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Beyond CMMI

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Capability Maturity Model Integration (CMMI) has widely spread its roots in both IT and non-IT organizations in today's technological era. However, the tendency is to get stationary in the process improvement journey until it's time to get started on reappraisal, or for the ones who truly desire breakthrough improvements, to ponder over multiple options. This paper attempts to help in that direction focusing on two contexts- organizations at level 3 and those at level 5 in the CMMI ladder. It does not sell one model or framework or methodology over the other but just weighs out multiple options for an organization as they decide to continue their process improvement journey after a CMMI implementation. It delves into the principles of Lean and Six Sigma, Agile, Theory of Constraints and other ideas that when implemented would cultivate industry-best practices in the minds of the people involved in the journey. It also discusses challenges that are expected with each of these philosophies. The paper hence provides some thought-provoking insights in the area of process improvement thereby encouraging further research.

Introduction

There has been a trending shift in more companies' implementation of various models and frameworks in an attempt to adopt industry best-practices. However, this could be either to their benefit or an entirely new battle to fight for- the common reason being fitment of that specific model or framework to the organization's culture, people, and practices.

Process improvement essentially means 3 things- improve ROI, reduce costs, and increase quality of delivery. Any other business objective is directly or indirectly related to one of these factors. In line with the business objectives, a top-down approach is usually taken in order to drill down to low-level objectives at the process level. This is true of any model or framework that an organization chooses to satisfy. But the deeper question is an overall health check-up of the practices in place for an eternal process improvement journey which improves itself with every step taken in that direction. Many organizations have implemented CMMI goals and practices, but sooner or later reach that phase where they begin to ponder if the implementation really added value to their people and the intrinsic culture of process improvement, and more importantly- "what to do next?"

Background

CMMI has come to be known and practiced as an industry benchmark in both IT and non-IT organizations. The figure along side illustrates an industry-wide adoption of CMMI across verticals.

If we get deeper into the trends, the two figures below show further numbers depicting number of CMMI appraisals in 2011 which indicate the global adoption of CMMI in different domains.
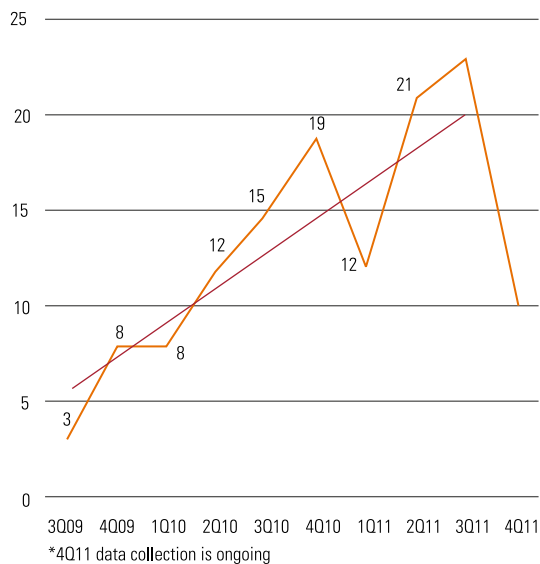
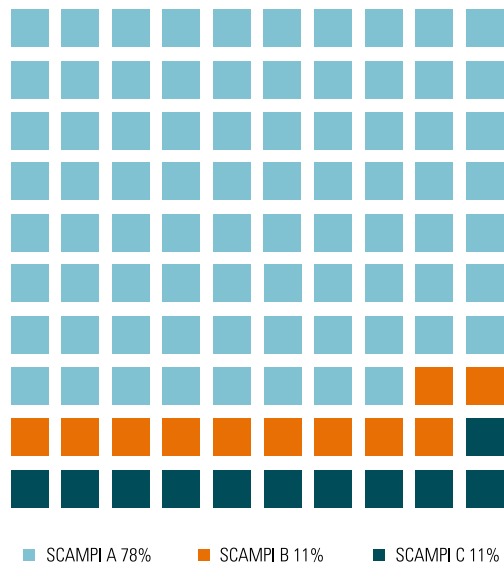### CMMI Appraisals across Industries
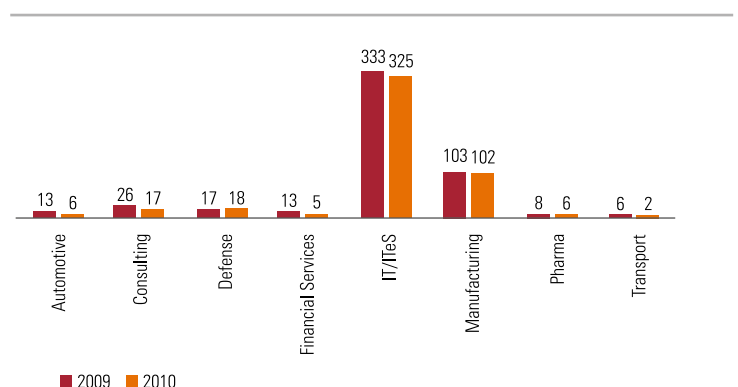
Source: SEI Report for 2010-2011 at http://www.sei.cmu.edu

