

A case study on the benefit of adopting Agile & CMMI in small software organization

Amr Emam

Quality Assurance Manager
Softxpert LLC
IT and Outsourcing services
Alexandria, Egypt
amr.emam@ymail.com

Marian Tadros

Principal Consultant & CMMI Lead Appraiser
Tri EXL for Training, Consulting & Appraisals
Cairo, Egypt
m.tadros@triexl.com

ABSTRACT

Rapid market changes, project estimation, requirements changes, people and budget planning and more, are all common issues and challenges in the software development industry. Many organizations, all over the world, embraced CMMI & agile to benefit from the value of both models to overcome these challenges.

However, the practitioners has doubts on getting tangible solutions for the problems they usually face when they adopt CMMI with agile practices, since the 2 ideas come from opposite ends of the software engineering community.

This paper presents a case study on a small organization that was successful in embracing the CMMI and agile. Two main dimensions were considered in the case study. The first dimension is to measure the practitioners' feedback and the second one is to evaluate the improvements from the process measurers based on four main matrices productivity, quality, responsiveness and predictability.

1. INTRODUCTION

Time, cost and scope (functionality) are the main constraints of any project's success. Yes it might not be the only attribute of a project's success as there are more factors to contribute to the success of a project for example: quality, resources or risks. However, this triangle of attributes can still offer guidelines for the success of a project.

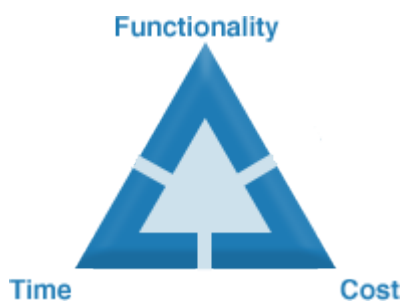


Figure 1 Project management constraints

These constraints are interdependent, and changing any of them will definitely affect the others. Software development organizations aim to deliver the required functionality with the most efficient usage of time and cost.

This paper presents a case study done for one organization Softxpert Inc. (<http://www.Softxpert.com/>) that adopted SCRUM (one of the agile methodologies) with the CMMI – DEV maturity level 2 framework, which implies that the organization projects are well managed, in order to satisfy the demand of being in control of these constraints.

2. Agile:

Using an agile methodology helps the organization to be in more control of the 3 constraints (time, cost and functionality) than the traditional methods by embracing an incremental and iterative approach in developing projects. An agile project attempts to fix resources and break the time into small and fixed durations (iterations), and as time and resources are the main components of the cost it becomes also fixed and leaves only one variable which is the functionality. Implementing this promotes adaptive planning that enables early delivery and drives a change not only on how projects are managed but also regarding the customer collaboration and involvement during the lifetime of the project, and that is why agile has a set of values and principles that should be considered as the base for developing the agile processes as defined by the agile community and agile alliance.

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.

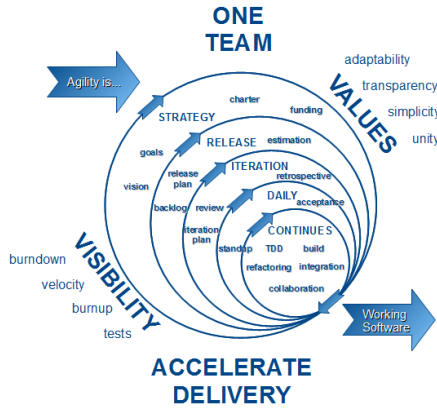


Figure 2 Agile values - Lifecycle

3. CMMI Framework:

The capability maturity model integration (CMMI) is a collection of best practices that helps organizations to improve their work, not only helps in controlling the project constraints but also addresses more areas of process improvement as quality, risks, training, etc.

CMMI for development (CMMI-DEV) goals and practices covers the life cycles of projects from conception through delivery; it is a powerful process improvement model that is suitable for software engineering, hardware engineering, and system engineering organizations. Thousands of companies across multiple industry sectors in 94 countries have adopted CMMI practices to elevate performance and have been appraise for capability and maturity CMMI models since 1990s as per the CMMI institute.

Maturity levels provide a staging of processes for improvement across the organization from maturity level 1 to maturity level 5. This improvement involves achieving the goals of the process areas at each maturity level.

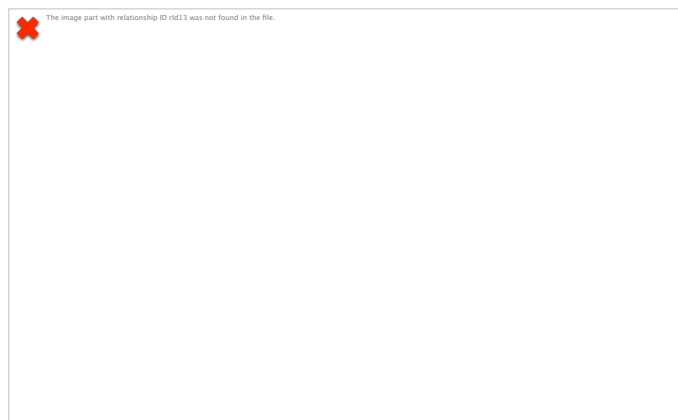


Figure 3 CMMI maturity levels

4. CASE STUDY METHODOLOGY:

Softxpert is an Egyptian software development organization that was established in the year 2008 and runs a full development for large and medium size projects with a range from 6 to 10 members per each project. They adopted SCRUM methodology since January 2013 so as to be able to keep the pace of the abrupt changes in the market of the software.

