UNIVERSITY OF GOTHENBURG

# Agile Method Implementation

# A literature review exploring challenges and solutions when implementing agile

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*Abstract--- While agile methodology provided a lot of benefits to companies who adapted agility as their development process, many other companies faced challenges in implementing agile on the team level or on the organization level. This paper is a systematic literature review exploring challenges when implementing agile methods, furthermore, this paper identifies solutions to the challenges that were identified.*

## 1. Introduction

Agile is increasingly becoming the dominating developing method in the software industry. A lot of companies are turning toward agility in one way or another because of the need for fast delivery while at the same time dealing with fast changing requirements (Sampaio et al, 2004). While many of these companies have succeeded in this to some extent, many others faced obstacles in their attempt to change from the old traditional methods to the modern agile methodology. This paper is a systematic literature review (SLR) (Kitchenham et al, 2009), that highlights the challenges associated with agile method implementation. Also the paper identifies solutions available for addressing these challenges.

The systematic literature review is a new research method (Babar et al, 2009), however it is considered as one of the key methodologies of the Evidence-Based Software Engineering (EBSE) (Baber et al, 2009), and it is attracting more researchers in the field of software engineering (Baber et al, 2009). Historically, the framework for the evidence-based software engineering (EBSE) was derived from the evidence-based practice in the medical and sociology research standards, (Brereton, 2011), and it can be defined as a "secondary" study that is based on primary studies that were previously published (Kitchenham et al, 2009). The reason for choosing SLR for this study was due to the fact that SLR follows a "defined methodology" that produces fair results because its open which means it has a predefined protocol of how the study is going to be conducted, also its unbiased because it tries to include all the relevant primary studies, and finally its repeatable because it

can be repeated by others according to the defined protocol to get the same results (Brereton, 2011).

This study has covered as much as possible of the primary studies talking about challenges facing agile implementation and potential solutions for these challenges. Some of these studies are literature reviews of other studies and some are empirical studies that were conducted within companies and enterprises.

This literature review is an attempt to answer two research questions:

RQ1 what are the challenges when implementing agile methodologies?

RQ2 what are the solutions suggested to these challenges?

To get the answer for the above research questions, a systematic literature review was conducted. The first step in the research method section was to choose the relevant digital databases to get the primary study papers from. Then the searching terms or the keywords were defined. At this initial step 4507 papers dealing with agile implementation challenges were identified. The next step was to narrow down the search in order to focus on the specifics concerned with challenges facing agile implementation within software industry. As a result of this, 297 papers were considered relevant. The final step was to narrow the search further according to specific inclusion and exclusion criteria. After this process 19 relevant primary studies were identified and selected for further analysis.

In general the sections of this paper are structured as follows:

The first section is the introduction followed by the related research section which points out the similar studies to this SLR. The third section explains the research method that was used in conducting this study. Section four displays the results extracted from the primary study papers. Follows section five the discussion, which conduct detailed discussion on the results of the previous section. After that follows section six the limitations, which points out the limitations of this study. Finally follows the conclusion section which displays the conclusions derived from the discussion of this study.

## 2. Related Research

Since 2004 the systematic literature review SLR has had increasing attraction in software engineering research (Babar et al, 2009). In addition there were proposals about the techniques for designing strategies to assess the quality of the primary studies included in the systematic review. Also there were proposals about designing the strategies used for assessing the quality of the primary studies used in SLR (Babar et al, 2009).

There are studies that investigate certain aspects of what is discussed in this study. For example, Procter et al (2011) study in depth the agile project management. The focus in this study was on the response to changing requirements during the development process. The response to changing requirements is in the core of agile practice and, as it will show in table 2 in this study, one of the challenges when implementing agile. The challenges here were about prioritizing the requirements and respond to the quick changes of these requirements made by the customer.

Another case study conducted by Srinivasan and Lundqvist (2009), focused on four areas of agile implementation, requirements management, scrum implementation, organizational learning, and verification & validation activities. This project was an online poker game which began as a university project then after success it evolved to a small firm. The study points out the power and weaknesses of implementing agility on a project that requires fast response to the market demands. Also it shows the positive effect of using Scrum as a development method, at the same time the project suffered from poor requirements quality that did not manage to meet the rapid development cycle time.

