

Adaptive Framework to Manage Multiple Teams Using Agile Methodologies

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Abstract—The increased demand of agile methods results in challenging and unique problems, one of which is the unsuitability of agile methods for software development companies, particularly those with multiple teams. Secondly, agile methods are silent regarding how to achieve long-term organizational goals within the umbrella of agile software engineering. Considering these software industry problems, a new contemporary learning-based adaptive framework is proposed in the domain of agile methods. The proposed framework will help software companies to achieve long-term organizational goals. It is anticipated that the proposed framework will increase employee satisfaction by improving their technical skills and interpersonal communication capabilities using contemporary learning and knowledge-sharing activities. A survey is conducted from multinational software companies to validate the proposed adaptive framework, and the results are notably supportive and encouraging.

Index Terms—Agile methodologies, strategic learning, knowledge sharing, leadership, long-term goals.

I. INTRODUCTION

The unique nature of agile methodologies provides with the opportunity to homogenize this economically stretched and competitive rich environment to help an organization become the market leader and retain its status in the long run. Agile methodologies provide leadership opportunities because they are notably different from the traditional software developmental methodologies. Ralston [1] and Pressman [2] consider the values of agile methodologies as:

- people and their communications over the practices and tools;
- functional software instead of extensive documentation;
- customer's cooperation vs. agreement negotiation;
- timely response in comparison to a strict and discipline plan.

This work is an empirical study to minimize the aforementioned integration issues of scaling agile in medium to large organizations in a long-term basis. Medium and large organizations are notably different from smaller ones in structure and culture. Because of the multi-team environment, learning and communication are significantly necessary within a team and with other teams. These activities foster the knowledge sharing and lead to technical skill enhancement, motivation, and satisfaction of team members by reducing the burn-out rates. This study focuses on two main issues:

- Is knowledge gained from this exercise worth the effort and cost?
- Will extra effort and budget requirement for this exercise be useful or wasted?

To address these two issues, the top management will discuss with each team in an agile method to design a thoughtful plan. This plan will become the strategic vision of an organization with emerging technologies and trends in the market.

The paper is organized as follows. Section 2 outlines the related work. Section 3 describes the problem statement. Section 4 depicts the details of the proposed solution. Section 5 validates the proposed solution.

II. RELATED WORK

Agile methodologies complete projects using small releases to produce non-reusable components and these methodologies also focus on small teams because of the characteristics of face-to-face informal communication and cooperation. When a team is large, face-to-face communication becomes notably difficult, and more documentation is required, which is a deviation from the agile spirit. Meanwhile, agile methodologies characterize teams to be self-organizing according to the changing environment, which is mainly feasible for small teams and it does not work for larger teams, where more time is required to self-organize according to a change. The support for large and complex software projects is also limited in agile development assuming that refactoring will purify the code. According to Turk et al. [3], the

agile spirit holds true for small projects but becomes notably difficult in large and complex projects. These limitations of agile methodologies are also reported by Sanjay [4] in a white paper: agile methodologies cannot handle large projects because of the difficulty in tracking the system development life cycle (SDLC) phases of the project. More specifically, it is mentioned by Sanjay [3] that agile methodologies are only suitable for small and medium projects. According to Turk et al. [4], it is a prerequisite that people involved in agile projects must be highly skilled, open-minded and able to accept changes because it is difficult to find people with such traits.

Kajko-Mattsson [5] surveys eighteen (18) agile organizations to discover what types of problems are raised after implementing the agile methodologies. The survey results indicate that lack of documentation is the main problem during the maintenance and reuse of projects. Developers have little knowledge about the entire projects, which causes confusion and problems. The project team's burn-out can result into sudden loss of valuable knowledge, which is difficult to fill without compromising cost, time and quality. Training of the new team members is another problem because of lack of documentation, and training the newcomers using a code is notably tedious.

Ralston [1] describes a list of ten values to be a project manager of an agile team: proactively demanding integrity of all stakeholders, building long-term relations, delivering according to the requirements, effortlessly encouraging learning, being able to define, delegate and exercise role and authority, recognizing that people are the ultimate value, encouraging talented people, fair play with customer, delivering in time result-oriented working products and building an excellent team. However, this list of ten values is not comprehensive, and a customized list per team and organization structure must be outlined.