The case study was done right after Softxpert’s development teams acquired CMMI for development maturity level 2 on September 4th, 2014 from the CMMI Institute with the accreditation number 22559.

The case study shows the projection of implementing the agile and the CMMI on the organizational improvement over the time of implementing these methodologies from measuring the project’s performance based on 4 matrices productivity, quality, responsiveness and predictability. Also it is based on a cross sectional survey that was done for 26 employees from 4 different development projects with the involvement of their stakeholders, management and the support functions to assess their feedback about their experience in adopting the agile and CMMI.

The diversity is one of the main factors that was considered while conducting the survey and that is to ensure that all the functions are covered and their feedbacks are assessed. The organizational populations surveyed are distributed as shown in figure 4. Also the organizational experience years for individuals surveyed are distributed as shown in figure 5

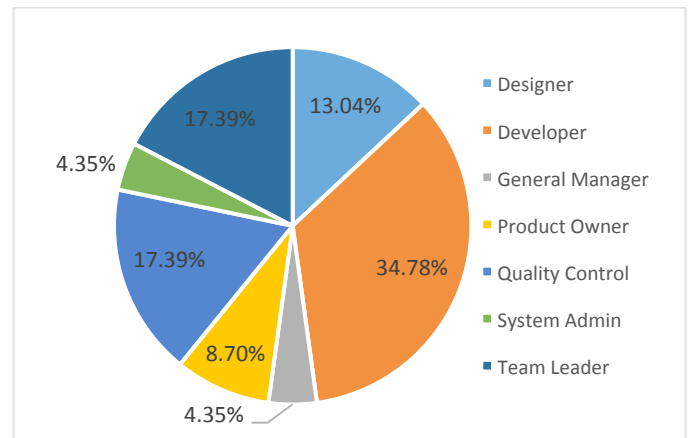


Figure 4 Designations distribution

- **Disagree:** “Slower the process... But more focused on delivery time, quality, etc.”
- **Disagree:** “CMMI didn't conflict with the adopted agile methodology; it supported commitment to some useful practices.”
- **Strongly Disagree:** “CMMI seems to be the person who always checks and ensures that the agile methodology is applied perfectly.”
- **Strongly Disagree:** “I think that the CMMI L2 module complies with the agile principles.”

5. CASE STUDY RESULTS AND ANALYSIS:

This section presents the findings of the case study that was gathered from the survey results and the actual organizational measures of the projects, which serve as an evidence on the effects of implementing these methodologies.

5.1. Implementing both CMMI and Agile together.

When Softxpert started its process improvement journey, they adopted the agile values and principles as a guide for their development process, later they needed to transform these process best practices to an institutionalized organizational system. That's when they decided to embrace the CMMI framework which was a challenge at the beginning for the team to understand and practice along with the agile, but although having some doubts about CMMI and agile and how they can fit together, the team eventually reached an understanding that CMMI is a guide for “What” should be done while agile is the one who answers “How” to do it and that CMMI and agile never contradict they in fact complete each other to ensure that the organizational processes are efficient and complete.

Figures 6 and 7 show how did Softxpert teams perceive the concept of the agile and the CMMI framework working together.

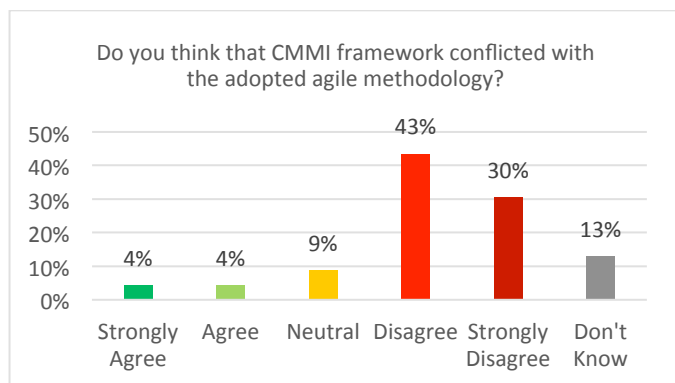


Figure 6 CMMI VS Agile

Comments:

- **Neutral:** “Agile Methodology barely has documentation while CMMI from what I got is more into formality, but we may have not been deep in documentation so I don't see a conflict”
- **Disagree:** “I don't think they conflict in any way. I actually think that agile is good for CMMI and helped us reach our goal.”

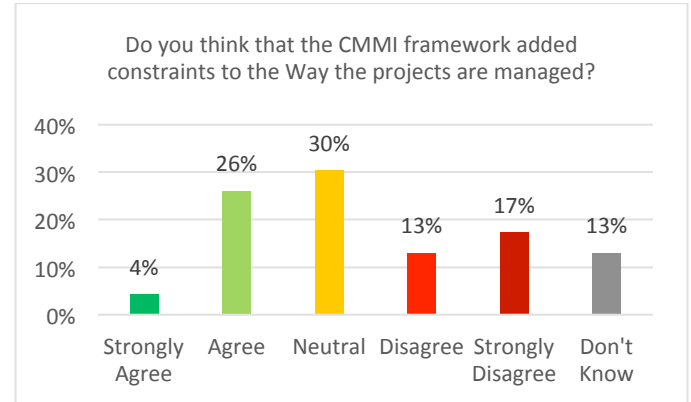


Figure 7 CMMI constraints

Comments:

- **Strongly Agree:** “Yes, I think that the CMMI L2 module constrains project management within the defined process, so that projects comply with the company's defined process and policies.”
- **Agree:** “Some constrains were added and some were difficult to be adopted at first, but we got used to it after practicing.”
- **Agree:** “It's a model that we try to stick to. You will naturally have constraints as long as you try to fit into a model.”
- **Neutral:** “I'd better call them rules more than constraints”
- **Disagree:** “It did add some constrains but for the better.”
- **Disagree:** “CMMI added a unified system for managing the projects, which made things clearer and organized.”

It's shown that after practicing 73% of the population doesn't see any conflict in embracing both. Also, 30% sees that there are no constraints added by endorsing the CMMI model while another 30% sees that it did but for a better improvement.

5.2. Performance indicators

Some of the performance indexes for the success in development projects are productivity, quality, responsiveness and predictability. The following subsections goes through each of these indicators to check the evidences of its improvement from the organizational measures. Also as the performance improvements of projects are better to be sensed and acknowledged by the actual practitioners, their opinions regarding areas affecting these performance indicators are gathered through the survey and presented in each subsection.

5.2.1. Productivity:

Productivity is the count of the features (user stories) completed in a given time period (release or iteration). The velocity of the production of the team is presented in agile by the number of feature points completed in a single iteration which varies from 2 to 4 weeks.

Figure 8 shows the actual number of feature points delivered over the last 7 consecutive iterations for a development project at Softxpert.

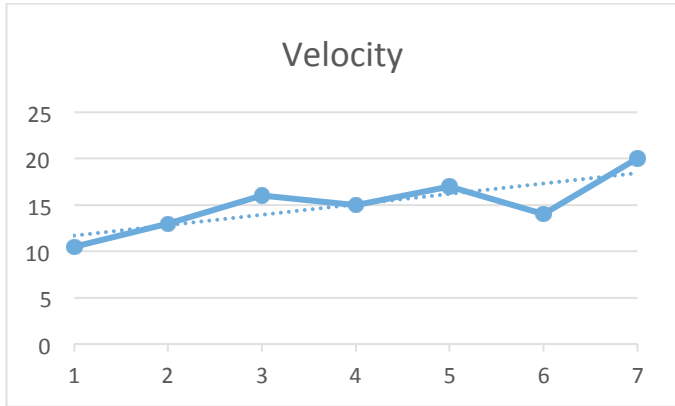


Figure 8 Features delivered trend

The trend shows a consistent improvement in the team’s productivity after implementing the new system.

Figure 9 shows, what does Softxpert’s teams think regarding the effect of the new system for delivering the required scope.

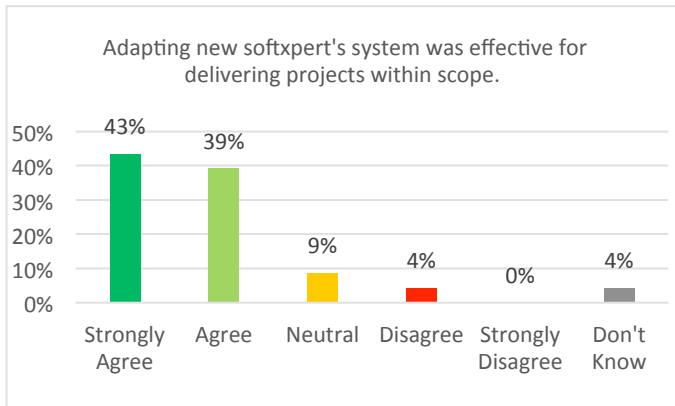


Figure 9 Deliver scope

Comments:

- **Strongly Agree:** “I think TFS as a process automation tool can prove that best.”
- **Strongly Agree:** “User stories concept kind of forcing the stream to work and deliver a specific scope.”
- **Strongly Agree:** “In my opinion, scrum makes the team's plan more accurate and precise as long as the customer and the team apply the scrum rules.”