In a study conducted by Drury et al (2011), decision making in a team is the key focus. The study found that the team implementing agile tend to use tactical decisions rather than strategic decisions. The researchers concluded the reason behind this was that working in sprints gives the team a short-term, two week focus. The study concludes that if decisions are not committed or implemented in the right way, the functional delivery at the end of the sprint suffers and customer satisfaction may be reduced during the sprint review as a result.

In this paper, a systematic literature review is conducted to identify the challenges associated with the implementation of agile methodologies.

## 3. Research Method

There are two ways to deal with a lot of primary studies related to the research question of this paper, either the "conventional expert literature review" (Kitchenham, 2007), (Brereton, 2011), or the "systematic literature review" (SLR) (Kitchenham, 2007). The SLR was chosen because the need of this research was to systematically summarize all the existing information about the challenges facing implementing agile methodology (Kitchenham, 2007).

Other reasons for choosing SLR were that the SLR starts with defining a review protocol which in its role will define the research question and the methods used to perform the research (Kitchenham, 2007). Moreover, SLR is built on a defined search strategy which targets all available relevant literature (Kitchenham, 2007), and this will result in covering all primary studies in the field. Finally SLR arranges its research strategy in a way that helps the user to assess its rigor especially for users of digital libraries (Kitchenham, 2007); which was important when deciding about what papers to include in this research.

### 3.1 Searching strategy

The following digital databases were used in searching for published primary studies:

- IEEE Xplore.
  http://ieeexplore.ieee.org/Xplore/dynhome.jsp?tag=1
- ACM Digital Library.
  http://dl.acm.org/
- SpringerLink.
  http://www.springerlink.com/

Journals issued since 2001-2012 were included as the primary study resource for this study. The reason for choosing 2001 as the starting year was that the agile manifesto was declared in 2001 and during the following years a lot of research on agile methods was conducted.

The research is limited to papers published in English and was available in the mentioned above databases.

## 3.2 Searching terms

As it is necessary to determine and follow a search strategy (Kitchenham, 2007), the search terms for this paper were defined through these steps:

- The phrase 'agile implementation challenges' was identified as a keyword to conduct the research.
- The phrases 'agile implementation difficulties', 'agile implementation obstacles ' and 'agile implementation barriers' were identified as synonyms keywords to expand the area of research.

## 3.3 Study selection criteria

After searching the above mentioned databases for relevant primary studies, we ended up with a lot of published articles. The need was to select only the papers that fit the specific purpose of this study. For this the inclusion and exclusion technique selection was used. And hence, it is the research question of this study determines what papers to select (Kitchenham, 2007).

Papers were chosen according to the following inclusion and exclusion criteria:

*Inclusion criteria:*

- Papers that deal with agile within software field in general.
- Papers that deal with challenges facing implementing agile methodology.
- Papers that deal with barriers facing agile implementation.
- Papers that answer directly the research question of this study, especially the ones that provide direct evidence about the research question (Kitchenham, 2007).

*Exclusion criteria:*

- Papers that deal with agile in general but outside the scope of software field.
- Books and papers that are part of a book, conference papers or any materials other than journals.
- Papers published before 2001.
- Studies that are in progress research or incomplete results.
- Studies that mention agile challenges in brief as part of another subject but not focusing on it as an actual research issue.

## 3.4 Study selection process

The study selection process was conducted using these steps:

- The selection process started by running a database research for all journals that deal with agile within software area.
- The second step was to narrow the size of primary study papers by using the inclusion and exclusion techniques mentioned above, at this stage the papers were selected depending on the title (Kitchenham, 2007). During this step it was gained the first selection of journals related to this study.
- The third step was to review the abstract of the papers in an attempt to select the papers that address the research question of this study.
- The results from the above steps were discussed and consulted with the supervisor (Kitchenham, 2007).
- Finally, from each database, a table containing two selections of papers, first and final, was created (table1).

**Table 1:** Initial and final selection of papers

| Database | Total of primary studies found | Initial selection | Final selection |
|----------|-------------------------------|-------------------|-----------------|
|          |                               |                   |                 |

| | | | |
|---|---|---|---|
| **IEEE Xplore** | 19 | 17 | 7 |
| **ACM Digital Library** | 2860 | 39 | 3 |
| **SpringerLink** | 1628 | 241 | 9 |
| **Total** | 4507 | 297 | 19 |

## 3.5 Data extraction

A review was conducted on the selected papers. In order to answer the research question of this paper, the review was targeting the following data:

- The references of the primary studies.
- The research methods that were used to conduct these studies.
- The context of each paper.
- The challenges that the authors of these papers point out when implementing agile methodology.
- The barriers mentioned in these papers that hinder implementing agile.

