The Economics of CMMI®

NDIA Systems Engineering Division

CMMI Working Group

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1.0 INTRODUCTION

Much has already been written on CMMI and how to use it as a model for process improvement. Relatively little, in comparison, has been written on strategies for how to achieve *business value* from CMMI. CMMI is an investment – implementation strategies can influence whether that investment is simply an added cost of doing business, or whether it translates into improved business performance and cost efficiencies. It is this equation, the "Economics of CMMI," which is sometimes overlooked by CMMI adopters, especially those motivated by external rather than internal influences. It is the alignment with performance objectives and relentless pursuit of business value that will help companies get the most from their CMMI investments.

The CMMI Working Group, sponsored by the National Defense Industrial Association (NDIA) Systems Engineering Division and comprised of recognized CMMI experts representing many companies in the defense and commercial industries, has seen and experienced numerous examples of both effective and ineffective implementations of CMMI – even within our own companies. This paper provides practical guidance for CMMI adopters in the effective use of CMMI, based upon established NDIA principles.[1]

Targeted at implementers and executive decision-makers setting strategies for improving business performance through process improvement, this document assumes readers have at least a basic familiarity and understanding of CMMI. Those looking for an introduction or explanations of the CMMI are referred to many other sources that cover these topics well.[2] The emphasis here is on strategies and mechanisms that emphasize practical business value achieved through CMMI.

This document is structured into two parts, organized around these themes:

- Achieving business performance improvement through the economical business application of CMMI (Section 2).
- Practical guidance on economical CMMI implementation mechanisms that take advantage of the business context (Section 3).

When implemented effectively with sound strategies focused on business returns, CMMI can be a catalyst for improved performance. Written by industry and for industry, this document can help guide businesses to realize these benefits.

2.0 ECONOMICAL BUSINESS APPLICATION OF CMMI

The CMMI model is a tool that many organizations have used as part of a long-term business strategy. A number of success stories have been documented[3] to support this approach. Characteristics of success include improvements in cost and schedule performance, quality, productivity, and customer satisfaction. However, many other organizations have faltered in their use of CMMI, resulting in costs invested without significant return or, in some cases, reduced overall performance. Since its initial publication in 2001, some first principles have emerged from observing organizations that experienced success using CMMI.

These first principles of CMMI adoption, and the potential impact of not recognizing these principles, are summarized in the following table:

First Principles of CMMI Adoption	Potential Impact When Not Adopted
• CMMI-based improvement efforts must align with and support defined business goals.	• CMMI investments do not affect business performance; process improvements which are not really improvements have detrimental effects.
• Organizational leadership must be actively involved and visibly committed to the improvement effort.	• Improvements are not substantial or lasting, due to lack of organizational commitment and resources. Missed opportunities to improve the business.
• Manage process improvement velocity. The rate at which processes are improved must respond to the needs of the business.	• Massive simultaneous change overwhelms an organization and results in loss of focus on high priority improvement targets. Improvements are not realized in a reasonable time frame, which reduces the return on investment.
• Continuous performance improvement must be an intrinsic part of the job – not secondary to it.	• Workforce not engaged in improvement initiatives. Waste due to inefficiencies and organizational resistance to change. Premature abandonment based upon failures leaving a worsened condition in the aftermath.

The remainder of this section examines each of these principles that, when taken together, provide a foundation for the effective business application of CMMI.

2.1 Support of Business Goals and Strategy

Most business strategies either directly or indirectly require improved performance. Reducing time to market, increasing quality, reducing cost, raising customer satisfaction, expanding capability . . . all involve improved execution to increase profit and market share and surpass the competition. The CMMI is an instrument built to support these business goals. Integrating the CMMI with other process improvement techniques such as Lean, Six Sigma, ISO, and Agile can create a powerful toolkit in an organizational business strategy.

Support of Business Goals and Strategy

- CMMI is for improvement with a purpose; fit CMMI to the business objectives, not vice versa.
- