roles granted a high visibility of the project’s practices. As a developer, the OP was able to observe and understand how Agile and Global Software Development practices were followed on a daily basis. Being part of the QM group granted the possibility to observe the problems on the established processes and understand how solutions to those problems were applied.

The OP was able to perform the required tasks as part of the development and QM due to his previous experience with the product to implement. At the moment of the

research, the OP counted with one and a half years experience in development working in the product to be implemented. Additionally the OP had two training sessions on this product, and was a certified developer at the time he joined the project. In terms of agile development, the OP did not have any official training, but had acted as Scrum Master, Product Owner and Development team member in three different Global Software Development implementation projects in Ireland and China.

The OP joined the project under study on the first Sprint of development, and moved to one of ImpCo's headquarters in the US, together with the rest of ImpCo's development members in the project. This granted an additional perspective on the other location where ImpCo's members were located for the implementation of the project under study. The OP was located in the US during the first two Sprints of the project. After the second Sprint, the OP came back to Ireland to continue with the development phase for three more Sprints. During that time, the OP worked in a late shift to synchronise with US colleagues during the third development Sprint, and on a need basis during the following Sprints.

3. Project Observations

The objective of this section is to provide a detailed description of the project context as observed during the development phase. The description provided in this chapter aims to describe the project context without valuations made by the OP. These observations are limited to the OP's profile described on Section 2 and the visibility obtained by the roles the OP carried out during the research period.

3.1. Project Description

3.1.1. Introduction

The project studied is an e-commerce implementation project carried out by one of the 10 largest software companies in the world. This report will refer to the implementation company as ImpCo. ImpCo's workforce for the project was distributed in two regions, the US and Ireland. The Irish team had the responsibility of delivering the project due to a wider experience on the product to be implemented. The US team supported the project with senior ImpCo members based on the US.

The customer of the project is one of the largest companies in the agricultural industry in the US. In order to preserve its anonymity, this document will refer to it as CustCo. CustCo's workforce for the project under study is based in the US and India.

3.1.2. Global Distribution

CustCo's business members were based entirely in the US, while CustCo's IT members were based in India. As ImpCo's participant observer, the OP could not observe CustCo's organizational model for the project. FIGURE 3.1 - Project Locations, represents all the locations where the project took place. During the development phase, one member of the US team moved to the west coast of the US. In FIGURE 3.1 - Project Locations This is represented with a dotted line, since that location was not relevant at the beginning of the project.

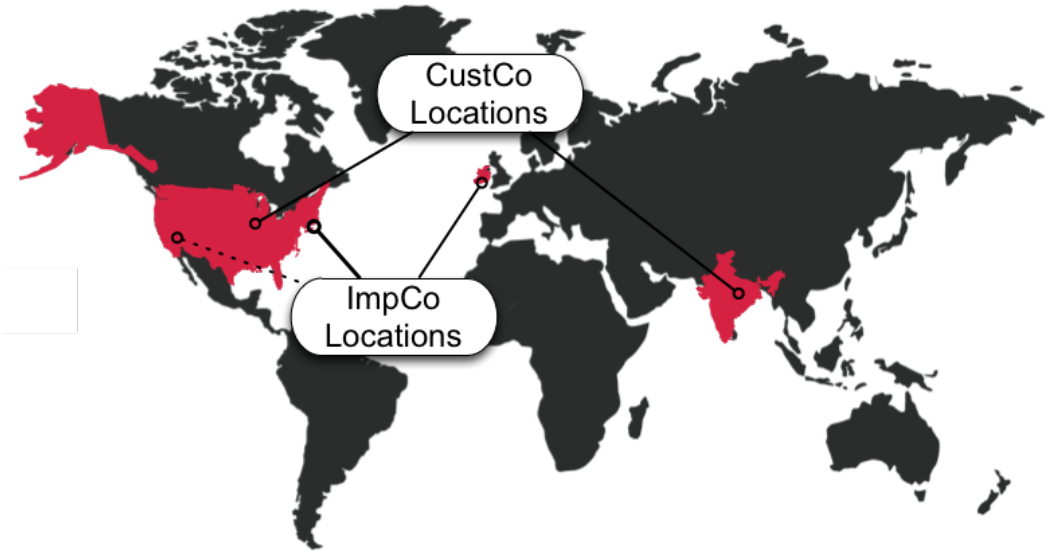

FIGURE 3.1 - Project Locations

The project under study is a co-development project between ImpCo and CustCo. Therefore, members of both companies worked in the project together. ImpCo had a wider experience on the implementation of the product and the application of Agile Methods in a Global Software Development environment. 64% of ImpCo's team for the project was based in Ireland, whereas the other 36% was based in the US. 37% of CustCo's team was based in India and the restating 63% in was based in US. ImpCo's members constituted a 69% of the project, while the remaining 31% was from CustCo's team. CustCo, in order to ramp-up for future projects and maintenance, supported the

project with business and technical professionals and supervised the development by taking part on the Architects group, PMO and steering committee.