According to Baker and Thomas [6], agile principles are unique because they are applicable to the product- and service-oriented companies for operational work and management. Consistently implying the agile methodology will help to establish a pool of multi-skilled managers, who can work at different positions in different departments. The idea is a concept to use survival for the fittest, which is also called the meme idea. Memes are used to introduce and effectively sustain a culture of leadership such as customer satisfaction through short-cycle releases, the incremental improvement to improve the quality instead of delivering software as a complete package after the deadline, and communication problems are solved by introducing daily meetings.

Faegri [7] describes that agile methodologies can be used to improve the general knowledge of the team members by embedding a job rotation cycle. Structured and bureaucratic organizations are more focused on the people, which results in specialists, who are often called gurus. According to Chung and Drummond [8], the success story of agile methodologies at the Yahoo organization shows that agile values are long term in nature. A useful report of the years 2004-2009 argues that how agile methodologies are practiced in the Yahoo

organization. Benefields [9] describes that agile methodologies are initially used for small teams at Yahoo, but it has become the backbone in Yahoo because of its decision-making, self-organization, and collective responsibility characteristics. Yahoo started implementing agile methodologies after the traditional model failed to handle complex situations. The agile methodology has shown remarkable success at Yahoo by providing users with creative and innovative applications in the ever-changing and competitive environment.

Doshi and Doshi [10] consider that agile methodologies help managing software projects and change the culture, environment, thinking and management style of the organization; team members become used to it. An agile culture leads a team to complete a project on time by sharing critical ideas and knowledge for the success. Another evidence of the satisfaction and agile addiction comes from the work of Morsicato [11]. Morsicato [11] describes the experience of selected volunteers from GBC/ACM seminars using two scenarios. In the first scenario, the volunteers were managed through a structured and bureaucratic method; although the volunteers completed the tasks, they were unwilling to continue them next year, which demonstrates burn-out. In the second scenario, the volunteers were engaged according to agile principles and values, where the teams had the right to make decisions with collective ownership. No burn-out was observed, and the volunteers were also ready to perform the tasks next year.

According to Gat [12], BMC is a large software development company with more than 300 employees in five countries. BMC was facing problems with Waterfall and shifted to an agile developmental methodology. An agile methodology helped them deliver fast, high-quality successful products, meaningful delivery, and more appropriate workflow. This success motivated BMC to continue using agile in the long run for software development methodology and apply agile values in other areas such as marketing. Agile methodologies affect the culture and broaden its scope from a developmental strategy to an organizational management process.

Ghobadi and Mathiassen [13] describe the observed obstacles to sharing knowledge effectively in agile teams. Four case studies are conducted to conclude the results. The data is gathered from project managers, developers, testers and user representatives. The objective is to identify the main obstacles those affect the knowledge sharing as per the roles of team members. Seven knowledge sharing barriers and thirty-seven general barriers, in general, are described by proposing a conceptual framework. Asnawi et al. [14] report the issues involved in the adoption of agile methodologies. The data is gathered to conclude the results from the early adopters (software development companies) of Malaysia. This research is conducted to highlight the issues and challenges those are faced to software development companies due to transition from traditional to agile methodologies. It is concluded that people factor is the most important factor in the adoption of agile methodologies as compared to technical factor. Asnawi et

al. [14] further divided the social factor into knowledge, mindset, commitment, management involvement, knowledge transfer, structure of organizations and communication areas.

III. PROBLEM STATEMENT

Agile methods are mostly used for small projects, and most available case studies examining their implementation are focused on small organizations using a single-team structure. Agile methods are almost silent about large software companies with multiple teams and their interactions. In agile methods, there are no guidelines on how to safeguard long-term organizational goals within the same umbrella. A number of researchers attempted to scale agile methodologies for medium and large projects, but many important aspects of scaling are missing, such as learning, competitive edge, focus, and reusable contemporary knowledge. In some cases, the spirit of agile is harmed by embedding structured approaches and bringing structural leadership values in software organizations to gain/sustain the role of the market leader. The research questions can be summarized as follows.

- How to scale agile methods to make them suitable for medium and large organizations with multiple teams?
- How to safeguard long-term organizational goals?
- What is the effect of scaling on the organizational productivity?

IV. THE PROPOSED SOLUTION

Seamless scaling agile for large organizations on the long-term basis through strategic learning for leadership is a methodology that embeds agile in strategic management documents which enable agile to be used on long term basis. Rotational learning for leadership is a heart of this approach that results in the organization sustainability and progress by improvement of knowledge flow, improvement of technical skills, improvement of employees leadership qualities, motivation and satisfaction of them and resulting lower burn out, dismantling structured organization and decision making.