- **Agree:** “Scrum made customer feedback reported to the team more often which helped the team to implement the right scope”

82% of the population felt a direct correlation between the productivity and adopting the new system.

5.2.2. Quality:

Quality is the defect density produced while developing features.

Figure 10 shows the trend for the number of bugs that arise while developing and the number of the failed test cases over the last 6 iterations of a development project at Softxpert maintaining the same number of feature points developed.

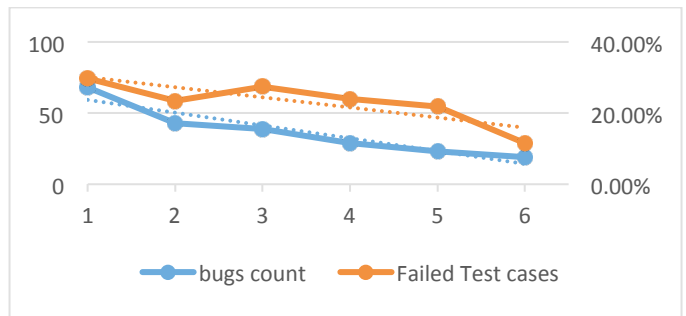


Figure 10 Deliver scope

The trend shows consistent reduction of the number of defects over time using the new system.

The methodology followed to improve the quality of work and reduce the defect density for Softxpert was driven from the CMMI framework process areas such as configuration management, measurement & analysis and quality assurance, where the teams follow these steps in order to improve and become more mature:

- Define and record defects.(Configuration management process area)
- Measure and analyze causes. (Measurement and analysis process area)
- Improve the performance. (Process and Product quality assurance process area)

Figure 11 shows that 87% of the population sees that using configuration management tools such as the team foundation server and the SharePoint helped in improving the way project’s data are managed and recording defects in order to improve the quality.

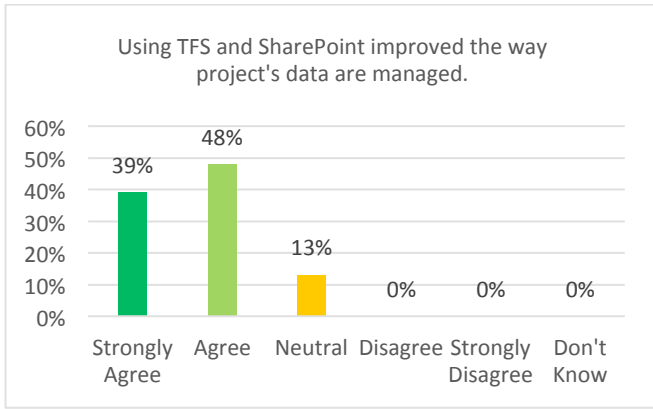


Figure 11 Configuration management

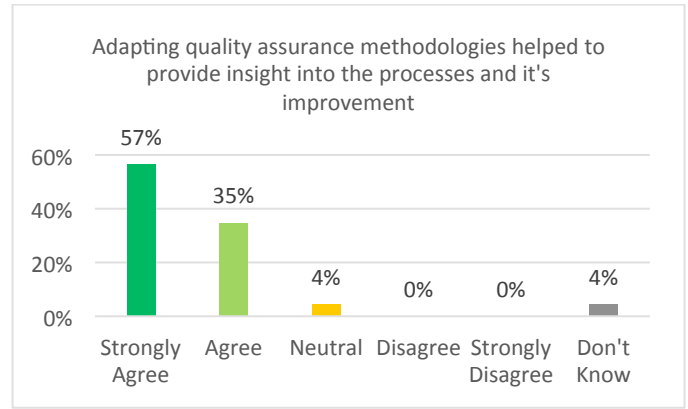


Figure 13. Quality assurance process

Comments:

- **Strongly Agree:** "It became easy with TFS for sure"
- **Agree:** "But I think there can be better tools out there"

Figure 12 shows that 78% of the population sees that measurement and analysis strategies introduced by the CMMI framework helped in assessing their performance and ensuring continuous improvements in the quality of the product.

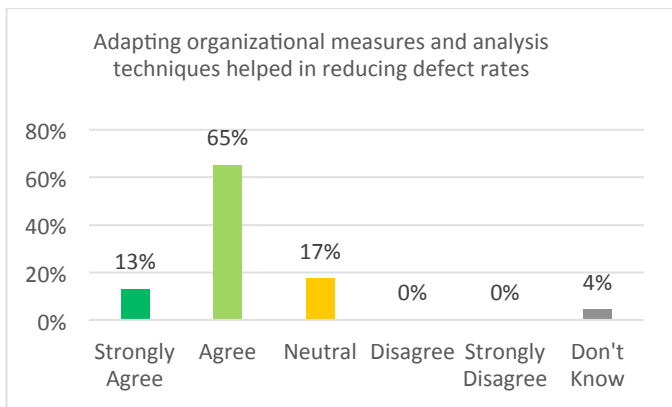


Figure 12 Project's measures

Figure 13 shows that 92% of the population sees that quality assurance methodologies introduced by the CMMI provided insight about the process followed and improved it in a way that reflects on reducing the defect rates.

Comments:

- **Strongly Agree:** "It helped improving and unifying the process through all projects in some areas."
- **Strongly Agree:** "QA auditing helps too much keeping committed to the policy in order to satisfy our goals, connect all the missing parts of the whole project picture. QA improvement suggestions always enrich our minds with new thoughts that helps our team and makes it easier to accomplish our goals"
- **Strongly Agree:** "In my opinion, no one can apply anything perfect, so the quality assurance coach teams to prevent failure, in order to make the process tend to perfection."

5.2.3. Responsiveness:

Responsiveness is the amount of time that is needed to finish a work item, which might be affected by some practices, for example: requirements gathering, customer communication and requirements changes.

One of the measures that represent the responsiveness of the team is the customer satisfaction level. Softxpert adopted a new robust surveying system for its customer's to gather their feedback at different milestones (after each iteration and release). This survey was based on a Likert scale of 5 values considering the top two boxes (4 and 5) as the target and threshold for the customer satisfaction.

Figure 14 shows the result of the Softxpert's customer survey results for the last 7 iterations for a project after implementing the new system, where it is consistently above the threshold defined.

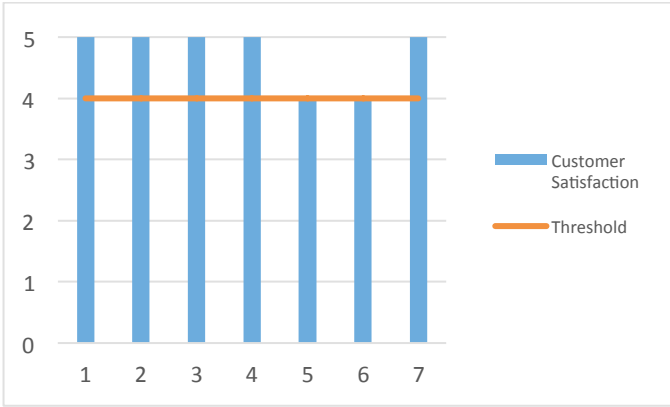


Figure 14 Customer satisfaction survey results

The new system has been successful in sustaining the level of satisfaction of the customers above the required threshold. The study shows that 61% of the population thinks that the new system was a reason of the customer satisfaction.

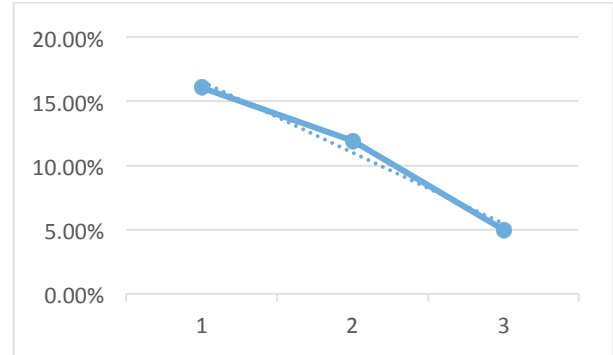


Figure 16 Stabilization ratio trend

This shows that the new system was successful in helping to reduce the amount of time needed to stabilize the developed application before delivery, which means less technical debt and more efficiency in production with no delays to ensure the delivery of requirements on time.

Figures 17, 18, 19, 20 and 21 show how the implementation of the new system affected the responsiveness of the teams at Softxpert to the customers' requirements by assessing their feedback about the following practices:

- Delivery on time.
- Requirements gathering.
- Change Management.
- Stakeholder's involvements.
- Effective communication.

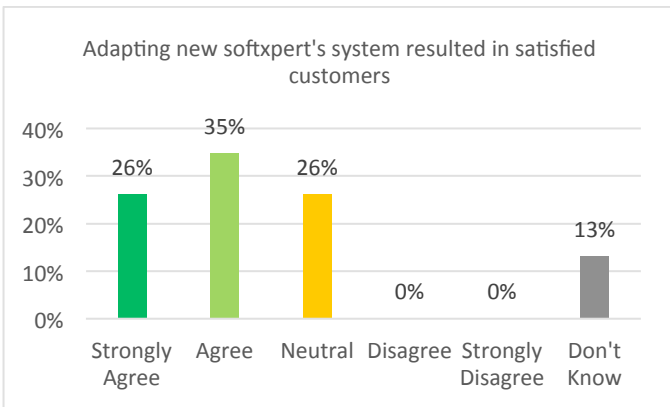


Figure 15 Customer satisfaction

Comments:

- **Strongly Agree:** "In my opinion, scrum makes the team more flexible towards the customer's requirements and changes, and gets their feedback regularly, so I think this would satisfy the customer."
- **Agree:** "because the customer is involved in the development process by providing a regular feedback"
- **Neutral:** "Not always."
- **Don't Know:** "Actually, I didn't join the project before adopting scrum so I can't efficiently compare."

