A Study of the Agile Software Development Methods, Applicability and Implications in Industry

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Abstract

There has been a tremendous importance in the field of agile software development approaches in the recent past. This is because of the fastness that agile approaches bring in the life cycle of software development. This interest in the field shows that there are benefits to reap through successful implementation of agile methods. The field is relatively nascent and research is in its initial stages. The paper has been carried with the distinct objectives of examine and gain insights into the current agile methods and practices, understanding the strengths and weaknesses of agile methods and various issues of their applicability. To meet the set goals and objectives, we used both qualitative and quantitative research methodologies. Apart from a systematized literature survey and review, we performed a case study of four software companies in India. The data collection methods included questionnaires, interviews and analysis of the companies’ web-sites.

Keywords: Agile software, Agile methods, Applications of agile methods, Extreme programming (XP)

1. Introduction

Software development is an organized thrives to deliver products in faster, better and cheaper ways. There have been many studies and suggestion in improving the development process. Software development is an organized process that thrives to deliver products in faster, better and cheaper ways. There have been many studies and suggestion in improving the development process. Recently, this interest has paved way to a new software development method called Agile Software Development. To overcome the fast changing organizational business needs using traditional methods agile methods were introduced. Agile methods aid in and focus on developing solutions more quickly and efficiently. Agile methods highlight customer satisfaction by structuring the development process into iterations where in each iteration produces sizeable amount of working code and artifacts of interest to customers. Agile software development (ASD) is a relative new term within software engineering. Agile processes, or development methods, represent an apparently new approach for planning and managing software development projects. ASD differs from traditional approaches as it puts less emphasis on up-front plans and strict plan-based control and more on mechanisms for change management during the project. Despite being a new approach, the foundational principles of ASD are based on some existing principles and theories, both from the field of software engineering, information systems and others such as production management.
Our paper is focused on the agile software development, agile methods centered on current practices in industry. Most commonly used methods will examined from the angle of their applicability, strengths and weaknesses and their adoption in industry. In order to investigate and analyze, there is a need to compare the issues in the literature, research studies and industry. This will lead us to find benefits, limitations and difficulties in transition from traditional to agile software development. The rest of paper is as follows: section 2 contains the previous related works on agile methods, section 3 contains the research questions that helped us meeting the goals, and section 4 contains the research design, research methodologies, i.e. how we carried out the entire study. Section 5 contains the analysis of the study, section 6 contains the validity threats and limitations to our study, section 7 contains the conclusions that we drew. The last section contains the references.

2. Background and Related Work

Agile Software Development is presently an emerging discipline in the field of Software Engineering. It is presently advocated by many software professionals. The Agile software development principles that are followed and advocated emerged from the traditional software development principles and various experiences based on the successes and failures in software projects. According to [1], customers found it difficult to define their needs because of the fast changing technology and the companies using them in products. New methods, now called agile methods are were designed to define the changing requirements in software environments. Traditional methods refer to the older and commonly used methods like the waterfall methods. These traditional methods have often been criticized to be far from the real ways software engineers functioning in developing the software. Agile Software Development emerged in February 2001 when a group of software consultants signed the Agile Software Development Manifesto. Agile methods focus on the challenges of unpredictability of the real world by relying on people and their creativity rather than processes [2]. The main theme in agile methods is to promote and speed up responses to changing environments, requirements and meeting the deadlines. The agile manifesto [1] states the main focus of the agile development as the following:

1) Individuals and interactions over processes and tools
2) Working software over comprehensive documentation.
3) Customer collaboration over contract negotiation.
4) Responding to change over following a plan.

There are a number of agile software development methods. Methods for agile software development represent a set of practices for software development that have been created by experienced people [3]. The most common methods are extreme Programming (XP) [8], Dynamic Software Development Method (DSDM) [9], Scrum [6], and Crystal [7]. The highest criterion of these methods is development of the software and customer satisfaction through continues delivery of software. This is achieved by having short iterations in the development process. The iterations focus on timely delivery of working code that provides substantial value to the customer. More importantly, is a very limited work that has been produced to assess the applicability of agile methods. This is an indication is a need for investigation.

