Improving Adherence to Agile Manifesto Principles in Agile Methodology – A Case Study

THESIS

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By

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Abstract

Within industry, there are major shifts towards Agile approaches and away from the traditional methods of Waterfall or Structured processes of software development. In this case study we increase an understanding of this shift by comparing different Agile development teams working on COBOL in a large IT organization of a large insurance enterprise. The research study compares two Agile development teams and studies their adherence to the principles in the Agile Manifesto. These Agile development teams were analyzed for the impact of certain widely accepted critical success factors like delivery strategy adopted by the team, project management, extend of client interaction, and team autonomy and diversity. This case study discusses the hypotheses we developed, the research methodology implemented, the analysis of data to support the hypotheses and results obtained from the analysis. The study was conducted using a survey-based methodology consisting of respondents who were members from the organization. The result from this case study allows us to quantify the adherence of Agile development teams to the principles in the Agile Manifesto. The developed hypotheses were supported using these results.
Dedication

This thesis is dedicated to my family and friends.
Acknowledgments

I would like to thank Dr. Jayashree Ramanathan for her constant support and guidance throughout the work in this thesis. I also thank Dr. Rajiv Ramnath and Dr. Benjamin Wierwille for their suggestions which helped shape up this thesis.

I would like to specially thank Dr. Thomas Bihari and Mr. Hari Narayanswami, whose insights about the problem provided a direction in this case study. I sincerely thank all the teams that contributed to the data collection and understanding the process.
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Field of Study

Major Field: Computer Science and Engineering
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Chapter 1: Introduction

Recently, there has been a major shift in the way the software development process is handled by software teams in large IT industries. There is an increasing inclination towards an Agile approach to the development process as opposed to the traditional method of Waterfall or Structured process. This change in the development process is being seen as a positive trend by both business people and development teams, since the Agile methodology for software development has proven to show an increase in customer satisfaction.

1.1 Structured or Waterfall Methodology

Structured or Waterfall methodology is a linear and sequential software development process. It is also known as the “top down” approach [12]. In Waterfall Model there are several phases during the software development life cycle. Figure 1 shows the linear and sequential order of these phases namely – Analysis, Design, Construction, Evaluation and Maintenance [11].

In this model, every phase begins only after the previous phase has been completed. The output of first phase will act as input to the second phase and this order of sequence continues.
Figure 1. Different Phases in Waterfall Model

1.2 Agile Methodology

Agile development is an incremental and iterative software development. Agile development approaches can be defined as a development process which focuses on the client’s ever changing needs and responding to those changes in an effective and efficient manner. Agile ranks the client or the customer as the most important asset and delivers the product from this perspective. Effective collaboration in the development teams and promptness to address customer's changes can be seen in Agile [9, 10].
1.3 Agile Manifesto

The core postulates of Agile were established in February 2001 in Utah by a group of seventeen people who represented Extreme Programming (XP), SCRUM, Dynamics Systems Development Method (DSDM), Adaptive Software Development (ASD), Crystal Methodologies, and Feature-Driven Development (FDD) respectively. This group was called the Agile Alliance and they established the Manifesto for Agile Software development [9]. According to this manifesto, there are four major principles based on which the Agile methodology is built [3].

1.3.1 Principles of Agile Manifesto

The following are the four principles of Agile Manifesto, which serve as the guidelines for teams adopting Agile methodology.

- **Principle 1 - Collaboration with the customer over the contractual negotiation.**

  This principle states that collaboration of the development team with the customers and regular communication between them is valued more than the contractual negotiation. In Agile, a contract restricts the interaction and does not add any further value since there is changes from the customer that need regular collaboration.

- **Principle 2 - Respond to change over the follow up of a plan.**

  This above principle shows that promptness of the development lines to accommodate changes and address the customer needs is valued more than following a pre-established plan. For a team to be more Agile, it has to incorporate changes than just follow a plan.
• **Principle 3 - Individual and interactions above the process and the tools.**

This principle discusses the importance of interaction between team members for a development line to be Agile. The team dynamics and involvement of every individual result in a better environment for software development than following pre-defined processes and tools. This gives an opportunity to explore the team's diversity and perform effectively.

• **Principle 4 - Software that works over an exhaustive documentation.**

This principle states that delivering working software regularly is more critical than an exhaustive documentation. The collaboration and interactions between customers and development teams add more value to the methodology. An exhaustive documentation might prove to be obsolete whereas communication between people through prototypes will add direct value to the software development process.

Agile methods emphasize increased collaboration, time-boxed development and better communication with the customers and within the team as well. Though Agile methods have been successful, there are still some shortcomings that have to be addressed. A constant change from the customer affects the project’s scope, quality, time and cost. In order to improve the Agile process, we need to identify the factors that are critical to the success of the projects. There are numerous factors that seem to affect the Agile methodology but only a few of them have been identified as critical [3]. There are literature studies that investigate the impact of the factors on a project and identify the critical success factors [2, 4, 5].
According to these studies, the critical success factors can be categorized as -

i. Delivery strategy of the team,

ii. Agile software engineering techniques,

iii. Team capability and Team environment,

iv. Project management, and

v. Customer involvement.

1.4 Iterations in Agile Methodology

Agile methodology uses several time-boxed iterative cycles for software development. These cycles are called iterations. The duration of an iteration and number of iterations for a project varies based on the size of the project, nature of the team and the Agile technique adopted. Usually, iterations zero, one and two are referred to as initial iterations. The major work done during initial iterations are preparing the product backlog and setting up the right environment for development.

![Figure 2. Iterations in Agile Methodology in comparison to the Structured model](image)

The rate of progress of an Agile team over an iteration is measured by ‘Velocity’. Velocity refers to the number of user story-points that is completed by a team during a
single sprint or iteration. Figure 2 shows iterations in comparison to the phases in the Structured model.

1.5 Objective of the study

Figure 3. Graph showing expected increase in velocity in initial iterations (green curve) against actual velocity (blue curve)

This case study compares different Agile development teams working on COBOL-based projects in a large IT company. Figure 3 shows a graph with two curves which depicts actual velocity and efficiency (blue curve) versus time and expected velocity and efficiency (green curve) versus time. We evaluate these Agile development teams in accordance with the principles in the Agile Manifesto and compare their
adherence to these principles. We study the agility of these teams on the basis of few critical success factors. The critical success factors considered for this research are the delivery strategy adopted by the team, the project management, the extent of client-team interaction, team diversity and the impact of requirements provided to development teams.

Based on the literature study, three hypotheses were developed. The first hypothesis is based on how well an Agile team satisfies the principles in the Agile Manifesto. The other hypotheses correspond to two success factors namely project management and team autonomy and diversity. Surveys and face-to-face interviews were used for data collection.

The data collected from two different surveys was analyzed using an evaluation framework and 7-point Likert scale. The evaluation framework determines the degree of agility of the development teams related to the principles from the Agile Manifesto. The result from this case study allows us to quantify the adherence of Agile development teams to the principles in the Agile Manifesto. The results obtained from the data analysis supports the developed hypotheses.

Figure 4 below shows the general construction of this thesis. The hypotheses developed in this thesis are based on literature study. The literature study concentrated on exploring methods for evaluation of an Agile practice quantitatively and identify the factors that contribute to successful delivery of the project. The data collection techniques used was surveys and face-to-face interviews. The data was analyzed using an evaluation framework that’s discussed in Chapter 4 of this thesis.

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Based on the results from analysis of data that has been discussed in Chapter 5, the developed hypotheses were supported or unsupported.

1.6 Contributions of the Study

The major contributions of the paper and case study are:

1. Illustrates an approach of using an evaluation framework to analyze and evaluate the Agile development teams in a company.

2. Identify and gain an in-depth understanding of degree of adherence to the principles in the Agile Manifesto by Agile development teams.
3. Provides a method to measure how Agile the development teams are towards certain critical success factors.

4. Shows potential to compare the performance of the different Agile development teams in future.
Chapter 2: Related Work

Analysis of recent trends in software development process shows an increasing acceptance of the Agile methodology over the Structured or Waterfall methodology. This inclination towards Agile methodology can be attributed to effective and efficient delivery of software on time and on budget. Studies have shown that Agile processes have done significantly well in capturing the client's changing needs and accommodating them in the development process [15]. Even within Agile, there are different types of practices namely Extreme Programming (XP), Scrum, Feature-Driven Development (FDD), Dynamic System Development (DSDM) and Adaptive Software Development (ASD). While each of these has its own advantages and disadvantages, the most widely accepted and practiced styles of Agile are Extreme Programming (XP) and Scrum.

There have been some studies showing the key aspects of XP and Scrum [16]. The comparison between XP and Scrum gives an insight into the factors that affect the Agile processes. There are several factors identified to have an influence on the effectiveness and efficiency of the Agile teams. These factors can be broadly classified into Organization, People, Process and Technology [3].

The critical factors that contribute to the success of Agile development are discussed in the following studies. These studies also present evaluation frameworks used for comparison between different types of Agile practices and different Agile projects. Lee and Xia [1] performed a quantitative and qualitative analysis of field data on the
agility of software development. They established two dimensions response efficiency, and response extensiveness, which affect the scope, cost and schedule of the project. They performed several surveys and verified the hypotheses with the data collected on different aspects of the Agile development like team autonomy, diversity, agility and performance. Their research finding discusses the theoretical and practical implications on these hypotheses on Agile development.

Another study on determining the critical factors that contribute to the success of a project was conducted by Chow and Cao [3]. They have considered a total of 36 factors categorized into 5 dimensions namely - Organizational, People, Process, Technical and Project. Each of these dimensions has several factors categorized under them. In the case of Organizational – executive support, commitment of the sponsor or client, organizational breakdown structure, collocation of the teams, and management environment were some of the factors considered.

The categorization People refers to factors involving the demographics of team members and their expertise in working in Agile environment and technology. It also includes team member’s motivation, self-organizing teamwork, customer relationship and management style.

The dimension Process includes factors pertaining to Agile oriented requirements analysis, project management and configuration management. This dimension also discusses the flow of communication between the team and clients along with their commitment to work schedule.
Regular delivery of software, following well-defined coding standards, sufficient amount of documentation, and performing rework are some of the factors that were classified as a dimension called Technical. This dimension even includes testing techniques followed by the team.

The Project dimension captures factors like nature of the project (critical or non-critical), team size for the project, up-front cost analysis and risk analysis. It also includes projects whose success is influenced by a dynamic and accelerated schedule.

Based on the above factors, Chow and Cao came up with 48 hypotheses. The data collection was through a web survey that spanned across the globe, covering different sectors. Based on the analysis of the data, it was concluded that only 10 hypotheses out of 48 were supported and were found to be critical for the success of a project. They defined successful delivery of a project by an Agile team based on cost, schedule, quality and scope.