Number of CMMI appraisal by 2011 quarters

Number of Appraisals by CY Quarter

3Q09 4Q09 1Q10 2Q10 3Q10 4Q10 1Q11 2Q11 3Q11 4Q11
*4Q11 data collection is ongoing

Percentage of Appraisals by class

■ SCAMPI A 78%   ■ SCAMPI B 11%   ■ SCAMPI C 11%

Source: SEI Report for 2010-2011 at http://www.sei.cmu.edu

Percentage of appraisals by industry and by class

■ Business Services, 38%

■ Engineering and Management Services, 33%

■ Other Services, 14%

■ None Selected, 9%

■ Electronic and Other Electric Equipment, 6%

■ Transport, Communication, Electric, Gas and Sanitary Services, 2%

■ Finance, Insurance and Real Estate, 1%

■ Public Administration (Including Defense), 1%
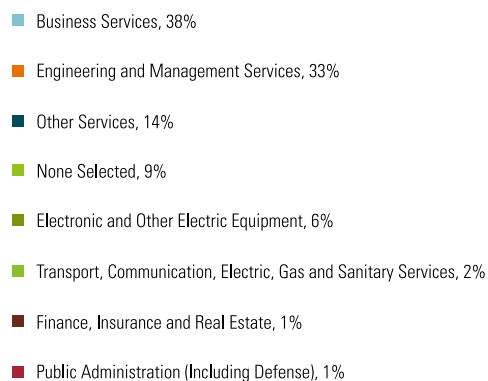
Source: SEI Report for 2010-2011 at http://www.sei.cmu.edu

What lies beyond CMMI is applicable to most of the organizations that have successfully been appraised at various levels of CMMI. Here focus is on two specific scenarios- A highly mature organization that has been appraised at CMMI Level 5 and one that has achieved Level 3.

Firstly, let's discuss how these two scenarios differ from each other. An organization at level 5 possibly has all the high maturity practices where processes are statistically controlled and are used to predict the variations and thereby reduce the number of defects. On the other hand, the one at level 3 has only little insight into the how's of statistical controls and they have just institutionalized their engineering and other management practices.

Both of these organizations would most expectedly like to continue their efforts in this direction of adopting best practices and creating a benchmark. The question that creeps in though is what would be the best approach or rather what is the next methodology to pick from? They need to look back and gauge the improvements and conclude if CMMI really added value to them or not. If CMMI was meant for them, and since no process improvement journey has an end-point, they need to introspect into further actions to be taken.

Proposed approaches

A general approach towards assessing what's missing from the current state of process to achieve clearly laid down business objectives is, conducting a comprehensive gap analysis which then feeds into process definition and then further deployment. And all of this is just about improving critical processes.

The main objectives for an organization beyond CMMI ideally ought to include-

- Improve delivery capability thereby increasing customer satisfaction (continuous improvement)

- Create core capabilities facilitated by these processes that thus offers differentiation

Steps in continuous process improvement

| Define the process: Ownership & Documentation | Measure the process: Visibility | Analyze the process: Tools and Techniques | Improve the process: Root Cause Analysis & Operations Reviews | Control the process: Reinforcement |

Few approaches that might seem relevant in most of the two scenarios mentioned here are discussed.