A. One-Time Implementation

As agile is embedded in strategic documents which will be used for the long-term basis, therefore, agile will become part and parcel of the organization's long-term policy. It will be used in long run to get benefits from it. Indeed tactical decisions still to be made but they cannot be fixed in advance. The only thing which can be done is the guideline and this guideline in the form of the statements will help tactical decision makers to make decisions in accordance with the agile guidelines. As a result of it agile will be used in the long run on long term basis. The explicit mentioning of agile in the strategic

documents set line of action clear for an organization. It will draw boundaries for the organization how to maneuver, how to manipulate and how to develop and maintain software in the changing environment. It will also help an organization to think and solve problems in an agile way. The next step is to change the structure of the agile team. Agile teams are cross-functional teams. They don't have any explicit learning member. It is due to short time nature of the agile. But when the organization is large and having the multiple projects and team, what will have to do with the project maintenance because no or little documentation will be available.

Learning Opportunities	Team A: File Handling with Java Duration: 1 Week Starting Date	Team B: Basic C++ Duration: 1 Week Starting Date	Team C: HTML Duration: 1 Week Starting Date
Learning Desires	√Emp. No. 2 √Emp. No. 3 √Emp. No. 1	√Emp. No. 6 √Emp. No. 9	√Emp. No. 6 √Emp. No. 8 √Emp. No. 9

Fig.1. Chart showing the learning opportunities and learning desires.

In a small single team, it is not the problem because same persons who have developed the project may still be available to modify or change the software according to the customer needs. But in the multi-project and multi-team organization, this will become a hoax as people will keep on moving to and from the organization.

B. Continuous Implementation.

Continuous implementation begins with the creation of the list of strategic organizational learning requirements. That will keep on changing due to the new and emerging technologies. A chart will be filled by each team in the organization stating any learning opportunities available in the team. A team member can also express his learning desires on the chart as shown in the fig. 1. The selection process can be summarized as follows.

$$\text{Employees Final List} = \{\text{List of opportunities} \cap (\text{List of strategic requirement} \cap \text{List of learning desires})\} \quad (1)$$

Employees, those will fall under this "Employees Final List", will be selected as the learner and a continuous process of learning will be initiated. The proposed new adaptive framework is shown in the fig. 2.

We have proposed some guidelines for the selection of learning requirements but they are not exhaustive. Marketing plan usually developed on the basis of many factors, of which some relevant factors are strategic planning, organization skills, competition factors etc. Naturally, it is an ideal document that can lead us proper finding of learning requirements. This will also bring coordination between different departments of the organization to prevent hazards of lack of coordination. Consider the situation in which marketing team is

marketing to find the new business with tools of Oracle while another department may be going for Java technologies. In case marketing team succeeded to bring in good business but the development team has nothing to do it. Agile methodology beauty lies in the extensive

personal interaction. Agile is people centric and discourage the documentation when a problem can be solved with face to face interaction. Scrum is an agile method. It has different types of extensive meeting.