## 3.6 Data analysis

After searching for, and selecting papers, the process of analyzing these papers began. This process involves collecting and summarizing the results of the papers that had been selected as relevant primary studies (Kitchenham, 2007).

As the systematic literature review of the software is qualitative in nature (Brereton et al,

2007), the data analyzing is more likely to be a descriptive process.

After narrowing and processing the primary study papers in the previous steps according to the research method, the actual literature review of this study began. Initially the goal of this literature review is to answer the research questions mentioned in the introduction of this paper; these two questions are concerned with identifying the challenges when implementing agile methodologies and potential solutions to address these challenges.

## 4. Result

The result of reviewing these primary study papers is shown in table 2 as six major areas. These areas are: development process, business process, people conflicts, communication problems, management's problems and cultural challenges. These areas emerged as a result of reviewing all papers. Each area covers several challenges which are considered important challenges; in relation to the challenges identified, there are suggested solutions that could potentially help addressing the challenges.

**Table 2**    Challenges when implementing agile methodologies and solutions that address these challenges

| Area | challenges | solutions | references |
|---|---|---|---|
| Development process | Merging agile with standard industrial process | Piloting small isolated or even failing projects with either pure agile methodology or hybrid of agile and traditional methods | Boehm et al, 2005 |
| | Managing variability in | Paying specific attention to identifying how | Boehm et al, |

| | | | |
|---|---|---|---|
| | subsystems and teams | to synchronize teams | 2005 |
| | Different life cycle | The traditional longer life cycles require adjustment to the agile process | Boehm et al, 2005 |
| | Requirements process | Strengthening agile requirement approach to provide additional information | Boehm et al, 2005 |
| | The requirement changes appeared all the time during the project | Scrum planning and review meetings | Pikkarainen et al, 2008 |
| | The construction of high quality software complying with severe project delivery time constraints | Agile processes such as Extreme Programming are emerging as a viable alternative to traditional development methods, helping to speed up software development via a flexible and effective process philosophy. | Sampaio et al, 2004 |
| | How speed and quality assessments vary when the experiment is performed in a professional software development organization as opposed to a classroom experiment. | | Sampaio et al, 2004 |
| | How speed and quality indicators unfold on mid and large scale web application Projects (e.g., more than 50000 LOCs). | | Sampaio et al, 2004 |
| | There is a widespread tendency to make a point of stressing that the success of SPI is only possible for large companies. | The results presented in this paper show that it is indeed very difficult to successfully apply formal SPI programmes which use models such as, for example CMM, to SMEs. | Pino et al, 2007 |
| Business process | Human resources | Empowering people to pursue non-traditional approaches | Boehm et al, 2005 |
| | Progress measurement | Using agile measurements such like requirement burn down instead of traditional measurement techniques like milestones | Boehm et al, 2005 |
| | Process standard ratings | It's possible that enlightened appraisers can find ways to include agile methods as alternative practices in many instances. | Boehm et al, 2005 |
| People conflicts | Management attitudes differences between traditional and agile paradigms | Focusing on project managers to be able to play the roles of protector and coach | Boehm et al, 2005 |
| | Logistic issues | Requirement for agile work space involves pair programming stations, walls for status charts, a layout that allows teams to communicate and easily share information , sufficient equipments to support continues integration | Boehm et al, 2005 |
| | Handling successful pilots | | Boehm et al, 2005 |