Scenario 1: CMMI organizations at level 3

Since an L3 organization has all of its practices with respect to SDLC phases in place, possible avenues that it can delve into after the appraisal could be the following.

1. **Six Sigma Principles** - Six sigma aims to reduce defects to about 3.4 DPMO and improve factors that are critical to business so as to achieve customer satisfaction; and this is essentially done by reducing variation in the process. Since CMMI is a framework which specifies what to achieve at an organization level to mature the processes used, a technique (*the methodology*) that synchronizes with the concept could be used to achieve *what's* in CMMI. The metrics architecture that epitomizes working ways through the high-level business objectives to sub-process level objectives is analogous to what CMMI expects to satisfy in a process.

Defect rate versus process sigma level
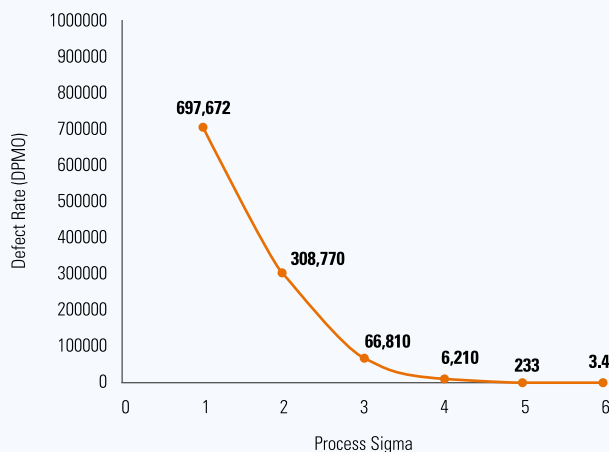
Source: Six Sigma Process and its Impact on the Organizational Productivity, Masoud Hekmatpanah, Mohammad Sadroddin, Saeid Shahbaz, Farhad Mokhtari, Farahnaz Fadavinia, World Academy of Science, Engineering and Technology 43 20085

The figure above indicates how the level of six sigma that an organization is at is directly related to the defect rate in its processes.

Six sigma as a methodology can be used for a smooth transition into high-maturity process areas of CMMI as their strengths would ideally complement each other. Both these models focus on predictability as a measure to understand and continually improve process performance. Hence while using Six Sigma to achieve high-maturity would imply a top-down approach to reducing variation of multiple elements in the metrics architecture. Thus Six Sigma, when combined with CMMI, is more or less a problem-focused technique. The following figure depicts successful implementation percentages of Six Sigma across the globe in various verticals.

Percentage of organizations implementing six sigma from a survey sample
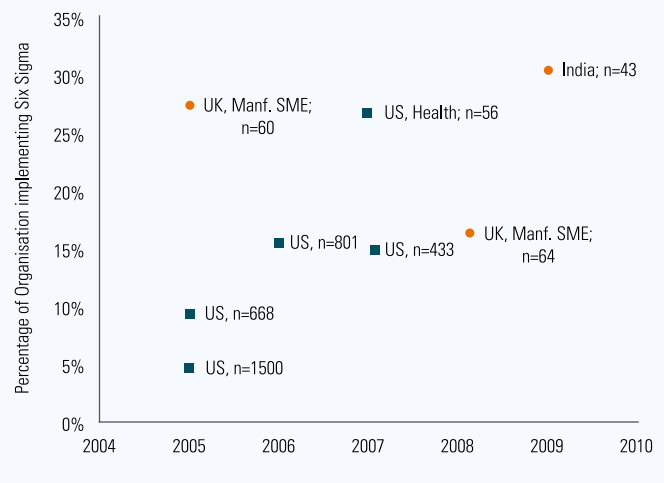

Source: Adoption of Six Sigma: Review of Empirical Research, Venkateswarlu Pulakanam and Kevin E. Voges, International Review of Business Research Papers Volume 6. Number 5. November 2010. Pp. 149 – 163

2. **Agile** - Organizations these days would like to embrace changes and stay adaptable to the changing needs of stakeholders. Agile is the call of the hour when it comes to the dynamism that the market displays. Agile practices are a way to reducing costs and brining in early ROI with lesser ceremonies. There are multiple models under the agile umbrella today that can be easily practiced within teams with some self-discipline and no direction- Scrum, Extreme Programming (XP), Dynamic Systems Development Model (DSDM), Test-driven Development (TDD), etc. are few examples.