Calo, Estevez et. al [4] developed a framework that evaluates the Agile methods in accordance with the Agile manifesto. This evaluation framework measures the team’s agility and their structured approach towards software development. Based on this measure, critical success factors were identified and Scrum and XP measures were compared. 4 DAT framework was proposed by Qumer and Henderson-Sellers [8], using which the project’s degree of agility can be determined. There are several factors that are considered at both the process level and the practical level to come up with the conclusion. Also, they have discussed about the six types of Agile methods and the evaluation of these using 4 DAT framework.
The value of Agile Manifesto principles perceived by several Agile teams was highlighted in a study by Williams, 2012 [13]. In this study, a survey was conducted in which many Agile-related user groups participated. The results showed that around 65% of respondents felt that they had to be in line with these principles to be more Agile. Also, 49% of the respondents said that Agile Manifesto principles guide teams that are new to the methodology.

Hence, the proposed research case study aims at comparing and evaluating similar Agile development teams using an evaluation framework. This study provides possible insights into the critical factors that can improve the performance of Agile teams in their initial iterations of development.
Chapter 3: Hypotheses Development

From the previous literature study, we understand that there are several factors that have been identified to affect the progress of an Agile project. The delivery strategy of the Agile project team, team's diversity, team's capability, team's autonomy, project management, client involvement and impact of requirements change or rework are the factors considered to build the hypotheses.

The success of Agile methodology is defined by the ability to finish the project on-time, on-budget and include all functionalities. Even though several factors affect the progress of Agile methodology, only a few of these factors are considered to impact the success of the project. These critical success factors are the fundamental basis on which the hypotheses are defined.

3.1 Hypothesis 1 - Team Agility

Agile methodology is based on the principles stated in Agile Manifesto. An increased adherence to these principles in day today working of an Agile team will make these teams satisfy Agile Manifesto principles better. Since each team has a different work culture, there are deviations from these principles. These deviations can be with respect to level of interactions between the individuals in a team, delivering working software on a continuous basis or involvement of the customer. Understanding how Agile
each team is towards these principles will help us to identify possible improvements. Therefore, each team’s degree of agility towards these principles is considered.

The degree of agility of the project team is defined as how closely the teams follow the principles in the Agile manifesto.

*Increased degree of agility of the development team will imply a greater adherence to the principles in the Agile Manifesto.*

### 3.2 Hypothesis 2 - Project Management

Project management is considered as one of the critical factors that defines the success of the project [17, 18]. There is a greater influence of project management on successful delivery of the project and efficient performance of the team.

*Increased agility in Project Management of the development team will imply that the team is more Agile.*

### 3.3 Hypothesis 3 - Team's diversity and autonomy

The Agile Manifesto values the project team and its interaction over processes and tools. This shows the impact of team diversity, composition, and interaction in effective performance of an Agile development line. There are also literature studies showing the level of involvement of a team in determining the success in Agile methodology [1, 3]. Based on this principle from Agile Manifesto, the following hypothesis is developed.
Team autonomy refers to “the degree of independence and discretion granted to the team in scheduling work, determining the procedures and methods used” [1]. Team diversity refers to “the heterogeneity in the team in terms of technical skill, knowledge, functional background and tenure” [1].

In increased agility in team autonomy and team diversity of the development team will imply that the team is more Agile.
Chapter 4: Research Methods

This case study investigates the impact of several factors on the Agile project and studies its effects on the performance of these teams. For the purpose of supporting the hypotheses developed, the case study was conducted in a large enterprise. The sector of the company is Insurance and it has yearly revenue of 20 billion US dollars. The whole company has around 36,000 employees and the company has an IT department of over 5,000 employees. The IT department in this insurance company uses both Waterfall/Structured approach (Enterprise Solution Delivery Methodology - ESDm) and Agile methodology for software development.

The criteria for selection of the Agile development lines for this case study include the following:

i. works in the same business segments,

ii. works on the similar product, and

iii. Uses similar technology for the application development.

The selected Agile development lines are slightly variable in their size, organizational structure and team culture. In order to make proper assessment of these Agile development lines and fair comparison between them, the above criteria was chosen. The selected teams have been adopting Agile methodology at least for the past 3 years. These teams have been adopting XP, Scrum and Lean principles over a period of
time for continuous improvement. The following section deals about the characteristics of the selected teams in detail.

4.1 Data Collection

The data to support of the hypotheses are collected from the teams following Agile methodology for software development. Team A and Team B are part of the IT department of the Insurance company which concentrates on application development. Both Team A and Team B were formed around 3 years back as a part of the application development center. Both these teams work on the same business sector - Auto Insurance and on the same technology for software development - COBOL. The organizational structures of both the teams are similar as well. Each iteration for development spans 2 weeks for both Team A and B. These similarities between the two teams help for a proper evaluation of the Agile practices being followed.

Figure 5 shows the team composition of Team A. The size of Team A is 20 members which comprises of 8 developers, 8 testers and 4 team leads. In this organizational structure the team leads are the Iteration Manager, Requirements Lead, Lead Developer and Lead Tester. The previous experience for the team leads in Team A in Agile methodology is 24 months on average. There are at least 3 members of the team who have an experience of less than 6 months and 8 members between 6 and 12 months working in an Agile environment. The average experience for the leads working in this business area is 24 months and the technology used for current development is 24 months
respectively. Table 1 shows a comparison of experience level of leads between Team A and Team B.

Figure 5. Team A Composition

Team B has a size of 16 members divided into 6 developers, 6 testers and 4 leads as shown in Figure 6. The organizational structure of Team B is similar to that of Team A. The average experience for the Leads in Team A working in an Agile environment is 36 months (approx.). The remaining team has an experience of 12 - 18 months working in Agile. While the leads have 5 years of experience in the technology that the team is currently working on. Business area experience for the leads is around 36 months. On a
high level comparison between the 2 teams, Team B has more experienced leads working in the Agile environment.

![Figure 6. Team B Composition](image)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Team A</th>
<th>Team B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of team</td>
<td>20 (8 developers, 8 testers, 4 leads)</td>
<td>16 (6 developers, 6 testers, 4 leads)</td>
</tr>
<tr>
<td>Experience in Agile for Leads</td>
<td>24 months</td>
<td>36 months</td>
</tr>
<tr>
<td>Experience in Business Area for Leads</td>
<td>24 months</td>
<td>36 months</td>
</tr>
<tr>
<td>Experience in Technology used for Leads</td>
<td>24 months</td>
<td>5 years</td>
</tr>
<tr>
<td>Average number of Reworks per Release</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 1. Team Characteristics
4.2 Data Collection Tools

The data collection methods were questionnaires/surveys and face-to-face interviews. There were two surveys used to collect data. These surveys were administered at different times. The participants in these surveys were the team members from Team A and Team B respectively. The face-to-face interviews were done once the surveys were completed by the participants.

Figure 4 in Chapter 1 explains the approach that has been used for data analysis through these surveys. The objective of these data collection tools was to understand the team’s standpoint towards the principles in the Agile Manifesto. The data collected in these surveys were analyzed using a framework (discussed below) and comparisons were made between the two Agile teams that are being studied.

4.2.1 Survey I

One survey was used to collect data related to the performance of the teams in accordance to the Agile manifesto. This survey is divided into 4 sections each corresponding to one principle of Agile Manifesto. Each principle of Agile Manifesto is considered from Agile perspective and Waterfall or Structured perspective. For example, ‘Collaboration with Customer over contractual negotiation’ is one the principles in the Agile Manifesto. The Agile perspective for this example will be - Value the Customer collaboration and Waterfall or Structured perspective will be – Value the contractual negotiation. From Agile perspective there are different options for the same principle with varied level of agility and similarly for the Structured perspective there are different
options with varied level of structure. A detailed discussion is presented under Section 4.3.1. Each option in these sections is associated with a certain measure which will be used in an evaluation framework. The details about the evaluation framework used to analyze the data from this survey are discussed in the following chapter.

4.2.2 Survey II

The other survey was used to collect information about the degree of agility associated with a few critical success factors. The critical success factors considered in this survey were i) delivery strategy adopted by the teams; ii) team diversity and autonomy with respect to the scheduling, use of tools and decision making; iii) project management and iv) incomplete requirements/ requirements defects. Each of these factors was a separate section in the survey. There were a set of 1 to 4 questions corresponding to each section of this survey. The survey uses a 7-point Likert Scale to evaluate the responses from the team members. A score of 1 means that a factor is highly structured and a score of 7 means it is highly Agile.

4.2.3 Face-to-face Interviews

The face-to-face interviews were conducted with the Requirements Lead or the Iteration Manager of the team. These interviews lasted for half an hour. The major points of discussion in the interview were the experience of the team members in Agile environment, the experience in the business area and the technology. The interview also had questions relating to the release of the current project and details of present iteration.
There were questions related to the requirements delivered to the development team and impact of these requirements on the team’s iteration velocity. There were discussions regarding change requests or reworks that were raised throughout the development of the project from clients and their strategy to accommodate these changes. For example one of questions related to requirements was - “How clear are the requirements given to the team?” The general motivation behind this interview was to understand the team structure in detail and the team’s standpoint in adapting to changes.

4.3 Data Analysis Method

4.3.1 Evaluation Framework - Survey I

We analyze the data collected through the above mentioned tools through an evaluation framework that has been adopted from the literature study done by Calo, et.al [2]. This evaluation framework adheres to the Agile Manifesto and measures the Agile practices of the development lines considered for comparison in this study. Table 2 below shows an example of the framework for one of the Agile manifesto principles. In this evaluation framework, the four principles of the Agile Manifesto are divided into 4 sections. Each of these sections is assessed from an Agile perspective as well as a Structured or Waterfall perspective. Each of the principles that are divided into two sections has several options. These options correspond to varied level of agility and are assigned a score from 0 to +5. While the options that have a Structured perspective for a particular principle have a score between -5 to 0.
<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Customer collaborates at team request.</td>
<td>-5</td>
<td>There exists a detailed contract and no changes are accepted.</td>
</tr>
<tr>
<td>3</td>
<td>Customer is part of team, answers questions and plans iterations.</td>
<td>-2</td>
<td>The contract demands considering changes during the project.</td>
</tr>
<tr>
<td>5</td>
<td>Customer is a team member, answers questions, plans iterations and writes requirements and tests.</td>
<td>0</td>
<td>The contract does not add any value for the construction of the project products.</td>
</tr>
</tbody>
</table>

Table 2. Evaluation Framework for one Principle of Agile Manifesto

In the above table, Value the Collaboration with customer is the Agile perspective of the principle with several options. The option with a score of 5 is highly Agile and agility decreases as score against these options reduce. On the other hand, Value the contractual negotiation is the Structured perspective of the principle. The option with a score of -5 means it is highly structured. Similar evaluations of remaining three principles of Agile Manifesto are discussed in Appendix A.
The sum of these scores put together for each principle of Agile Manifesto is calculated. The final measure for each principle is attributed with points on a scale of -5 to +5. The sums of the measures of all the sections are calculated as:

\[ m(P_i) = m(P_{i.1}) + m(P_{i.2}) \]

In the above equation, \( m(P_{i.1}) \) refers to the score associated with Agile perspective for principle \( P_i \) and \( m(P_{i.2}) \) refers to the Structured perspective value of principle \( P_i \). As per the evaluation framework, range of values the final measure can have is between -5 to +5. The higher value of final measure shows a greater adherence to the Agile Manifesto. For example, a final measure of 4 or 5 for a certain principle suggests that the methodology completely satisfies the Agile Manifesto for that principle. If the result of the final measure is negative or 0 means that the Agile practice evaluated using this framework satisfies partially or does not satisfy the principles in the Agile Manifesto. This type of assessment in the framework helps us to understand and evaluate the practices followed by the development lines at a deeper level.

4.3.2 Likert Scale – Survey II

The Team Performance survey is evaluated using a 7-point Likert scale. A 7-point Likert scale was chosen as opposed to a 5-point Likert scale to provide the respondents with a greater set of options. A 7-point Likert scale helps in capturing feedback with more granularity and better decision making [14]. This survey contains questions that consider the critical success factors for the Agile methodology. There are 5 sections in this survey each corresponds to a critical success factor chosen. Each section contains
questions ranging between 1 and 4. The weight age for all the sections and questions in this survey are the same. A participant can choose a response for a question from a range 1 to 7. On the Likert scale, a score of 7 for any question shows that the factor is highly Agile and a score of 1 means it is highly structured. Based on the response from the team members for each question in the survey, the scores are averaged out for each section. This provides us with a single value for each section in the survey. A weighted average is calculated across the team to compare the responses from the 2 teams. This will provide information about the degree of agility of each team and their agility associated to these critical success factors. On comparing this result obtained from the analysis, our developed hypotheses will be supported or not supported.
Chapter 5: Discussion of Results

We discuss the analysis of the results of the evaluation framework survey and the team performance survey in the following section.

5.1 Survey Results from Evaluation Framework

The results from the survey are analyzed using the evaluation framework discussed earlier. These results would give insights into how Agile each of the team considered for comparison are according to the Agile Manifesto principles. The results below are discussed for each team, for each role in the team namely Developers, Testers and Iteration Managers and for all these roles specific to each team. This analysis of the results will provide an understanding of the agility of a team on the whole and each role in particular.
Table 3 shows the agility value (-5 to +5) according to the evaluation framework used for each of the teams in comparison.

<table>
<thead>
<tr>
<th>Agile Manifesto</th>
<th>Scrum</th>
<th>XP</th>
<th>Team A</th>
<th>Team B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual and interactions over the process and tools.</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Working software over comprehensive documentation.</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Customer collaboration over the contractual negotiation.</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Responding to change over the monitoring of a plan.</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 3. Measure of Team A and Team B in comparison to Scrum and XP using evaluation framework

These values reflect the team’s practice of Agile principles according to the Agile Manifesto. While both the team value the individuals and interactions over the process and tools to the same extent. On delivering working software and dependence on the exhaustive documentation, Team A is less Agile compared to Team B. From the analysis, we find that the value shows that Team B has an effective collaboration with the customers than Team A. Finally, both the Teams A and B respond to changes over monitoring a plan to the same extent of agility.
<table>
<thead>
<tr>
<th>Agile Manifesto</th>
<th>Iteration Manager</th>
<th>Testers</th>
<th>Developers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual and interactions over the process and tools.</td>
<td>4</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Working software over comprehensive documentation.</td>
<td>5</td>
<td>-1</td>
<td>2</td>
</tr>
<tr>
<td>Customer collaboration over the contractual negotiation.</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Responding to change over the monitoring of a plan.</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 4. Team A - Role based measure using evaluation framework

<table>
<thead>
<tr>
<th>Agile Manifesto</th>
<th>Iteration Manager</th>
<th>Testers</th>
<th>Developers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual and interactions over the process and tools.</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Working software over comprehensive documentation.</td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Customer collaboration over the contractual negotiation.</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Responding to change over the monitoring of a plan.</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 5. Team B - Role based using evaluation framework

The analysis of the results from the evaluation framework according to each role in the team will provide an understanding and assess the ability of each role to satisfy the principles of Agile Manifesto. Table 4 and Table 5 show the measure after evaluation of
these principles by Iteration Managers, Developers and Testers of Team A and Team B respectively. In both the teams, we see that Iteration Managers satisfy the principles of Agile Manifesto according to the values recorded in the survey. Developers and Testers from both Team A and Team B do not satisfy these principles completely. In fact, the values recorded by the Testers in Team A suggest that there is more importance for documentation than working software from their perspective. Whereas the results indicate that the developers from Team B reflect the same. The positive impact of customer collaboration over contract negotiation is not significant for both the developers and testers from Team A and Team B. Finally, testers and developers from both the teams respond to changes in more Agile manner.

5.2 Survey Results from Team Performance Analysis

The results from this survey are used to support the hypotheses that were developed. The survey has 5 sections - delivery strategy of the team, team’s autonomy and diversity, project management, client involvement and impact of requirements delivered to the team. The survey uses a 7-point Likert Scale for evaluation. A 7 on the survey shows that the corresponding factor is extremely Agile and 1 on the scale shows it is extremely structured. A value of 4 on the survey indicates that the factor is neither Agile nor structured. Any value more than 4 means the team is inclined towards Agile methodology and gives more emphasis on following them.
<table>
<thead>
<tr>
<th>Factors</th>
<th>Team A</th>
<th>Team B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery Strategy</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Team’s Autonomy &amp; Diversity</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Project Management</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Client Involvement</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Impact of Requirements gap</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 6. Measure for Team A and Team B using Likert Scale

From the analysis of the results shown in Table 6, we find that both the teams follow Agile methodology strongly. The values from the survey indicate that both Team A and Team B have shown a high degree of dependency on these factors for the successful software delivery by the team.

On analyzing the responses for each role in the team, we identify that the teams are more Agile than structured towards these factors mentioned above. Figure 7 shows the response of the Iteration Managers and we can see that delivery strategy in their view is highly Agile with a score 6 on 7-point Likert scale and impact of requirements with a score 4 making it neither Agile nor structured.
Figure 7. Iteration Managers measure from Likert Scale from Team A and Team B
Responses from developers in Figure 8 indicate delivery strategy, team’s autonomy and diversity and project management are highly Agile with a score of 6. Similar to Iteration managers, developers have recorded same value for impact of requirements making it neither Agile nor structured.
Figure 9. Testers measure from Likert Scale from Team A and Team B

Figure 9 shows that testers from both teams have recorded a value of more than 4 for all the factors considered in this survey.
Table 7 shows the number of respondents who answered specific score on 7-point Likert scale for each of the questions in this survey. This table clearly explains that for most of the respondents have recorded value a value of more than 5 for many questions. Only 4 questions in the survey have a participant record value less than 4. A maximum of 5 participants have given a score of 4 for requirements impact section and a maximum of 5 participants have recorded a score of 7 for delivery strategy and freedom in scheduling work. Appendix B contains the detailed survey and response by the participants.
Chapter 6: Conclusion

This research case study explores the data to compare Agile development lines in an IT company. The data collected using surveys and interviews from 2 Agile teams varying in size and experience level for the leads provided information for statistical analysis.

On analyzing the data collected and comparing the values to the agility values for Scrum and XP from the framework evaluation presented in the study previously [2], we find that both the teams are Scrum oriented in following the individuals and interactions over the process and tools. Team A is more Scrum oriented and Team B is more XP oriented on adhering to the Agile Manifesto principle which values working software over an exhaustive documentation. For the principle ‘Customer collaboration over contract negotiation’, values of both the teams suggest that they do not completely satisfy this principle in Agile Manifesto. Team A and Team B have an agility value more than Scrum and less than XP for responding to change over monitoring a plan. The evaluation results support the first hypothesis which is based on degree of agility of the team.

The data analyzed in the team performance survey using 7-point Likert Scale, supports the research hypotheses that were based on critical success factors. The data collected supports the claim that increased agility in project management and team autonomy and diversity will make the development teams more Agile.
The analyzes of data from both the surveys with respect to each team and particular roles give insights into the actual performance of the team in real life software development. We can conclude that the focus on the factors covered in these hypotheses will demonstrate an increased adherence towards the principles in the Agile Manifesto by Agile development teams. This case study showed potential to measure the extend to which an Agile development team satisfies the principles in the Agile Manifesto and the factors that can make these teams be more Agile.
Chapter 6: Future Work

This case study provides possible avenues for further research in evaluating the Agile teams in an IT industry. In future work, a more robust evaluation framework and qualitative and quantitative success criteria are needed for comparing different Agile practices.

One aspect is to study the impact of requirements delivered to Agile teams. The quality of the requirements and the ability of the development team to build and test based these requirements should be studied.

This case study will act as a platform to comparative studies about Agile teams that work on different technologies, varied business sectors and different organizational structure in future.
References


Appendix A: Survey I

This survey was designed and conducted to evaluate the Agile development line’s team agility. An evaluation framework was employed to analyze the results from this survey. This survey is based on the principles in Agile Manifesto. There four sections with each section having two sub-sections to it.

Team and Personal Information

Team and Personal information was gathered to gauge the team composition, project details and individual’s experience level.

1. What is your team name?
2. What is your team size?
3. What is your current project?
4. What is the duration of your current project (in months)?
5. What is your primary role in the team?
6. What is your experience working in Agile methodology (in months)?
7. What is your experience in present technology the team is working on (in months)?
Questions related to Agile practice

Section 1: Individuals and the team interactions over the processes and the tools

To what extend does your team define the role of the individuals and team interactions?

- Does not define roles for individuals.
- Clear definition of roles for individuals.
- Clear definition of roles and responsibilities.
- Clear definition of roles, responsibilities and technical knowledge.
- Clear definition of roles, responsibilities, technical knowledge and interactions between members of the work team.

To what extend does your team define and follow the processes and the tools?

- Defines activities, deliverable, development and management tools.
- Defines activities, deliverable and development tools.
- Defines activities and deliverable.
- Defines activities for each iteration.
- Defines project activities but not at the iteration level.