Another measure for the responsiveness is the delivery on time of the requirements. In order to avoid the delays in delivery Softxpert has defined an organizational measure for the amount of time needed to stabilize the application and clear any technical debt before delivering the features. Figure 16 shows the stabilization ratio over the last 3 releases with a minimum of 2 iterations in each release.

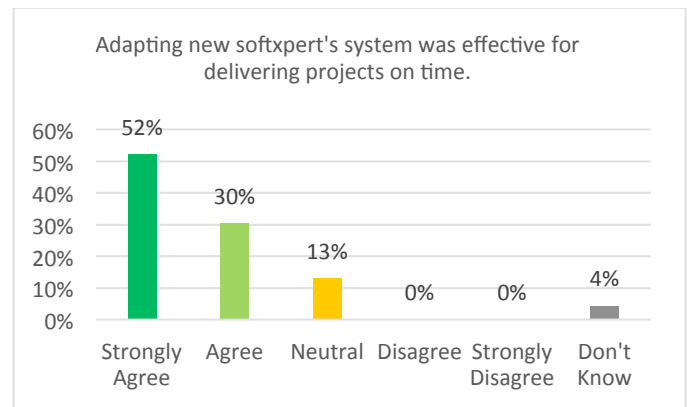


Figure 17 On time delivery

Comments:

- **Strongly Agree:** "Personally, I think scrum helped to improve my estimation skills -also I think the same for my fellow team members- which led to a better commitment on deadlines."
- **Strongly Agree:** "In my opinion, scrum makes the team's plan more accurate and precise."

- **Neutral:** “Scrum events do consume time, but on the other hand the customer is continuously updated so the needed changes are discovered earlier and hence time is saved.”

Gathering requirements and transforming it to user stories is the first step in the lifecycle of the new development process.

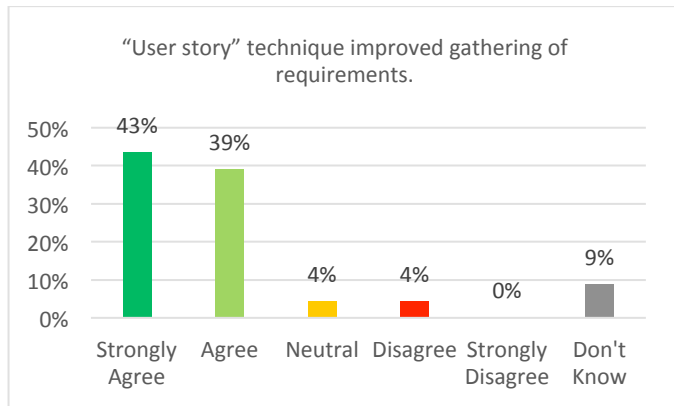


Figure 18 Requirements gathering

Comments:

- **Strongly Agree:** “In my opinion, writing the requirements in a form of user stories makes the development and delivery more organized and clearer for both (customer and team)”
- **Strongly Agree:** “The “User Story” technique helps put into focus what a requirement is for, who would use it and how to deliver it (i.e. acceptance criteria). It helps ensure that the requirement is independent from any other requirement, negotiable in case the customer had any changes in the requirement, valuable to the customer, estimable, as small as possible and testable, which would help clearly identifying and specifying what the customer want and avoid confusion.”
- **Strongly Agree:** “With product owner’s help I think we now can understand the client better and keep an organized trace of requirements.”
- **Agree:** “depending on the user stories only will lead to a lot of missing scenarios because the user story must be small and it doesn't show the workflow between the stories”
- **Agree:** “Made requirements easily understood for all team members and easier to implement and maintain changes.”

Change management process is used to ensure that customer’s requests are acknowledged and implemented in a timely manner which guarantees the competitive advantage for the customer in the market.

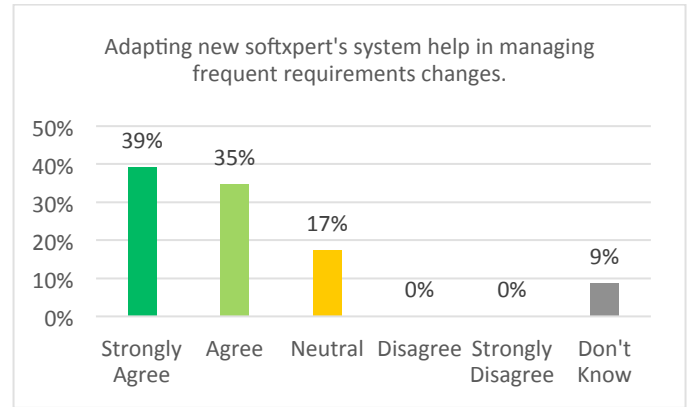


Figure 19 Change management

Comments:

- **Strongly Agree:** “In my opinion, scrum makes the team more flexible towards the customer's requirements and changes. And on the other side, it manages the team time so as not to be interrupted by the changes at any time. For example, once the sprint begins, the customer is not encouraged to change.”
- **Agree:** “This is what Scrum is for in the first place.”