Agile being the recent trend in the IT industry today, has found its way into many organizations. Agile adoption has also proven high success rates, obviously depending on the strategy of adoption and choice of the best-fit process for teams. Below is a figure depicting the adoption and respective success rates of using agile practices.

Recent Agile adoption and respective success rates
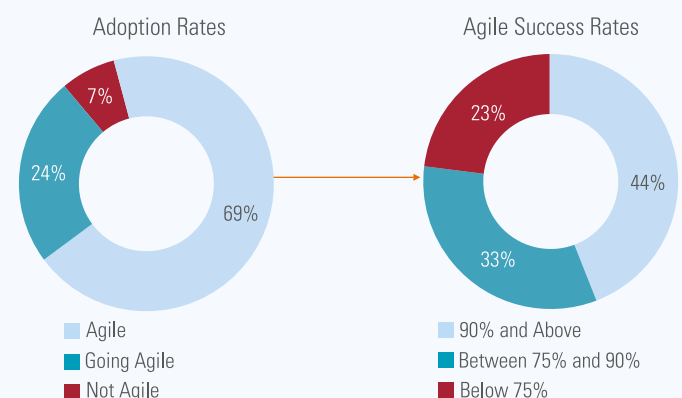
Source: Agile Adoption Rates Survey Results" by Scott Ambler at http://www.ambysoft.com/surveys/agileFebruary2008.html
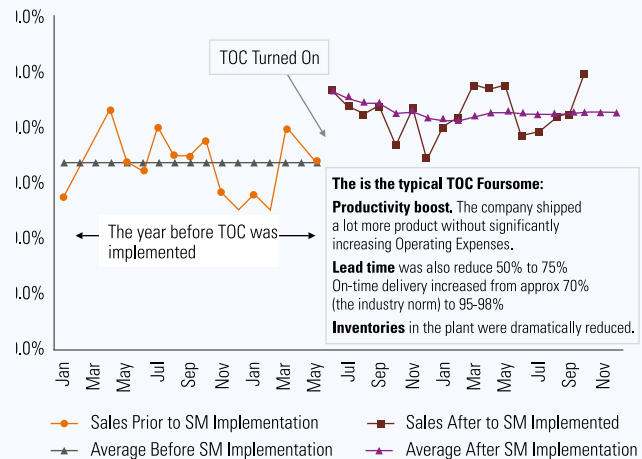
Agile could fit into organizations that are either CMMI appraised and a project's nature demands following agile practices, or those who have Agile in their DNA but project demands CMMI compliance. For instance, most of the practices under Scrum have been clearly mapped to CMMI process areas.

So when the management calls for adaptability in a CMMI implementation, agile is the proven choice. Moreover, agile implementation can easily apply to organizations which have chosen a continuous representation to CMMI opposed to a staged representation.

3. **Theory of Constraints**- Theory of constraints (TOC) focuses on optimizing the existing processes by focusing the team's energy on eliminating constraints within the process. This theory, introduced by Eli Goldratt in his book The Goal[1], was claimed as common sense by his audience but the subtle practice was definitely not followed in a structured manner in any organization. The analogy used often to explain TOC is that a chain is only as strong as its weakest link. Hence, as long as the weakest link is not worked on, the overall strength of the chain cannot be improved. This weakest link is the constraint in the system which reduces the overall throughput. TOC logically attacks the bottlenecks using cause-and-effect constructs to arrive at the root cause of a problem, instead of just treating the weak linkages. Subordinating other linkages to improve the weakest link, results in an overall improvement in the system.

TOC operates around a basic framework of 3 questions- What to change, what to change to, and how to cause the change? And then executes it through a 5-step approach where identifying the constraints, exploiting them and synchronizing processes ahead to work in harmony are critical. Figure in the next page is indicative of improvements in revenue while using TOC, which arise from positive impact on productivity and lead time. The results are from testimonials derived from surveys conducted across several organizations that have implemented TOC.