3.1.3. Project Structure

As is shown in FIGURE 3.2 - Project Organisational Structure, the project was composed by a Steering Committee, made up by executive level professionals who were in charge of supervising the initial phases of the project and the processes implemented; a Project Management Office in charge of driving the project by taking into account the defined scope and budget; an Architect group, responsible for the high level design of the implementation project and the integration with the customer's infrastructure; and several tracks and virtual tracks in charge of the development of the required features. Members of both ImpCo and CustCo constituted each of the groups of the project.

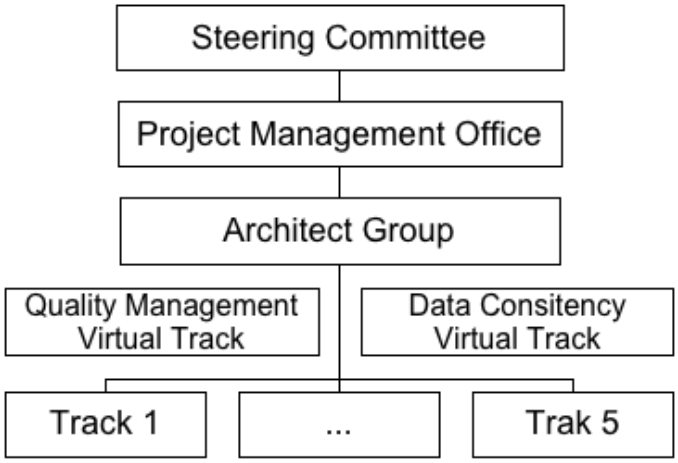

FIGURE 3.2 - Project Organisational Structure

3.1.4. Track Concept

A track is the equivalent to a SCRUM team. A Virtual Track is a track without direct responsibility on the deliverables of the project. Members of the other tracks compose Virtual Tracks. A Virtual Track holds a concrete responsibility in the project that affects all the deliverables of the rest of the Tracks. A Track Lead, Business Analysts and development team members compose each of the tracks. FIGURE 3.3 - Track Organisation represents the organization of a track and the location of the members of each of the companies that were involved in the project.

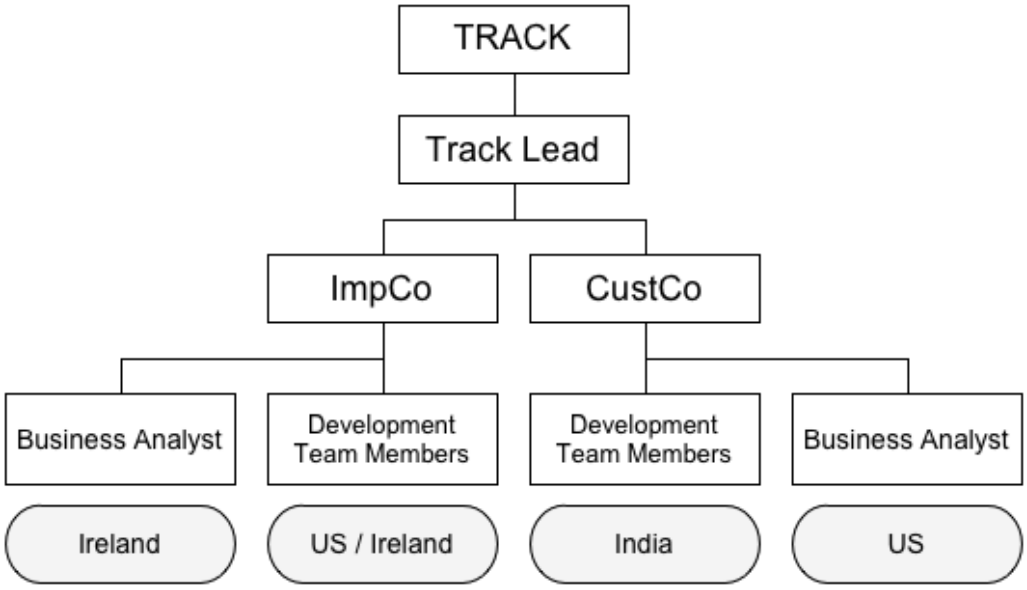

FIGURE 3.3 - Track Organisation

3.1.5. Track Roles

The Track Lead is in charge of ensuring the deliverables of the track. A senior member of ImpCo held this role. Track Leads would either have extensive experience in several other implementation projects, or an advanced knowledge on the topic for which the track is responsible. Track Lead position requires good organizational and communicational skills to guide the track and to align with the rest of the tracks and the Architect Groups. In terms of SCRUM, the Track Lead holds the role of SCRUM Master and shares the Product Owner role with the Business Analysts.