Customer and Management involvement in any changes and the progress of production is essential to ensure that the visibility and the collaboration between the team and the stakeholders exists at all times.

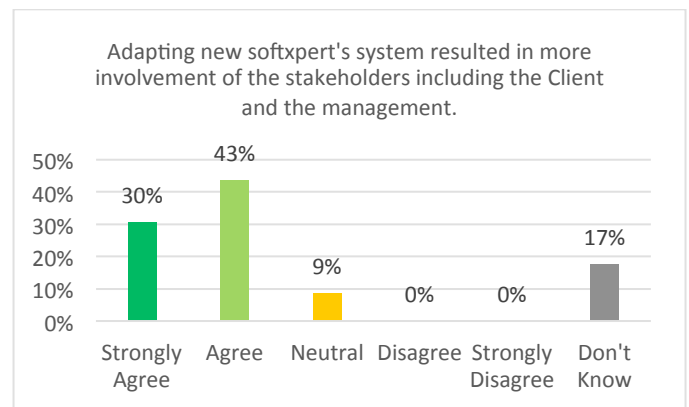


Figure 20 Stakeholder's involvement

Comments:

- **Strongly Agree:** “Having the customer representative (Product Owner) available helps a lot in this”
- **Neutral:** “It did not help in more involvement. I'd rather say it helped organize the communication and involvement”

Effective communication between the individuals participating in the development is critical to avoid any delays or rework that may occur and affect the responsiveness to the customer’s requests.

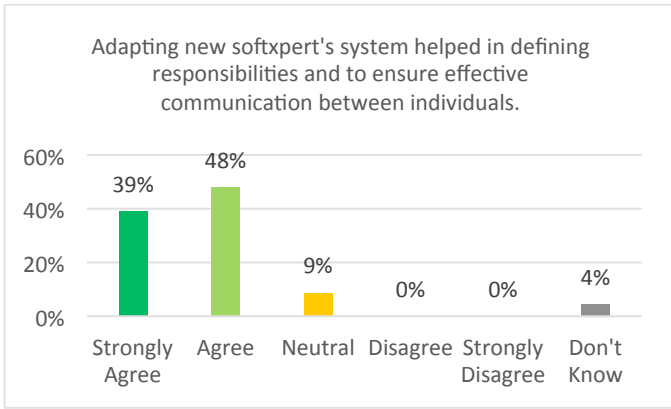


Figure 21 Effective Individual's communication

Comments:

- **Strongly Agree:** "In my opinion, scrum defines the roles clearly which makes the communications straight forward and this increases the contact between all the Individuals"
- **Agree:** "Daily stand ups made communicating progress and reporting blocking issues easier and effective by the whole team involvement."

5.2.4. Predictability:

Predictability is assessed by measuring the variance between the throughput and the plan. The new system depends on an incremental and iterative approach in development that is based on a breakdown of requirements and work into smaller parts which enables more accurate estimation of time or scope at the time of planning, also the new system introduced practices that contribute to the accuracy of the predictability for example: project estimation techniques, risk management and teams' commitment to plans.

The new system uses the user story sizing technique to quantify the requirements into points that facilitates the estimation and planning process. Figure 22 shows what Softxpert teams think of this.

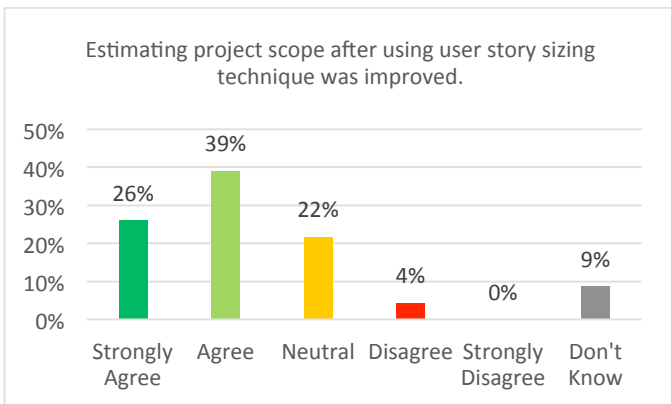


Figure 22 Estimate scope

Comments:

- **Strongly Agree:** "In my opinion, the story sizing helps in getting an accurate plan for the project (as long as the team is stable and size the stories properly)"
- **Agree:** "It's my first time to be in a project which applies such concept and I think our sizing got a lot better which is helpful to measure our productivity."

Commitment to plans and requirements development in the new system is collective from all the team members, Figure 23 shows what the Softxpert teams think of this.