Immediate impact on productivity from TOC in work case study

The is the typical TOC Foursome:
Productivity boost. The company shipped a lot more product without significantly increasing Operating Expenses.
Lead time was also reduce 50% to 75% On-time delivery increased from approx 70% (the industry norm) to 95-98%
Inventories in the plant were dramatically reduced.

Source: Implementing CMMI using a Combination of Agile Methods, Julio Ariel Hurtado Alegr´ıa and Mar´ıa Cecilia Bastarrica, CLEI ELECTRONIC JOURNAL, VOLUME 9, NUMBER 1, PAPER 7, JUNE 2006

Theory of Constraints for its nature of being a common-sense technique can be applied in any environment, including marketing and sales. However, one of the TOC applications called Critical Chain Project Management (CCPM) is extremely powerful for organizations implementing CMMI. The critical chain approach, as opposed to critical path technique, aims to focus on resources that execute the project tasks and identifies the critical chain of tasks that constrain project's completion. It manages uncertainty well by effectively scheduling tasks and buffer management techniques, and hence focus is on throughput maximization versus resource utilization. According to[2], "Critical Chain enables organizations to generate schedules that are 25 percent shorter than traditionally planned schedules, AND to meet the promised completion date 85 percent or more of the time. Better still, organizations are finding up to 100 percent more productivity from the same project resources when they follow the Critical Chain approach." This technique becomes very crucial in a typical CMMI environment where on-time and within-budget are majorly the key objectives.

Hence, TOC can be used in combination with six sigma, as a way forward to achieve L5 in an L3 organization, or even simply to identify the process bottlenecks in order to channel team's energy on the weaknesses. This approach will undoubtedly yield positive results in a process improvement journey.

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1. The Goal by Dr.Eliyahu M.Goldratt, North River Press, 1984

2. Theory of Constraints Applications at http://www.synchronix.com/about-theory-of-constraints/theory-of-constraints-applications

Scenario 2: CMMI organizations at level 5

Most of the approaches that apply to an L3 organization by far are applicable to ones at L5 too. However, once some level of statistical control is achieved, there's more to be done in an effort towards continuous improvement. Few of those principles to be followed and methodologies to be taken into account are discussed here.

1. **Lean Six Sigma**- Lean is a philosophy and set of management techniques focused on continuous "eliminating waste" so that every process, task or work action is made value adding as viewed from customer's perspective. Lean "waste elimination" targets the "Eight Wastes" classified as Defects, Overproduction, Over-processing, Transportation, Waiting, Defects, Rework and scrap, Inventory, Motion and unused creativity. Lean Six Sigma is hence a synergized managerial concept of Lean and Six Sigma that drives business agility at a rate of 3.4 defects per million opportunities (DPMO).[3]

   Lean techniques focus on removing the wastes that add no value to either product or service being delivered to the customer. Essence of such a process is to manage variations, reduce defects and have predictability that prepares you to adapt to changes. All this controls future performances of all processes. Hence the aim is to identify the value-added features, and to understand the sequence of activities that create this value stream so that the other activities like transportation, work in progress, or over-production of inventory could be reduced. This technique is flow-focused so that the customer can pull out the product and service from the process as and when needed.

   Lean principles reduce waste and speed up delivery, which then helps increase predictability and thus aid in complying with CMMI. And since Six Sigma is not a one-time project or improvement effort, lean can be combined with six sigma in order to comply with the CMMI concepts of continuous improvement.
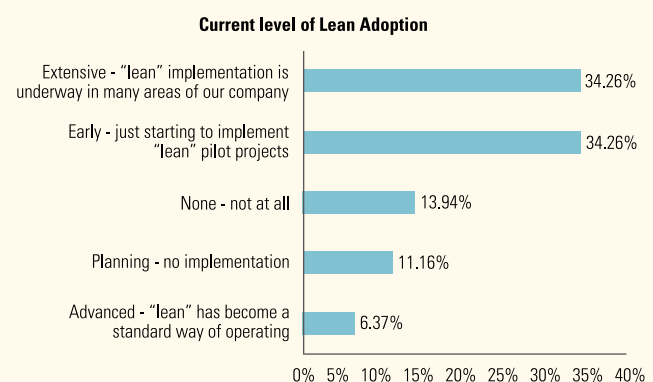
   In light of this approach, it's important to get rid of the misconception that Lean is only for manufacturing. Lean can also be applied in application development and maintenance projects within organizations. Many processes around these projects are poorly managed and result in rework. Identifying the main sources of waste is important while implementing lean techniques- for instance, cost of using those heavy-weight tools in a software development environment and then re-working your way through another one, the cost of resolving hundreds of telecom customer tickets, the cost of simply writing code without any business rules and so on.