| | | | |
|---|---|---|---|
| | Change management | | Boehm et al, 2005 |
| | Uncertain situations due to culturally dependent differences | People involved in cross cultural transactions are advised to be aware of the cultural background of their counterparts | Jaakkola et al, 2009 |
| | Hard to focus in open office space | | Pikkarainen et al, 2008 |
| | In pair programming, as in any software process, there exist human factors (including developer personalities and temperaments) that cannot be easily identified and understood well enough to be controlled, predicted, or manipulated | Managers have much to gain from psychology to understand where and why slowdowns occur (Beck 2000; Cockburn 2002; Ferdinandi 1998; Gorla and Lam 2004). This means that they must utilize processes which first identify and understand developers' personalities and then capitalize on their potential talents and strengths, effectively combining them. | Sfetsos et al, 2009 |
| | While the boundary object is a "pioneering concept" that has been "a useful placeholder for explaining that artifacts 'live' in the space between collaborating communities of practice," it is limited to providing different communities of practice a "means of translation" between them since the boundary object can "inhabit multiple worlds simultaneously." | A collective boundary of what is the Software Process is under constant negotiation. | Cohn et al, 2009 |
| Communication problems | Although it seems that the use of agile practices would increase communication capabilities in software intensive companies, Turner (2003) argues that the companies using agile methods would also face a risk from overemphasizing tacit knowledge across a team. | Agile software development does not, however, include only tacit ways of communicating (Turner 2003). Formal communication such as source codes, test cases, and a minimum, essential amount of documentation is also used in agile software development projects. | Pikkarainen et al, 2008 |
| | It has been claimed that the use of agile software development methods can increase the chasm among the actors in software development organizations and even lead to project failure (Boehm and Turner 2003). | Most of these problems may be a consequence of the lack of communication between these actors as identified in many studies (Cohn and Ford 2003; Coram and Bohner 2005; Svensson and Host 2005). | Pikkarainen et al, 2008 |

| Management problems | The difficulties of managing at a distance | 'Constant communication' via email, Skype chat, etc. in the team's attempt to guarantee the orderly coordination and management of the project. | Procter et al, 2011 |
|---|---|---|---|
| | Motivating the work while keeping both the customer and the team satisfied. | Trust and team morale building was supported through various formal mechanisms such as partner site visits. | Procter et al, 2011 |
| | Fostering user engagement | Favoring rapid responses to change over the careful following of a 'plan' and working software over comprehensive documentation—features that resonate throughout the project. | Procter et al, 2011 |
| | The essence of agile project management is to be found in the ongoing struggle for a balance between the seemingly contradicting and conflicting agendas of flexibility and planfulness, and improvisation and orderliness. | It is the maintenance of this balance that provides the foundations for the meaningful and continuous user engagement essential to tackling the challenges of embedding eResearch applications successfully. | Procter et al, 2011 |
| | People are Unwilling to Commit to a Decision | | Drury et al, 2011 |
| | Conflicting Priorities | | Drury et al, 2011 |
| | Inconsistent Resource Availability During Sprint | | Drury et al, 2011 |
| | Decisions are Not Implemented | | Drury et al, 2011 |
| | Lack of Ownership | | Drury et al, 2011 |
| | Lack of Empowerment | | Drury et al, 2011 |
| Cultural challenges | Integrating cross-cultural knowledge into SE(software engineering) projects and processes | We have proposed that the integration can be realized with our knowledge classification framework. The three-layer model provides a means for a better understanding of the requirements arising from context-dependency and culture awareness for the software engineering process. | Jaakkola et al, 2009 |

A short look to the table above shows that it covers several different areas of the challenges and problems that face agile implementation. In sequence these areas are: development process, business process, people conflicts, communication problems, management problems and cultural challenges. These areas were defined as a result of reviewing the primary study papers selected in this study. The areas are considered the major categories under which the challenges to implementing agile might show.

The first area in the table, the development process area, focuses on the challenges that face the

development process when implementing agile. The first and the most obvious of these challenges is the merging of lightweight agile process with standard industrial process without either killing agility or destroying the ongoing industrial standards (Boehm et al, 2005). The solution to this is creative managers who might for example run pure agile methods or hybrid of agile and traditional methods on isolated or not critical projects as pilot programs (Boehm et al, 2005). Other challenges in the area of development process is managing the variability in the subsystems and teams, as it is difficult for example to integrate the software of two teams working on the same project when one team adapts agile methodology while the other team follows the traditional methods (Boehm et al, 2005). The different life cycles between traditional and agile methods is another problem in the area of process development challenges, that is traditional methods focuses on optimizing the development process over a long time, while agile method support the fast delivering functionality (Boehm et al, 2005). The difference of how agile and traditional methods deal with requirements might be another challenge, as agile requirement implementation tends to be functional and informal, and this might not fit the traditional way of verification and validation approach (Boehm et al, 2005). Even in a pure agile practice, especially in large software products, the new requirements from the customer give the impact that the requirements changes all the time during the project (Pikkarainen et al, 2008).

Business process is the second area where agile implementation challenges might show. When talking about human resources, agile team members might cross the boundaries that govern the traditional organization relations. The human resources department should empower individuals to follow more non-traditional approaches (Boehm et al, 2005). Another difference between agile and traditional methods is the way to measure progress. In traditional methods; contracts or milestones for example are normal practices while it has less importance in agile methodology. One solution to this conflict might be for example using the technique of requirements burn down or story completion to measure the progress in the ongoing project as suggested by Boehm et al (2005).

Back to the table, the third area of challenges when implementing agile is the people conflicts. For example; the project manager role differs significantly between the traditional paradigm and agile methodologies. In traditional development, the manager's role is to allocate or assign team members with specific tasks, while in agile practices; the members of the teams are "multitasks" team members and empowered team members that take responsibility also for assigning tasks within the team (Boehm et al, 2005). Another issue in the people conflict category is the logistic requirements needed to adapt agile, meaning the need to have a common workspace which should have pair programming stations, walls for status charts a layout that eases the share information between teams (Boehm et al, 2005).

The fourth area of challenges is the communication problems that show when implementing agile. As agile supports the informal way of communication between actors, it seems that the use of agile practices would increase communication capabilities in software intensive companies (Pikkarainen et al, 2008), sometimes there were claims that the use of agile methods may increase the chasm among the actors in software development organizations and even lead to project failure (Pikkarainen et al, 2008), this might be the result of less documentations in agile and can be solved by adapting more formal communication like source code, test cases or the minimum essential text documentation.

The fifth area of the table displays the management problems when implementing agile. One of the challenges here is motivating the work while keeping both customer and team members satisfied. The suggested solution to this challenge is by building trust and moral values among the team members and between teams and customers (Procter et al, 2011), A second challenge facing managers is fostering the user engagement in the development process, which is one of the aspects of agile methodologies, there are many techniques to achieve this among them is the partner site visits (Procter et al, 2011). Another challenge might face managers is the difficulties of managing at a distance, and this shows in particular when managing a project that relies heavily on technology (Skype chat, emails ...) to manage a virtual team (Procter et al, 2011), the constant communication via email or Skype chat can be a solution to this challenge. The forth challenge is the continuous struggle for the balance between contradicting and conflicting agendas of flexibility

and planning or agility and traditional aspects (Procter et al, 2011), and the solution will be the maintenance of this balance between the two aspects. (Procter et al, 2011).

The table shows some other challenges that were mentioned in the primary study papers and were without solutions, these challenges are: the people are unwilling to commit to a decision, conflicting priorities, inconsistent resource availability during sprint, decisions are not implemented and lack of ownership and empowerment.

The sixth and final area of challenges in the table that might face implementing agile is the cultural challenge, as integrating cross cultural values into software processes and projects is a challenge for the new culture aware software engineering (Jaakkola et al, 2009), as globalization is one of the major trends in this era, software engineering can be a good example of the cross cultural work (Jaakkola et al, 2009). To show the challenges linked to cultural dimension in global work environment, we quote from Jaakkola et al, (2009), "Despite the trend of globalization, software business executives, project managers and project team members are finding themselves in uncertain situations due to culturally dependent differences in communication protocol, language, and value systems."

## 5. Discussion

As the section above shows, the challenges facing agile implementation can be categorized into six major areas.

The first area in table 2 is covering the challenges relating to the development process. These challenges are evident in particular when trying to implement both the traditional and agile methods on the same project. This will need mixing and "forging alloys"of both methods (Boehm et al, 2005). In fact mixing light weight agile with heavy traditional method without killing agility or undermining the standard industrial process is the most difficult challenge facing managers in software projects (Boehm et al, 2005). One of the clear challenges shows when agile and traditional teams work on the same project is the integration of the product developed by both teams. It needs coordination to merge the work of the two teams (Boehm et al, 2005).

The second area in table 2 is about business process challenges, this area points out the differences between agile and traditional methods during running the daily business issues. For example when it comes to human resources, the agile team members should be more skilled, should accommodate team values rather than individual values and often cross the boundaries between standard development position descriptions (Boehm et al, 2005). Also when it comes to progress measurement it differs between traditional methods which adapt techniques like milestones and agile methods which adapt techniques like requirements burn-down, these differences in measurements techniques is due to the differences in the work breakdown structure between the two.