The Business Analyst (BA), in addition to a shared responsibility as Product Owner, is responsible for the communications CustCo's business members. At the beginning of the project they were in charge of transforming the business requirements into the User Stories that would conform the SCRUM's Product Backlog. During the project, a Business Analyst is in charge of understanding all the pieces that need development and the ones that are already built on the product to implement. Based on those terms, they need to advise the customer's business on what is the best way to proceed. At the end of each Sprint, one of ImpCo's Business Analysts was in charge of presenting the Show & Tell: a functional demo presented to the project stakeholders. In this project, BA's also hold the Quality Assurance responsibilities. As QA's, they were in charge of creating functional test cases and testing the features that required development during the project in the different environments where the system was

deployed. A BA needs to have very strong communication skills, particular attention to detail and an understanding of the functionalities and dependencies of the product to be implemented. BA's of both ImpCo and CustCo composed each track.

At the beginning of the project, the BA's transformed the requirements into User Stories. The Development Team members were the ones in charge of transforming the User Stories into working functionality. Technical members and developers of ImpCo and CustCo composed the Development Teams of each of the Tracks in the project. The development team members were assigned to a track based on his or her previous experience. The Irish development team members counted with less experience in general development, but had a wider exposure to global implementation projects of the product. The development team members located in the US and India were senior developers and had a wider experience in development and implementation projects, but had a limited knowledge of the product to implement. The gaps of each location were covered by a continuous structured communication and visits to different sites.

3.1.6. Project Visits

Different visits were organised during the development phase of the project at different levels of the project. During the first two Sprints, all the ImpCo's developers were co-located in the US. This allowed the ImpCo's team members to get to know each other, aligning during the first phases of the project, and establishing different communication models and processes. During the fourth Sprint, two development team members from CustCo travelled to Ireland to work with ImpCo's Irish implementation team.

During the development phase of the project, members of the Architect Group travelled between the development locations and CustCo's headquarter to meet the customer's business and ensure that the project was aligned with CustCo's requirements and needs. This was also used as a measure to control the different locations of the project and to propose improvements to the process in case it were necessary.

3.2. External Factors

The organisation and locations of the project have an important effect on the success of it. However, there are other factors, outside of the scope of a project that could have a significant impact on its success. In order to fully define the context of the project under study, this sub-section describes the external factors affecting the project. There were three main external factors: Firstly, ImpCo was transitioning to a new implementation model; secondly, the product to be implemented was recently acquired by ImpCo and, thirdly, due to the recent acquisition of the company owning the product, the implementation team did not count with Subject Matter Experts in the product.

3.2.1. ProdCo Acquisition

As mentioned before, the product to be implemented in the project is an e-commerce platform developed by a company. This document will refer to it as ProdCo, to preserve its anonymity. ImpCo recently acquired ProdCo, therefore the processes were not fully aligned, leading to breaches in the communication process between the two companies. ImpCo's efforts on aligning the companies since the acquisition were fundamentally done in the technical integration of the platform with ImpCo's product landscape. This helped during the implementation of the project under study by reducing the amount of effort required in terms of developing the integration infrastructure.

3.2.2. Implementation Team Experience

ImpCo's US development team members were senior developers with wide experience in system integration. It was observed that ImpCo's implementation team was able to overcome the problems arising in terms of system integration and system communications due to the level of expertise of the US team. In addition to the system integration, the project consisted of the development of new features for CustCo on the product offered by ProdCo. ImpCo's US senior members did not have experience in implementing ProdCo's product.

The Irish team, on the other hand, had a wider experience in the implementation and enhancement of ProdCo's features, and knew the capabilities and limitation of the product, to a certain extent. Even though the Irish team did not count with any Subject Matter Expert in ProdCo's product and was composed by an 80% of graduates and professionals with less than 2 years of experience, 94% of the user stories required were

delivered on time by the end of the development phase. Some of the members of ImpCo's Irish team had exposure to the first pilot Agile Global Software Development project implemented by the ImpCo's Service & Support organization.

3.2.3. Organisational Change

As mentioned earlier, the organisation under study is ImpCo's Service & Support organization. ImpCo's Service & Support organization was transitioning to a new business model driven by ImpCo's managing board. ImpCo's Service and Support (IS) had a wide experience working with partners in implementation projects and providing recommendations on ImpCo's products, but commonly did not do the implementation of those projects. IS responsibilities covered a wide range of technical and customer facing activities, either remotely or on the customer's site. ImpCo's managing board decided to align and combine several internal responsibilities across different organisations and gave IS the additional responsibility of implementing projects for certain global customers. The project under study is the first project of this kind implemented for a customer based in the US, and the first implementation project where an IS's Irish team had full responsibility of implementing ProdCo's product.