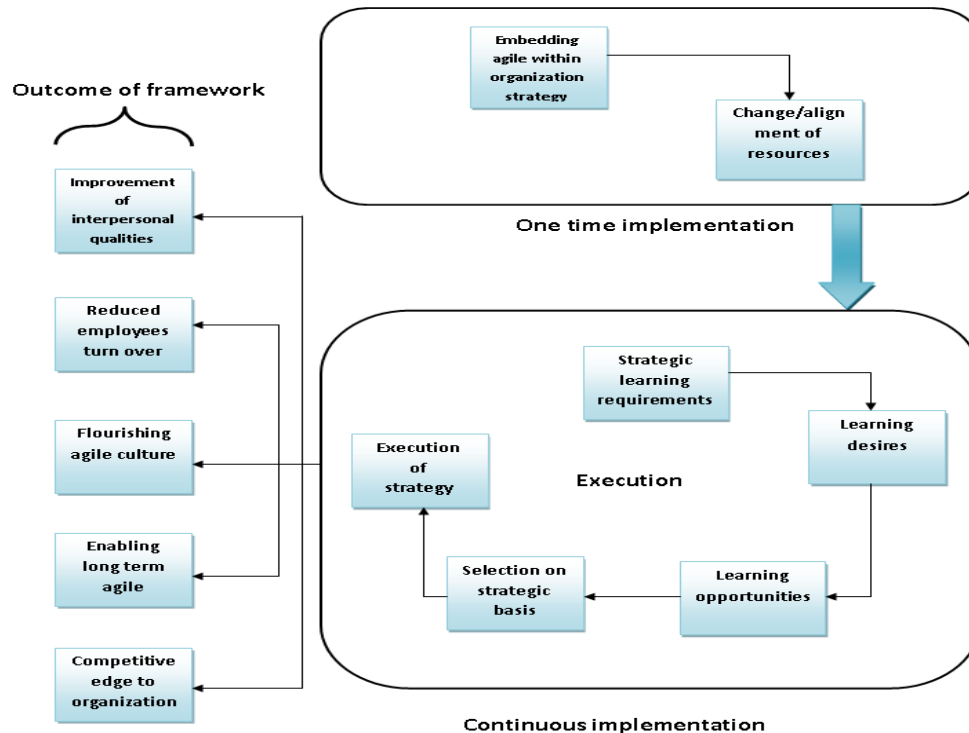


Fig.2. The Proposed Adaptive Agile Framework.

During these extensive interactions learning desire can be judged. For example, if a person is more willing to perform tasks related to the databases and less interested in interface development then it can be judged that he is more suited to oracle database programming than the front end programming.

Learning opportunities means any unique task that can provide new learning to the people within or outside of the organization (training & seminar). The main focus of our methodology will be to find such opportunities within the organization. A chart can be made and each team which has some learning opportunity will post it on the chart. The proposed layout of the chart consists of a brief description of learning opportunities and the expected date of the commencement along with its duration and place.

We have a list of strategic learning requirements. Secondly, the list of learning desires is also available. List of the learning opportunities is also there.

For example, consider following as the list of learning desires.

L_Desr = "File handling with Java, Database programming SQL Server, Linux shell scripting"

And on the other hand, we have the strategic learning requirements as:

L_lear_Requirements = "File handling with Java, Database programming SQL Server, SQL reports"
Next, these two lists will be intersected as:

Inter_Narr = "File handling with Java, Database programming SQL Server".

As a result of this intersection a narrowed down list of learning desires and strategic learning, requirements will be available. This narrowed down list will then be further intersected with the learning opportunity list. Consider for example we have the following learning opportunities list:

L_lear_opportunities = "TeamA: File handling with Java, TeamB: C++; TeamC: HTML"

Now the intersection of the narrowed down and the learning opportunities list will be

L_Final = "File handling with java"

So the persons whose learning desire was the file handling with java will be selected for learning for leadership and will be sent into to the team a for the learning process.

The whole process can be depicted as:

$$L_Final = \{L_lear_opportunities \cap (L_lear_Requirements \cap L_Desr)\} \quad (2)$$

This learner will not only learn the specific technology but also the domain knowledge of the project and different culture and working style. Indeed he will also share his own experiences with this team. After returning to another team, he will also share his learning that will help to maintain the flow of knowledge. When this activity will be performed on constant basis it will result in the constant flow of the knowledge in the whole organization

Effects are an attempt to measure whether the proposed methodology does have any valuable impact on the organization to obtain and sustain the market leadership through learning for leadership. When a team member will move from one team to another team as a trainer, he will interact with other team members. The trainer will understand the culture and style of new team and he will share his knowledge and experience with the new team to maintain the flow of knowledge. In this way, multiple teams will have knowledge about themselves. Similarly, when a trainer will move to some another team then he will be in a position to interact with members of another team in a much better way. Therefore, the interaction between the teams will be enhanced due to the learning for leadership.

This study was divided into the following five goals to evaluate the proposed framework.

- Goal 1- Agile as strategic management corner stone.
- Goal 2- Measuring the alignment of resources according to the proposed framework.
- Goal 3- Execution of strategy:
 - goal 3.1- find the strategic learning requirements;
 - goal 3.2- search the learning desires of the people;
 - goal 3.3- find the learning opportunities.
- Goal 4- Measuring the effect of the proposed framework over learning on leadership.
- Goal 5- Measuring the effect of implementing the proposed framework to achieve long-term learning goals of an organization.