The third area in table 2 is talking about the challenges related to people conflicts. In fact people issues are in the heart of agile methodology and major part of agility is targeting empowering 0individuals (Boehm et al, 2005). One of the major challenges under this area is the differences between traditional and agile paradigms when it comes to management. On one hand in agile, especially in large scale management processes, teams and individuals are looked at as interchangeable parts and it is usual to have multi task teams in agile projects; on the other hand the managers in agile plays both the role of protectors and coaches of the teams (Boehm et al, 2005).

The fourth area in table 2 is dealing with communication problems related to implementing agile methods. As Pikkarainen et al (2008) quoting from Turner (2003) there might be the challenge of overemphasizing the tacit knowledge across the agile team. Another challenge might be using agile methods can result in the increasing of the gap between the actors in the organization (Pikkarainen et al, 2008). As it is clear in this area that agile is a little bit informal when it comes to communication between team members, this in one way means fewer documents to describe events of the development process, which might evolve in future chasm within the teams.

Moving to the fifth area in table 2, it discusses the management problems related to implementing agile. The first of these problems is the situation that concerns the difficulties that arise

when managing a project at a distance; this situation needs various forms of managing and leadership abilities to keep track of the project and use communication technology to motivate teams working on the project (Procter et al, 2011). Another challenge under the field of management problems is how to build a trust and moral environment to motivate the work while in the same time satisfy both the customer and the team, this can be achieved through interaction using mechanisms such as partner site visits (Procter et al, 2011). One more management challenge is how to empower user's involvement as actual features of daily project work not only as interesting slogans (Procter et al, 2011).

The sixth and final area that the table 2 covers is the cultural challenges that are linked to implementing agile. Jaakkola et al (2009) mentioned that integrating cross-cultural knowledge into software projects is a challenge and this integration might produce a new shape of software engineering and called it "Culture Aware Software Engineering or CASE". In fact the multi culture concerns are new to the software community; it emerged for two reasons, the first is the software products are increasingly distributed in a wide geographical area (Jaakkola et al 2009), due to the market driven development process, companies should take in consideration the cultures related to these markets as these cultures might affect the demands of the customers belonging to these markets. The second reason for the multi culture concerns, is that the software business itself is getting increasingly a global process (Jaakkola et al 2009), and this means international teams and global organizations that should care about the differences in cultures between their members and sub-teams (Jaakkola et al 2009).

Taken together, the areas above show that many challenges appear when trying to implement agile methodologies into a software development organization.

On one hand the traditional methods were there for a long time and companies have developed their own standards through defining and refining their systems (Boehm et al, 2005), while on the other hand the market is changing rapidly which means the environment of developing products is more changeable than ever been before.

To address this situation, many organizations regard agile methods as a way for solving key problems in software development; in particular, the software takes a long time to develop, costs are high and have quality issues upon delivery (Holmström et al. 2006).

Back to table 2, as it shows challenges facing implementation of agile methodology, it also shows solutions that might address some of the problems. These solutions in general, are addressing the empowering of skills of the actors working within the software projects weather those actors are managers or team members.

In the different areas in table 2, it can be noticed that one type of solution can address many challenges (different aspects) at the same time, for example when trying to address the problem of fast requirement changing, the solution is scrum planning and review meetings, this solution is interchangeable with the communication area, as the communication in agile is less formal and more creative. By its role, the interactive communication depends on the human factor which is under the area of people conflicts. Also the cultural challenges might affect the communication when a project is globally developed.

For the first area, the development process, one of the solutions is to pilot a small project as a way to measure the results and train staff before implementing agility on the actual project, other solution is to focus on synchronizing the teams working on the same product and this of course demands creative and skilled managers. Here in the area of development process, it can be noticed that there is no solution for the challenge of balancing between speed and quality, as quality needs longer time to be improved and as table 2 shows this problem shows more clear in the large scale applications with more than 50,000 lines of code.

Under the business process, the solutions to confront the challenges related to human resources are to empower the people to adapt agile approaches, also to use tools provided by agile like requirement burn down to measure the progress in projects.