Section 2: Working Software over comprehensive documentation.

How does your team develop a working software?

- Generate a deliverable at the end of the project.
- Generate a deliverable with satisfactory testing at the end each iteration.
- Generate a deliverable with satisfactory testing and integrated with the rest of the functions at the end each iteration.
How much does your team depend on a detailed documentation?

- Requires detailed documentation at the beginning of the project.
- Requires only the necessary documentation at the beginning of each iteration.
- Does not require documentation to start implementing the functionality defined for an iteration.

Section 3 - Customer collaboration over contract negotiation.

What is the extend of your team's collaboration with the customer?

- The customer collaborates at the team's request.
- The customer is a part of the team. He answers to questions and plans the iterations.
- The customer is a part of the team, answers questions, plans the iterations and collaborates in writing requirements and tests.

What is the degree of changes that can be allowed in accordance to the contractual negotiation?

- There exists a detailed contract at the beginning of the project and no changes are accepted later on.
- The contract demands considering changes during the project.
- The contract recommends changes strongly whenever they are raised during the project.
- The contract does not add any value for the construction of the project products.
Section 4: Responding to change over following a plan.

How does your team respond to changes?

- No changes are allowed during the project execution.
- Only high priority changes can be introduced during the project execution.
- Evolution and change is recommended to be considered during iterations.
- Changes can be introduced during project iterations.

How does your team devise and follow a plan?

- Defines a detailed plan at the beginning of the project.
- Defines a detailed plan of iterations and it does not accept changes during an iteration.
- Defines a detailed plan of each iteration and changes are made during the iteration.
- Defines no planning whatsoever.
Evaluation Framework used for Survey Analysis

The following quantitative framework for evaluation has been adopted from the study done by Calo, Estevez and Fillottrani [2]. The original framework was used to study the agility of two Agile practices namely Scrum and Extreme Programming (XP). We have employed this framework to study two Agile development lines in the Application Development Center of an IT company.

The framework has 4 sections and each section with 2 sub divisions. These sub divisions have several options with a measure associated with it.
**Principle 1: Collaboration with the customer over the contractual negotiation**

<table>
<thead>
<tr>
<th>P1.1</th>
<th>Value the Collaboration with Customer</th>
<th>P1.2</th>
<th>Value the contractual Negotiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Description</td>
<td>Value</td>
<td>Description</td>
</tr>
<tr>
<td>0</td>
<td>Customer collaborates at team request.</td>
<td>-5</td>
<td>There exists a detailed contract and no changes are accepted.</td>
</tr>
<tr>
<td>3</td>
<td>Customer is part of team, answers questions and plans iterations.</td>
<td>-2</td>
<td>The contract demands considering changes during the project.</td>
</tr>
<tr>
<td>5</td>
<td>Customer is a team member, answers questions, plans iterations and writes requirements and tests.</td>
<td>0</td>
<td>The contract does not add any value for the construction of the project products.</td>
</tr>
</tbody>
</table>

Table 8. Framework measure for Principle 1
Principle 2: Respond to change over the follow up plan

<table>
<thead>
<tr>
<th>P1.1</th>
<th>Value response to change</th>
<th>P1.2</th>
<th>Value following the plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Description</td>
<td>Value</td>
<td>Description</td>
</tr>
<tr>
<td>0</td>
<td>No changes are allowed during the project execution.</td>
<td>-5</td>
<td>Defines a detailed plan at the beginning of the project.</td>
</tr>
<tr>
<td>1</td>
<td>Only high priority changes can be included during the project execution.</td>
<td>-3</td>
<td>Defines a detailed plan of iterations and it does not accept changes during an iteration.</td>
</tr>
<tr>
<td>4</td>
<td>Evolution and change to be considered during iterations.</td>
<td>-2</td>
<td>Defines a detailed plan for each iteration and changes are made during the iteration.</td>
</tr>
<tr>
<td>5</td>
<td>Changes can be introduced during the project iterations.</td>
<td>0</td>
<td>Defines no planning whatsoever.</td>
</tr>
</tbody>
</table>

Table 9. Framework measure for Principle 2
### Principle 3: Individual and team interactions over the process and tools

<table>
<thead>
<tr>
<th>P1.1</th>
<th>Value individuals and team interactions</th>
<th>P1.2</th>
<th>Value process and tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Description</td>
<td>Value</td>
<td>Description</td>
</tr>
<tr>
<td>0</td>
<td>Does not define roles for individuals.</td>
<td>-5</td>
<td>Defines activities, deliverable, development and management tools.</td>
</tr>
<tr>
<td>1</td>
<td>Clear definition of roles for individuals.</td>
<td>-3</td>
<td>Defines activities, deliverable and development tools.</td>
</tr>
<tr>
<td>2</td>
<td>Clear definition of roles and responsibilities.</td>
<td>-2</td>
<td>Defines activities and deliverable.</td>
</tr>
<tr>
<td>3</td>
<td>Clear definition of roles, responsibilities and technical knowledge.</td>
<td>-1</td>
<td>Defines activities for each iteration.</td>
</tr>
<tr>
<td>5</td>
<td>Clear definition of roles, responsibilities, technical knowledge and interactions between members of the work team.</td>
<td>0</td>
<td>Defines project activities but not at the iteration level.</td>
</tr>
</tbody>
</table>