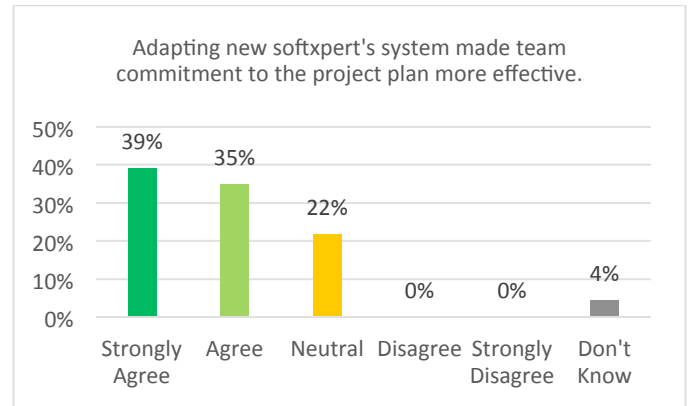


Figure 23 Team's commitment

Comments:

- **Strongly Agree:** "In my opinion, the scrum puts the rules and roles for the team to gain the commitment from each member towards the plan, so as to get a precise and accurate one."
- **Neutral:** "It depends on each team member commitment which varies between individuals"

Risk management was introduced to the new system from the CMMI framework to make sure that the plans aren't to be interrupted by any circumstances that may appear through the lifecycle of the project by identifying mitigation and contingency plans for any risk.

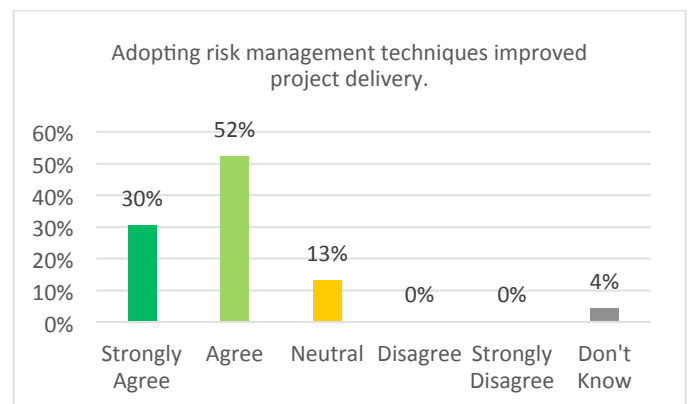


Figure 24 Risk management

Comments:

- **Strongly Agree:** “Knowing what the risks may be, what to do to mitigate it and in case it happens, how to deal with it, keeps the project managed and avoids chaos in case a risk actually happens.”
- **Strongly Agree:** “In my opinion, the risk management is one of the essential points that makes the team's plan more accurate and precise”
- **Agree:** “Some risks could be avoided from beginning or solved during the project due to risk planning.”

6. CONCLUSION

This paper showed the results of a case study on the benefits of adopting agile methodology within the CMMI framework which is in a more professional managed environment, more satisfied customers and partners, improvement in the production velocity, more skilled and self-organized individuals and better visibility & control of the projects by the management.

Overall agile is a practical technique that supports teams while CMMI shapes these good practices into the organizational system by defining a policy and adopting quality assurance that ensures the consistent implementation across all the projects.

Figure 25 shows the affected areas due to adopting agile and CMMI together.

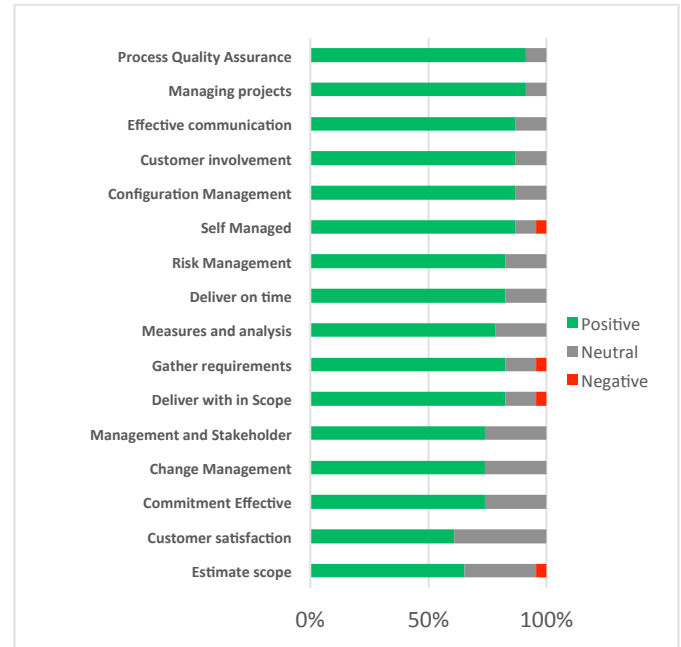


Figure 25 Affected areas by the new system

ACKNOWLEDGMENTS

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