Methods for agile software development represent a set of practices for software development that have been created by experienced people [8]. These methods can be seen as a new idea to plan-based or traditional methods, which emphasize “a rationalized, engineering-based approach” [10, 9] in which it is particular that problems are fully specifiable and that best and anticipated solutions exist for every problem. The
“traditionalists” are said to advocate extensive planning, codified processes, and rigorous reuse to make development an efficient and predictable activity [11]. By contrast, agile processes address the challenge of an unpredictable world by relying on “people and their creativity rather than on processes” [12, 9]. In 2001, the “agile manifesto” was written by the practitioners who proposed many of the agile development methods. The manifesto states that agile development should focus on four core values: [13]

1. Individuals and interactions over processes and tools.
2. Working software over comprehensive documentation.
3. Customer collaboration over contract negotiation.
4. Responding to change over following a plan.

In the article [14], the authors describe the history of incremental and iterative development and identify Dynamic Systems Development Method (DSDM) [15]. The first agile method followed by extreme programming (XP) [16]. In the year 1998, in “software process” the word “agile” and the concept was used for the first time [17]. Many further methods followed, which includes the family of Crystal methods [18], Feature-Driven Development [19, 20], Lean Development [21]. Table 2 gives the overview of the most referenced agile development methods.

Comparison of traditional and agile development is explained in [9]. Many people have tried to explain the core ideas in agile software development and some of them by examining similar trends in other disciplines. Some of the core ideas in this system were to eliminate waste, achieve quality first time, and focus on problem solving. The agile ideas have been in Complex Adaptive System by providing a theoretical lens for better understanding and how the agile development is made in volatile business environments by Meso and Jain [22]. Turk et al., in [23] have clarified the assumptions that execute the processes of agile development and also identified the limitations that may arise from these assumptions. To mature design ideas in architectural design and strategic management made by Nerur and Balijepally [24]. The agile development methods have also been analyzed by some practitioners and academics, mainly focusing on four aspects:

1. Agile development is nothing new, such practices have been in place in software development since the 1960s [12].
2. The lack of focus on architecture is bound to engender suboptimal design-decisions [25].
3. The practices in XP are rarely applicable, and are rarely applied by the book [26].
4. Agile development methods are suitable for small teams, but for larger projects, other processes are more appropriate [24].

A clear finding of the literature review the work published on agile methods is that there is a need to increase both the number and the quality software development. In particular, agile project management methods, such as Scrum, which are popular in industry, warrant further attention. There seems to a clear need to establish place objectives for further research in agile software development and for future field studies to pay more attention to the fit between their research methods and the state of prior work. There exists a need to dwell into incorporating agile methods in industry and the affects of the same.
“Table 1: Description of Main Agile Development Methods with References”

<table>
<thead>
<tr>
<th>Agile method</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystal methodologies</td>
<td>The most agile method, Crystal Clear, focuses on communication in small teams developing software that is not life-critical.</td>
<td>[18]</td>
</tr>
<tr>
<td>Dynamic Software Development Method (DSDM)</td>
<td>It divides projects into three phases: pre-project, project life-cycle, and post project</td>
<td>[28]</td>
</tr>
<tr>
<td>Feature driven development</td>
<td>Combines model-driven and agile development with emphasis on iterative design.</td>
<td>[19, 20]</td>
</tr>
<tr>
<td>Lean software development</td>
<td>It Consists of seven principles: eliminate waste, amplify learning, decide as late as possible, deliver as fast as possible, empower the team, build integrity, and see the whole</td>
<td>[21]</td>
</tr>
<tr>
<td>Scrum</td>
<td>Focuses on project management in situations where is difficult to plan ahead, with an importance on feedback mechanisms</td>
<td>[28]</td>
</tr>
<tr>
<td>extreme Programming</td>
<td>Focuses on best practice for development. Consists of twelve practices.</td>
<td>[16]</td>
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3. Research Questions

The paper is being carried with the following objectives:
- To examine, gain insight into the agile methods and practices
- To find out the issues in where, when and how agile methods are used
- Strengths and weaknesses of agile methods
- Understanding the applicability of agile methods
- Understanding transition from traditional methods to agile methods and its effects on the organization

To get good understanding of the above mentioned, we formulated research questions. These are discussed as follows.

A. What are the current agile methods and practices?

This research question attempts to discuss the agile methods. It is understood that some agile methods are not popular, so it is of immediate concern to know how the agile methods are differ from each other. Also, this contributes to one of the fundamental tasks of the paper. The outcome would be to identify the companies that have incorporated the agile philosophy and methods. This will give an understanding of the most commonly used agile methods.

B. What are the benefits of the agile methods and their level of applicability in industry?

We primarily focus on understanding what has been published on all the agile methods, benefits and limitations. It would give a broader perspective on the following:
- Is there any relation between type of software developed and the agile philosophy adopted?
- Is there any relation between size of the project/company and agile methods?
• Benefits with respect to agile methods chose and type of project.

C. What are the impacts of using the agile methods in industry?

The subjects of relevance to this research question would be to collect information on the changes that the introduction of agile methods has brought to the organization. This also helps in knowing the following:

• Practicing agile methods is always beneficial to employees in terms of job satisfaction, communication etc.?
• Level customer satisfaction achieved and issues, if any, encountered among the customers

4. Research Design

In this section the research design in answering the above mentioned research questions are explained. We conducted research using both the qualitative and quantitative methodologies. As part of the qualitative method, data was collected through interviews and questionnaires. The quantitative data was collected by conducting a survey. We identified ten software companies in India. Company 1 is relatively a young company and it has incorporated agile philosophy in the year 2004. The company has a team of 60 software developers. The main focus of the company is building Java applications. The company’s expertise is its rapid delivery of enterprise applications against a complex set of fast changing requirements.

Company 2 is focused on helping customers with their business goals by providing best technology combined with highly skilled team efforts. It builds information technology services. Company 3 is a provider of integrated business, technology and process solutions. It is globally spread. It has 5 branches. It is a business and information technology consulting company. Company 2 is relatively larger than Company 1 and Company 3. Company 2 and Company 3 incorporated agile methodology in the year 2002 and 2003 respectively. The research was done with only three companies only because of the time constraint and availability. In obtaining the answer to the first research question, we conducted a literature survey of the literature. It fetched the information on how the agile methods are different from the traditional methods.

The pros and cons of the agile methods have been identified. In answering the second research questions, case study has proven to be useful. Case study helped in identifying the agile methods that the companies have incorporated and reaped benefits by doing so. Questionnaires were developed and were forwarded to the companies. Based on the filled questionnaires, we had conducted interviews on phone, or through e-mail. The answer to the third research question was done through interviews. The main focus was to know the change that agile methods brought. The purpose was to know the perspective of the employees, the change in the work they experienced and to know the change from the customer’s point of view. The questionnaires and interviews were aimed at the project managers and developers. Face-to-face interviews were not possible as planned. Telephonic interview was done with only one company and we obtained answers through e-mail from the rest two companies.

5. Findings

Through the study we understood that the companies are adopting agile methodologies. Interviews showed there are certain problems. The benefits and problems of successful adoption of agile methodologies are shown below.
Agile methodologies like XP are capable of quickly adapting to the changing requirements of the customers. XP accommodates frequent changes in the software product and is tailored made for such purposes. XP facilitates frequent releases of the working software. A developer from Company 3 believes and experienced a positive outcome in obtaining regular feedback on the software being built. Another important aspect of XP we found is its role in testing. XP maintains a very high quality throughout the design and testing. As software is released in intervals, defects can almost be perceived as public and are easy to rectify.

"Table 2: Reasons Motivating Adoption of Agile"

<table>
<thead>
<tr>
<th>Reasons motivating to adopt agile methodology</th>
<th>Agile methodology key aspect</th>
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<tbody>
<tr>
<td>Ability to adapt quickly to Change</td>
<td>Agile methodologies acknowledge that customer requirements will change</td>
</tr>
<tr>
<td>Market pressures demand short time frames and releases</td>
<td>Agile methodologies such as XP are based on small iterations of 1 week or more between releases of working software</td>
</tr>
<tr>
<td>Ability to get instant feedback from customer</td>
<td>Short time frames between releases of working software allow developers to gather quick feedback from the customers and users</td>
</tr>
<tr>
<td>Organizational processes demand high quality bug free software</td>
<td>Continuous testing and integration regime of agile methodologies such as XP enforces the delivery of high quality bug free software</td>
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Company 2 implements XP in most of their projects. Identified benefits include better quality of the code, better communication among the team members and there is readiness with the team members to respond to changes innovatively. Company 3 implements Scrum in majority of their projects. Identified benefits include a good control over the development schedule mainly. The project manager of the company attributes this to their customer satisfaction. There are always timely releases. There were certain problems identified with company 1. Project manager feels that the existing organizational structure was not changed completely to suit the agile philosophy. There have been cases of concern over the issue of communication gap because there are employees with quality team and testing. Maintaining and following schedules was difficult. In the case of company 2 and 3, it is understood that project managers do not want to implement a new agile methodology because they feel it is risky. There is also a breach of experienced people to guide the team. But they are satisfied with the existing agile method are using in the software projects.

Some results of the interviews are shown in Table 2 and Table 3. They describe the reasons why project managers would and would not like to adopt agile methods.

We here highlight the differences between the agile methods. The agile methods are designed to serve particular purposes. These are mentioned here.

- DSDM provides a framework for RAD.
- Scrum is like a custom made methodology for project management of iterative development.
- XP aims at software development in frequent change environments. Teams are usually small.
ASD provides a framework for managing software projects that are under intense time pressure and where requirements are changing rapidly.

“Table 3: Reasons Restricting Adoption of Agile”

<table>
<thead>
<tr>
<th>Reasons that restrict the adoption of agile methodology</th>
<th>Organization characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional waterfall development mind set</td>
<td>Organizations steeped in waterfall development mind set are reluctant to adopt agile methodologies such as XP</td>
</tr>
<tr>
<td>XP requires a disciplined approach</td>
<td>XP enforces a disciplined approach to systems development may not sit well with agile organizations pushing for the next product development release</td>
</tr>
<tr>
<td>Unrealistic expectations concerning pace of development</td>
<td>Agile organizations may have unrealistic expectations with which agile methodologies such as XP can meet market demand</td>
</tr>
</tbody>
</table>

A. Environmental or organizations factors for agile methods

<table>
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<tr>
<th>Situations where agile methods are most effective</th>
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<tbody>
<tr>
<td>From the article [28]</td>
</tr>
<tr>
<td>1. Based on Scrum only</td>
</tr>
<tr>
<td>2. Not for large complex team structures</td>
</tr>
<tr>
<td>From the article [29]</td>
</tr>
<tr>
<td>Based on XP, Scrum, Agile Unified process, Agile Modeling Internet application domains Significant time-to-Markey pressure Cost of upgrade to the next release is minimal Not suitable for long-lasting, large, complex systems</td>
</tr>
<tr>
<td>From the article [30]</td>
</tr>
<tr>
<td>A management style of leadership and collaboration Project manager acts as facilitator or coordinator Teams capable of self-organizing Developers are competent, above-average people Small teams High change environments Where communication is formal Where the customers is prepared to accept a critical role in development Organizational structure is flexible, participative and encourages cooperative social action Object-oriented technology</td>
</tr>
</tbody>
</table>

Based on the questionnaires and data from the interviews, we understood there is a relational between environmental factors and the agile method that is put in use. It is seen that there is a tremendous importance given to feedback learning, and teamwork. Employees tend to have the feeling of empowerment. Face-to-face communication is given utmost importance; the organizations encourage informal communications, and social interactions.

In our case study, we found that when software development is done with several teams, there are problems with communication and coordination. Even face-face communication is not enough as there is overburden of requirements for planning. Certain projects had too many stakeholders that communication became difficult. This was prominent in the case of company 1. A literature review also suggests situations where agile methods are most efficient. It is described in the following table.

Most of the projects undertaken in Company 2 are small projects. We identified, in an interview, the pros and cons of the agile methods.
B. Extreme Programming (XP)

Pros

The basic process structure (life cycle) of XP looks like it could adapt also to very small projects also. However, when having only one developer, pair programming and continuous review practices have to be dropped out.

Cons

Pair programming is a very important practice in XP. However, it cannot be applied to one-developer-projects. Customer collaboration is not very strong. Testing and code development is done by the same person. All the possible problems may not be found because the developer tests from the same perception the product is built.

C. Scrum

Pros

Scrum fits well into small projects. Some work releases are created and requirements can be prioritized in a well-structured manner.

Cons

Customer is offsite and tight customer collaboration is not possible. Also improved team dynamics enabled by Scrum are not available in one-developer project.

D. Dynamic Systems Development Method

Pros

This is heavier than XP and Scrum. It provides a technique-independent process and is flexible in terms of requirement evolution. It is efficient in terms of budget and time.

Cons

It is based on user involvement which is not possible in every project

6. Validity Threats

We identified these threats as explained in [31], as internal validity, external validity and construct validity. Internal validity is the cause-effect relationship. Firstly we identified internal threat. Case study was possible with three companies only. Moreover, face-to-face interview and communication could not happen. We believe face-to-face communication would have given better scope in conducting the questionnaire. We lost a substantial amount of time in identifying and then contacting the companies and fixing up the appointments with the managers. The survey results are naturally bound to be affected by opinions, attitudes and current knowledge of the individual respondents, and provide a very narrow viewpoint of each individual organization as a whole. The different backgrounds, knowledge and experiences of the managers with regard to traditional and agile software development are also likely to affect their understanding and interpretations of the agile methods. Another threat we identified is external threat. This arises when the researcher draws inaccurate conclusion from the data obtained and apply it to some other setting, experiment etc. The case study of three companies and the data obtained might valuable information. But we believe it is not sufficient to make assumptions and recommend, generally speaking, that a particular project be done using an agile method. However, we feel
there is agile methods can be implemented for the first time with good understanding of success factors. The last validity threat we identified is construct validity. Construct validity refers to the ability of a researcher in measuring what he/she intends to measure. In the previous work, we assumed this could be a major threat as it is common that we get influenced by sociological factors. But our work has been carried through e-mails and telephone. We believe the major portion of the work could have affected by and was done with a very detached view. We could not observe the work culture and we understand observation could have proved to be beneficial.

The limitation of the study is we dwelt into the agile methods that the above companies have put into practice only; the other existing agile methods are not put as part of the results.

7. Conclusion

Agile approaches are meant to increase flexibility, agility and to be more adjusted to the environment where software development projects are present and working today. This is a contradiction to large global project organizations with no overview and multiple interdependencies that cannot be effectively monitored. However, nothing speaks against incorporating ideas and practices from agile methods in order to increase agility even in large projects though keeping in mind that the fundamental conditions are different and that that needs to be fully understood. The ideal approach would likely be to break large projects into smaller projects which would become more flexible. This idea is brought up both by the interviewees, respondents of the survey as well as recommended by the agile methodologists.

Agile approaches are meant to increase fastness and flexibility in the software projects. We have done a case study of three software companies in India. An interesting fact we noticed is that a company mostly developing small project is enjoying a good amount success in using agile methods. We have also observed that the companies are not really encouraging in terms of using a variety of agile methods. This is because of lack of sound proficiency in this field. We also observed not very substantial amount of work has been published so far. It is therefore important that empirical research and investigation should be carried in this field. We understood that agile methods are a highly practical oriented field. The application of different practices of XP and Scrum differ from company to company. So to say, sound judgment on agile methods can be done by doing rigorous case studies, using the historical record of the companies and their projects. The developers involved in the study mainly stressed the following four reasons for adopting agile methods: adaptability to change, short time frames of releases, continuous feedback from customers, high-quality and bug free software.

References


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