The people conflict area is of special importance as it is concerned with people and this is the core interest of agile, here for example the

managers role is more important in agile than it is in the traditional practice, as the manger here plays both the role of the protector of the team members and the coach at the same time, this needs a higher skilled manager than it needed in traditional way and the solution here is to focus on managers to be able to play their role in the developing process. Another important solution in this area is the space where the development process is conducted, as agile requires a space that support pair programming, easy communication, walls for status chart and equipments for continues integration.

The suggested solution for the forth area, the communication problems, is to enhance both informal communication and a sort of formal communication like source code, test cases or minimum essential documentation. Also as Henttonen and Blomqvist (2005) say, the regular communication is the best way to build trust in teams. It has to be said here that both agile principles and methods provide solutions for communication problems such like practices for collaboration and interaction between the stakeholder groups (Pikkarainen et al, 2008).

The suggested solutions for the challenges of the fifth area, the management problems, in general is by building trust and moral values among team members and between teams and customers, this might help to satisfy both team members and customer, and one way to conduct it is by using partner site visits. Another solution especially for distance management problems is to focus on effective communications like for example using technology (emails, Skype) to establish constant communication to guarantee the coordination and management of the project. While at the same time, some management problems might not have suggested solutions, like for example when people are unwilling to commit to a decision or decisions are not implemented or conflicting priorities.

The solution for the cultural challenge in the sixth area of table 2 can be for example integrating cross cultural knowledge into software engineering projects, and as Jaakkola et al (2009) suggested that people working in multi cultural transactions should be aware of their counterparts cultural background, this can be achieved by understanding the cultural dimensions and adjusting to the cultural differences (Jaakkola et al, 2009).

# 6. Limitations

Like other studies, this research has some limitations that might affect the accuracy of the result gained from it. One of these limitations is that only papers written in English were included. There might be some good papers in other languages as well, but due to language restrictions they were not used. Another limitation is that papers published during this study are not included. Those new papers might be of high importance as they are the most recent studies in the field. In spite of these limitations, the using of SLR method and the adapting of (Kitchenham, 2007) guidelines in this study; gave it the feeling of the appropriate validity and acceptance.

In addition to the above limitations, there were difficulties related to this study, and in fact there are many reasons for the difficulty of studying a topic like agile and challenges related to implementing it.

One of these reasons is that agile is a very wide topic and it is actually implemented in a lot of fields other than engineering and industry, this might give agility different definitions according to the field it is implemented in.

Another reason for difficulty is that when studying a case in a company, the circumstances of this case-study might differ from one study to another; for example the results of a study are no doubt different between companies that has recently implemented agile compared to a company which has long experience of agile implementation.

It seems the most important difficulty when studying agile is the human factor. As agile methods are targeting an environment where humans (not machines) are the major actors, this will cause the results of implementation very different from one place or company to another.

In this study, the aim was to include relevant papers on challenges that face companies when implementing agile methods, and also solutions that address them.

# 7. Conclusions

As recognized in the very beginning of this paper, agile methods are becoming increasingly popular. In this study, we identify challenges when implementing agile methods. Also, we identify solutions that address these. This study presents a number of important insights:

- This study is a systematic literature review that identifies challenges when implementing agile methods as well as solutions that address these challenges.
- Based in the literature review, this study identifies six areas in which challenges usually appear. These areas are (1) development process, (2) business process, (3) people conflicts, (4) communication problems, (5) management problems, and (6) cultural challenges.
- A common challenge that influences all areas is the challenge of implementing light weight agile methods into an organization with already existing heavy weight traditional practices.
- Mixing agile methods with traditional practices is challenging and usually produces new problems concerning the adjustment between the two paradigms.
- All six areas are closely related to the 'human factor' and it is clear that communication and coordination between people is critical. The human factor is complex and even more important in agile methods since this approach to software development is more informal than traditional ones and therefore, even more dependent on the people involved.
- Management commitment is critical and this study presents a number of important management issues that need to be considered when implementing agile methods.
- This study identifies solutions that address the challenges. As can be seen, most of the solutions are targeting people, i.e. the actors involved in the software development process.
- While the solutions identified do indeed address the challenges, there are still a number of challenges that do not have a clear solution. As experience as well as research advances in this area we will see more solutions and hopefully, less challenges associated with agile method implementation.

## Acknowledgements

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