   In order to be a lean enterprise, lean techniques need to be applied strategically to all operations and businesses within the organization. From the research conducted in[4], it

highlights principles of Value, Value Stream, Flow, Pull and Perfection to achieve what few case studies have proven of Lean techniques used at a Construction firm-

- Reduction in construction times by 25 percent in 18 months
- Reduction in schematic design time from 11 weeks to 2 weeks
- Turnover increases of 15-20 percent and increase in productivity
- Satisfied clients looking to place repeat orders
- Reduction in project costs

Trends in Lean implementation- Electronics manufacturing survey

Current level of Lean Adoption

Extensive - "lean" implementation is underway in many areas of our company	34.26%
Early - just starting to implement "lean" pilot projects	34.26%
None - not at all	13.94%
Planning - no implementation	11.16%
Advanced - "lean" has become a standard way of operating	6.37%

0% 5% 10% 15% 20% 25% 30% 35% 40%

Source: Trends in Lean Implementations, Bruce Rayner, VP Consulting and Research, Technology Forecasters Inc., Apr 12, 2007 at http://www.emsnow.com/npps/story.cfm?id=25997

The figure above shows recent trends in lean implementation. It's clear from the figure that rates of adopting lean are significantly high and would only increase as more organizations take on the path of continuous improvement.[5]Reports that "since companies are consistently under pressure to improve operational efficiency and profitability, turning to Lean Six Sigma, which Mr. Hubert Eke describes as the science of breakthrough improvements, could bring near magical results that would reflect from changes made throughout the value chain, including internal pressures, supplies and most importantly customers relationship."

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3. Lean Six Sigma, An Overview, from eXample at http://www.examplecg.com/pdf/Lean%20Six%20Sigma%20Overview.pdf

4. Strategic Application of Lean Thinking, Naomi Garnett, Daniel T. Jones, and Simon Murray, Berkeley

5. Lean Six Sigma, science of breakthrough improvements, by Neta Nwosu at http://www.sunnewsonline.com/webpages/features/marketingmatters/2012/feb/29/market-matters-29-02-2012-02.html

2. **Agile**- Although there are hesitations while combining agile with CMMI high-maturity practices, the reality is to find a sweet spot between the what's of CMMI and the how's of agile where predictability and adaptability play along together. There are certain challenges in mapping high maturity process areas to say Scrum practices, where predictability proposed by CMMI contradicts adaptability inherent within Agile. However, if a radical shift in "doing" process improvement is required, there can always be a Scrum-but approach that could be mapped to the high-maturity areas and where agile metrics can be used to create statistical models.

From one of the case studies in KPMG in 2010, a CMMI level 5 IT company intended to introduce Scrum to better serve its large customer needs. It used concepts from Feature-driven development (FDD) as well as lean and data-driven techniques like Story process efficiency to surface product backlog impediments. The product backlog was continuously maintained and a standard checklist was used across developers for implementing stories. In addition, the team had demonstrable software at the end of every sprint and statistical process control was used for chosen measures. The result was a 2X boost in productivity and cut in defects by 40 percent. This exemplifies how to effectively use agile methods in a high-maturity environment for continuous process improvement. The figure below indicates relation of agile process asset to CMMI components when implementing CMMI with Agile.