3.3. Solutions Applied

Several measures were applied before and during the project in order to mitigate the negative impact that the external factors could have had in the project. Some of the measures taken were the distribution of skills among tracks, enforcing the FIGURE of the track lead and the creation of virtual tracks to control the deliverables of the project.

3.3.1. Skills Distribution

During the discovery and estimation phase, before the development phase started, the number of tracks was decided and the different members of the team were assigned each track based on their previous experience. Five tracks were created based on the functional aspects to cover during the project. Each track counted with at least one senior development member and one member with wide exposure to ProdCo's product implementation. ImpCo's members from Ireland composed four of the tracks, while the fifth had members from both US and Ireland. CustCo's development and BA members were included in all of the tracks. Some of CustCo's members were part of more than one track. This distribution had two objectives, the first of them was to ensure that each track had knowledge in all of the areas of the project. The second objective was to maintain each of the tracks co-located whenever possible. In order to ensure the communication between tracks, a track lead was assigned to each of the tracks.

3.3.2. Track Leads

Defining the FIGURE of the Track Lead and assigning them to the different tracks was another preventive measure to mitigate the risks of the project. In the project, Track Leads were very senior members of ImpCo. In the tracks with a higher amount of development required, Track Leads had an architect level of experience. In order to maintain the communication between different Track Leads and to keep the stakeholders informed about the progress of each track, different meetings were scheduled between Track Leads, and the different stakeholders of the project. At the beginning of each Sprint a *Sprint Kick-off* meeting was scheduled between the Tracks Leads, Architects Group and the PMO to decide on the deliverables for the following Sprint. During each Sprint, two or three alignment meetings were scheduled per week. In the last Sprints of the development phase the Track Lead alignment meetings were scheduled on a need basis. At the end of

each Sprint, Track Leads presented the results of the Sprint to the PMO in the *Sprint Wrap-up* meeting.

3.3.3. Virtual Tracks

Track leads were assigned before the start of the development phase, when the tracks were established. Nevertheless, some other measures were not foreseen and were established once the development phase had started. Three major problems were identified during the Sprint of the development phase.

The fist of these problems was due to the difficulties of establishing code sharing tools between the ImpCo and CustCo, since each company used a different internal network and different code repository tools. CustCo used Subversion, while ImpCo used Git. ImpCo solved the problem by providing a common Git repository accessible from CustCo's network during the first development Sprint. During the subsequent Sprints a semi-automatic deployment process was established to ensure the code migrations.

The second problem identified was the ensuring data consistency across the different tracks. Even though the entire ImpCo's implementation phase was co-located, the lack of communication between developers of different tracks increased the risk of data inconsistencies. In order to this, a Data Consistency Virtual Track was established. Each Track nominated a responsible for data consistency. Every developer had to inform the data consistency responsible of his track of any change made in the data. The members of the Data Consistency Virtual Track met regularly to ensure that the changes made on each track were consistent across the project.

The third problem encountered was the limitations of the quality checks established for the project. In order to solve that problem, a Quality Management Virtual Track was created with different senior development members of the project. The mission of the Quality Management Virtual Track was to create a set of procedures and tools to measure and ensure the quality of the delivered solution. During the first two Sprints of the project the members Quality Management Virtual Track met daily. Those meetings helped to align on the measures to implement and to review the code submitted the previous day. After the second Sprint the Quality Management Virtual Track spread between US and Ireland, and the meetings were scheduled on a need basis. The Quality Management Virtual Track provided a dashboard solution capable of measuring the quality of the code

by performing different checks and tests. The Track Leads were informed if the delivered code was causing problems to the whole solution.

4. Conclusions

At the end of the development phase, 94% of the user stories were completed based on the final scope of the project. The scope was increased on a 6% during the project. Even though the project has not yet been completed by the time this study, it was performed and based on the user stories completed. The development phase of the project can be considered as a success.

One of the possible reasons of the success of the project could be ImpCo's investment on ramping-up the Irish implementation team by sending them to other locations, like China and Germany, to collaborate in other Agile Global Software Development Projects. That provided with full exposure to ProdCo's product implementation projects to some of the members of ImpCo's Irish team with. Another possible factor could be the high levels of motivation observed, especially during the initial phases of the project, where most of the members of the Irish implementation team would voluntarily work overtime on a regular basis. Another factor that could have strongly influenced the success of the project, could be the mixed skills on each of the tracks and the co-location of the full ImpCo's implementation team during the first half of the project. The collocation of teams improved the relationship between ImpCo's Irish and US team members, and provided a base of trust between the two locations. This continued during the following phases of the project, diminishing the communication barriers between different locations. Also, the fact that Irish members synchronised their working times with US members could have had a major impact on the communication between different members of the implementation team in the different locations of the project.