V. VALIDATION

Descriptive research is used to evaluate the proposed solution. The results of a descriptive analysis are presented in the form of frequency tables and bar chart [15]. Oppenheim [16] discusses that the descriptive research does not conduct to prove a causal relationship between variables but its objective is to present what ratio of a sample has a definite viewpoint. Survey is the most appropriate research method to validate the scope of this study because it is widely applied in software engineering research and it can collect data from a large number of respondents as compared to other research methods. Furthermore, it is easy to distribute. Likert scale is used

to capture the responses as follows. Likert Scale Key: 1 = Strongly Agree (SA), 2 = Agree (A), 3 = Neutral (N), 4 = Disagree (D), 5 = Strongly Disagree (SD)

A survey is conducted from more than 500 respondents from software companies of three different countries of Pakistan, Sweden, and Italy. Survey is conducted online as per the recommendation of Nardi [17] to avoid human error in data collection and analysis. Only those software companies are involved in the research having experience more than 1 year in agile software development. The response rate is 49% of the population under study. The questionnaire consisted of fifty-five close-ended questions. Questions 1-7 are related to the integration of the agile in the organization's strategic documents in order to make them clear to everyone that the organization is going to adopt this methodology as the main cornerstone for achieving their long-term objectives. Questions 8-14 are how to align resources with the organization to achieve strategic objectives. These objectives can be achieved by learning and implementing an agile culture in the organization. This group of questions also tries to ascertain the rotation of resources and how many resources will be sufficient at any time that should be in this process. Execution of the strategy is discussed in detail where the most important aspect of this execution is the accurately finding the learning requirements. Questions 15-22 are designed to find the organization learning requirements. These requirements are ascertained from different sources ranging from the SWOT analysis to maintenance contract. New and emerging technologies have the paramount effect on the learning requirements, therefore, these must be undertaken into consideration before finalizing the strategic learning requirements. Execution also has another important activity that is an activity of finding learning desires. To find learning requirements in an agile way, one should benefit from the extensive nature of interactions and easy open access among various stakeholders in the agile process. Therefore, learning desires can be ascertained during these extensive meetings. All these steps are covered in questions 24-27. Learning opportunities will be found in the each team. It is obvious that all strategic learning requirements are hard to be found in the organization, therefore, higher management should find the learning requirements outside the organization. These factors are covered under the questions 28-31. Questions 32-35 are about the selection of the team member and then sending them in the team or outside for learning for leadership. Question 36-55 are related to the calculation of the effects of our methodology, to see whether this methodology will benefit organization to raise it as the market leader. Effects which are described in this set of questions ranges from the personal enhancement (communication, presentation etc.) to team structural effect (heroism etc.) and then overall effects (market leader, effectiveness etc.) of this methodology. This indeed will lead to the learning for leadership.

A. Cumulative Analysis Of Goal 1.

Cumulative responses of the Goal 1, 'Measuring the effect of the proposed framework on strategic management', are shown in Table 1.

76.7% of the responses were in favor of Goal 1, of which 60% agreed while 16.7% strongly agreed to the effects of the proposed framework on strategic management documents to enable it to be used on long term basis. 13% of the cumulative responses were neutral while 10% of the participants were not in favor of it. 6.5% of the respondents disagreed and 3.3% of the software engineers strongly disagreed to Goal 1.

Table 1. Cumulative frequency analysis of Goal 1

		Frequency	Valid percent	Cumulative percent
Valid	1	41	16.7	16.7
	2	148	60.4	77.1
	3	32	13.1	90.2
	4	16	6.5	96.7
	5	8	3.3	100.0
	Total	245	100.0	

B. Cumulative Analysis of Goal 2.

Cumulative responses of the Goal 2, 'Measuring the alignment of resources according to the proposed framework', were shown in Table 2. According to Table 2, 55.7% of the responses were in favor of Goal 2 of which 12.3% were strongly agreed and 43.4% were agreed to it. 11.4% of the respondents disagreed while 3.7% of the participants were strongly disagreed to Goal 2. Responses which remained neutral were 29.1%.

Table 2. Cumulative frequency analysis of Goal 2

		Frequency	Valid percent	Cumulative percent
Valid	1	43	12.3	12.3
	2	152	43.4	55.7
	3	102	29.1	84.9
	4	40	11.4	96.3
	5	13	3.7	100.0
	Total	350	100.0	

C. Cumulative Analysis of Goal 3

Table 3. Cumulative frequency analysis of goal 3

		Frequency	Valid percent	Cumulative percent
Valid	1	181	20.7	20.7
	2	465	53.1	73.8
	3	161	18.4	92.2
	4	46	5.3	97.5
	5	22	2.5	100.0
	Total	875	100.0	

Cumulative responses of the Goal 3 were shown in Table 3. Table 3 showed that 73.8% of the responses agreed to goal 3 in which 20.7% of the software engineers strongly agreed and 53.1% of the professionals agreed to it. 18% of the responses remained neutral for

Goal 3. A total of 7.5% of the responses was not in favor of the Goal 3 in which 5.3% of the participants disagreed while 2.5% of the responses strongly disagreed to goal 3.