Implementation relationship between CMMI requirements and Agile
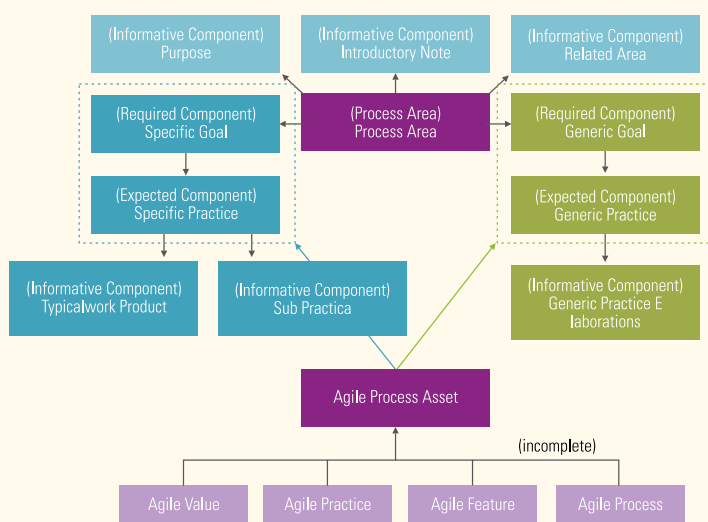
Source: Implementing CMMI using a Combination of Agile Methods, Julio Ariel Hurtado Alegr´ıa and Mar´ıa Cecilia Bastarrica, CLEI ELECTRONIC JOURNAL, VOLUME 9, NUMBER 1, PAPER 7, JUNE 2006

3. **Theory of Constraints**- As discussed previously, TOC aims to identify the bottlenecks using a logical approach as opposed to six sigma's data-driven approach, and can be used at any stage of a CMMI implementation-either during or beyond to evaluate where the focus deserves to be.

TOC is constraint-focused and wishes to improve overall system performance by eliminating these constraints. Goldratt had rightly said- "Focus on everything, and you have not actually focused on anything". Breaking the constraints is an iterative process and does not require extensive knowledge of statistics unlike what's required in Six Sigma or Lean. Still it eventually reduces variation and improves quality of the entire system by improving a local constraint. Just as Lean, TOC gives importance to speed and volume at which an output is produced. However, this approach is more suited in organizations where the teams are not required to be self-disciplined, but driven by management decisions. Also, this approach clearly assumes that the current design of the system and the processes underlying beneath are stable to achieve the output, which is true of organizations at level 5.

4. **Multi-model approaches that focus on People, Process and Technology**- Most of the approaches listed above can be termed multi-model approaches as they tend to combine other models and practices into a CMMI environment. Apart from these methodologies, various constellations of CMMI itself can be combined with each other in order to expand areas of improvement.

It's apparent that most of the process improvement models focus only on the process and lose visibility into people and technology which also are critical pieces in achieving goals and an overall organizational improvement. From this perspective, CMMI-DEV or CMMI-SVC can be combined with PCMM to achieve best results. PCMM brings into picture competency assessments, training effectiveness and the like which create a whole new focus area to improve upon people who are the drivers of process improvement.

Also for instance, CMMI-DEV can be combined and work in unison with CMMI-SVC in organizations which run both development and service delivery projects in parallel. This lets organizations understand nuances of being a product company in addition to aspects of operating a service model.

5. **Tools & automation, and business process integration**- Along with right strategy and operating model, high performance organizations get execution and process right. A critical yet inherent part of process improvement is about effectively integrating, optimizing, streamlining and automating processes. As mentioned under multi-model approaches, technology is another crucial part that needs to be focused on during process improvement in addition to people and process, and tools and automation are a part of it.

Without automation, any effort becomes counter-productive to the "real" goals and distractions occur. Not having tools to support defined processes goes against the lean principles and speed of delivery gets negatively impacted. Hence to carry forward improvements to processes and people, it's important to feed in as much automation as appropriate and which can be handled by the current set of resources. This also involves establishing new processes or value based enterprise architectures from which to make and deploy better technology decisions.

This approach should however also consider the trade-off between bringing in the set of tools in practice and training people to use them.

Usually, most of the organizations have their IT function working in a separate silo completely disintegrated from other business operations. Integrating business processes with IT is an improvement in real sense which can be measured and monitored like any other process improvement. Once businesses integrate with IT, highly-valued automations occur and both these functions get to complement each other in ways that increase productivity. This also succumbs to the fact that all functions within a business need to work together to achieve a common goal which then converts into success.