Table 10. Framework measure for Principle 3
**Principle 4: Software that works over an exhaustive documentation**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Generate a deliverable at the end of the project.</td>
<td>-5</td>
<td>Requires detailed documentation at the beginning of the project.</td>
</tr>
<tr>
<td>3</td>
<td>Generate a deliverable with satisfactory testing at the end each iteration.</td>
<td>-2</td>
<td>Requires only the necessary documentation at the beginning of each iteration.</td>
</tr>
<tr>
<td>5</td>
<td>Generate a deliverable with satisfactory testing and integrated with the rest of the functions at the end each iteration.</td>
<td>0</td>
<td>Does not require documentation to start implementing the functionality defined for an iteration.</td>
</tr>
</tbody>
</table>

Table 11. Framework measure for Principle 4
Appendix B: Survey II

This survey was designed to capture the views of the Agile development lines on a few critical success factors for successful delivery of the project. This survey contains five sections with each section ranging from 1 -4 questions. A 7 point Likert Scale was used to collect the responses from the participants.

Team and Personal Information

Team and Personal information was gathered to gauge the team composition, project details and individual’s experience level.

1. What is your team name?
2. What is your team size?
3. What is your current project?
4. What is the duration of your current project (in months)?
5. What is your primary role in the team?
6. What is your experience working in Agile methodology (in months)?
7. What is your experience in present technology the team is working on (in months)?
Survey Questions

Section 1: Delivery Strategy of the Team

Structure and regularity of the delivery of software by the team.

1 – Highly Irregular
2 – Irregular
3 – Somewhat Irregular
4 – Neither Regular nor Irregular
5 – Somewhat Regular
6 – Regular
7 – Highly Regular

Figure 10. Number of respondents vs Likert Scale for Section 1
Section 2: Team's Autonomy and Diversity

2.1 Team member's competency and knowledge on the technology used in the project.

1 – Lowest
2 – Bad
3 – Average
4 – Moderate
5 – Good
6 – Very Good
7 – Highest

Figure 11. Number of respondents vs Likert Scale for Section 2.1
2.2 Team member's ability to learn and adapt to new technology.

1 – Lowest
2 – Bad
3 – Average
4 – Moderate
5 – Good
6 – Very Good
7 – Highest

Figure 12. Number of respondents vs Likert Scale for Section 2.2
2.3 Team member's diversity in terms of tenure and technical abilities related to the project involved.

1 – Lowest

2 – Bad

3 – Average

4 – Moderate

5 – Good

6 – Very Good

7 – Highest

Figure 13. Number of respondents vs Likert Scale for Section 2.3
2.4 Degree of freedom to the team in terms of scheduling work, determining the procedures and methods, using resources, etc.

1 – Lowest
2 – Bad
3 – Average
4 – Moderate
5 – Good
6 – Very Good
7 – Highest

Figure 14. Number of respondents vs Likert Scale for Section 2.4
Section 3: Project Management

3.1 The degree of agility in the project management in your team.

1 – Highly Waterfall
2 – Waterfall
3 – Somewhat Waterfall
4 – Neither Agile nor Waterfall
5 – Somewhat Agile
6 – Agile
7 – Highly Agile

Figure 15. Number of respondents vs Likert Scale for Section 3.1
3.2 Efficiency and effectiveness of communication between the team members.

1 – Lowest
2 – Bad
3 – Average
4 – Moderate
5 – Good
6 – Very Good
7 – Highest

Figure 16. Number of respondents vs Likert Scale for Section 3.2
Section 4: Client Involvement

4.1 Clarity in the expectations from the customer.

1 – Highly unclear

2 – Unclear

3 – Somewhat Unclear

4 – Neither Clear nor Unclear

5 – Somewhat Clear

6 – Clear

7 – Highly Clear

Figure 17. Number of respondents vs Likert Scale for Section 4.1
4.2 Communication of customer needs to the team.

1 – Very Bad Communication
2 – Unsure with Communication
3 – Average Communication
4 – Moderate
5 – Somewhat Communicated
6 – Well Communicated
7 – Very Well Communicated

Figure 18. Number of respondents vs Likert Scale for Section 4.2
Section 5: Impact of Requirements

Impact of requirements gap on the velocity in the initial iterations.

1 – Lowest
2 – Bad
3 – Average
4 – Moderate
5 – Good
6 – Very Good
7 – Highest

Figure 19. Number of respondents vs Likert Scale for Section 5
Appendix C: Face to face Interview

The face to face interviews were conducted with the Iteration Managers or the Requirements Lead. The main purpose of these interviews were to gauge the team dynamics, experience of the individuals in Agile methodology, technology used for development in the present project and number change requests during the duration of the project. The following questions were asked during the interview –

1. What is the total number of members in your team?
2. What is the total number of developers, testers and leads in your team?
3. What is the average experience of the Leads in Agile methodology?
4. What is the average experience of the Leads in present Business area?
5. What is the average experience of the Leads in present technology used for development by your team?
6. How many team members have an experience of less than 12 months in Agile methodology?
7. How many team members have an experience of less than 12 months in Business area?
8. How many team members have an experience of less than 12 months in present technology the team is working on?
9. What is the programming language used for development by your team?
10. What is the duration of each iteration (in days)?

11. What is your average velocity over the project?

12. In which iteration did your team deliver highest velocity?

13. What is the average number of change requests your team receives for a project?

14. How effective are the requirements that are delivered to the team?