D. Cumulative Analysis Of Goal 4.

Cumulative responses of the Goal 4, 'Measuring the effect of the proposed framework over learning on leadership', were shown in Table 4. Table 4 showed that overall 76.8% responses were in the favor of Goal 4. 54.6% of the respondents strongly agreed while 22.2% of the professionals agreed to it. 17.5% of the responses remained neutral. A total of 6% responses disagreed to Goal 4, of which, 4.8% of the respondents disagreed while 1% of the software engineers strongly disagreed with the Goal 4.

Table 4. Cumulative frequency analysis of goal 4

		Frequency	Valid percent	Cumulative percent
Valid	1	70	22.2	22.2
	2	172	54.6	76.8
	3	55	17.5	94.3
	4	15	4.8	99.0
	5	3	1.0	100.0
	Total	315	100.0	

E. Cumulative Analysis of Goal 5.

Cumulative responses of the Goal 5, 'Measuring the effect of implementing the proposed framework over the productivity of an organization', were shown in Table 5. Table 5 showed that overall 76.4% responses were in favor of Goal 5. 54.1% of the respondents strongly agreed while 22.3% of the professionals agreed to it. 17.1% of the responses remained neutral. A total of 6.5% responses disagreed with the Goal 5, of which, 4.5% of the respondents disagreed while 2% of the software engineers strongly disagreed with the Goal 5.

Table 5. Cumulative frequency analysis of Goal 5

		Frequency	Valid percent	Cumulative percent
Valid	1	226	22.3	22.3
	2	549	54.1	76.4
	3	174	17.1	93.5
	4	46	4.5	98.0
	5	20	2.0	100.0
	Total	1015	100.0	

F. Cumulative Analysis of Goals 1 To 5.

The final cumulative evaluation of goals 1 through 5 was shown in Table 6. Table 6 showed the validation results of the proposed framework: 73% of the respondents were in support of the proposed framework in which 20% of the professionals strongly agreed, and 53% of the respondents agreed). 8% of the professionals were against the proposed framework in which 6% of the software engineers disagreed and 2% of the participants strongly disagreed. 19% of the respondents remained neutral as shown in fig. 3.

Table 6. Cumulative analysis of goals 1-5

		Frequency	Valid Percent	Cumulative Percent
Valid	1	561	20.0	20.0
	2	1486	53.0	73.1
	3	524	19.0	91.8
	4	163	6.0	97.6
	5	66	2.0	100.0
	Total	2800	100.0	

The bi-variant analysis is used to estimate the correlation between variables. Cronbach alpha is also used for the same purpose to estimate the reliability of this study. The values of Cronbach alpha are in the ranges of 0 to 1. The proposed research is reliable if the value is closer to 1. The value of the Cronbach alpha is 0.90 indicating that this proposed research is reliable.

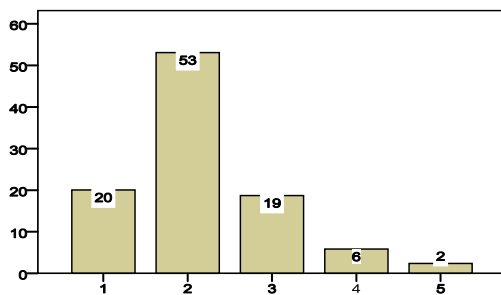


Fig.3. Cumulative Evaluation of goals 1 through 5.

VI. CONCLUSION

The adaptive framework is embedded in strategic management documents to scale suitable agile methodologies on a long-term basis. The strategic management documents will provide proper ownership, clarity, transparency and long-term implementation of agile to an organization. Next, the cross-functional agile team is changed with the introduction of a learner to accommodate rotational learning for leadership. Continuous focus and refinement of leadership qualities are required to be able to act as a leader. We focus on the technical aspects of leadership and other aspects, such as coordination skills, presentation skills, communication skills, motivation, and satisfaction. We attempt to synchronize agile methodologies with our proposed framework in the sense that both frameworks focus on the people. The proposed framework is validated in medium and large organizations of Pakistan, Sweden, and Italy using a survey, and it is supported by 73% of the respondents. The results indicate that the proposed framework to scale agile methodologies is acceptable, practical and applicable to medium and large organizations. We anticipate that the presented work will stimulate target companies to implement the new adaptive framework to scale agile methodologies to improve the organizational productivity. This study does

not drill into details what will be dynamics when a new person will be introduced to a new team, will it be accepted or there will be a difference of personalities and culture.

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