6. **Improvement science**- In addition to picking from one of proposed approaches here, another avenue to consider would be an amalgamation of all of these that can be collectively called Improvement Science where focus is on global delivery and improving the delivery quality. Here, the requirement might not necessarily be CMMI implementation, but real internal process improvement that serves as a transformation within the people and process that defines culture in an organization.

In an overall sense, it's been observed that a culture of innovation needs to be instilled into organizations that aspire to be benchmarked as process improvement idols. Essentially, the entire process that's used for process improvement needs to be improved iteratively using the DMAIC (Define, Measure, Analyze, Improve, and Control) principles.

Expect challenges

All of these proposed approaches come with challenges as with any other improvement initiative.

- When multi-model approaches are picked, there are differences in terminology and basic principles. This might result in few conflicts between improvement efforts using each model or framework as each would follow its own approach.

- When mapping CMMI process areas to Agile practices, practices in one might not seem coherent with the other. The iterative nature of agile might appear illogical in a traditional manufacturing environment that has adopted CMMI.

- There can be problems identifying similarities between the models and methodologies which hence invalidate the idea of them working together.

- In scenarios where every project is different and processes are not consistent and repetitive, lean techniques might not hit right at the first place.

- There are always certain hard and soft strategic constraints (resource capacity, firm policies) that can be a major pitfall in implementing any improvement technique.

Critical success factors

All of the above challenges display a lack of sustainability of improvements across processes. Few things are critical to success on this continuous process improvement journey despite the challenges-

- Performing an initial assessment of practices from which only good-practice and best-fit elements that suit your needs can be picked.

- Definition of a threshold of success (ToS) for any technique chosen and continuously monitoring the same. The criteria under ToS need to be data-driven. At any point if a technique can be proven to not add value to your environment, drop it to avoid further wastes.

- Applying common sense and judgment while implementing any of the techniques since there's no silver bullet to tackle all problems.

These factors should be considered so that improvement methods work in harmony and institutionalization can be achieved. There might be instances where one practice might have to be tailored to meet the needs of the other, but it should never be at the risk of deteriorating process improvement.

Conclusion

In summary, all roads lead to Rome and hence the selection of a process improvement technique is solely dependent on the culture of an organization. Although all these techniques intend to introduce strategies that could maximize revenues with minimal investment within an organization, the crux is to identify the right technique that best suits your organization's values, people and environment. Digging out the assumptions that lie beneath any process in an organization and questioning the core emphasis of each of these techniques might just result into an improved management strategy and a whole new philosophy might just emerge. Nevertheless, irrespective of the methodology chosen for process improvement, the one element that remains constant is the process of improvement never ends!

Reviewers' Profiles

He handles Strategic Advisory Services encompassing Model based, Six Sigma and Sourcing Process Improvement Advisory Services. An MBA from IIM(B), Raman has directed over 200 advisory engagements and served on the review panels and pilot initiatives for new models and frameworks from the SEI. He is also an executive member of SPIN BLR chapter, member of European SEPG review panels, member of Institute of Public Auditors and is active on NASSCOM, CII panels and conferences in the field. KK serves as a IT Industry Champion for KPMG in India in his role as an Advisory Partner.

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Prasanth has rich experience of more than 18 years in process advisory and quality assurance. Consulted clients in achieving business objectives through improved processes by facilitating implementation of industry best practices and process improvement models/ reference frame works (CMMI®, TMM and ISO 9000) to bring lasting value to organizations.

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Arpan carries a Masters degree in Software Engineering from Carnegie Mellon University, USA, and has been involved with the Big 4's in the management consulting domain. She is a Certified Scrum Master (CSM) and has in-depth knowledge of the process improvement space. She has a working knowledge of many models, frameworks and methodologies like CMMI, e-SCM, Six Sigma and Agile. Her expertise lies in agile where she has worked on multiple projects using processes like OpenUP, Scrum, etc. and is versed with agile tools like Process Dashboard, GForge, Redmine, etc. Besides, she has written many whitepapers on Software Engineering practices and published technical reports mapping various process capability models.

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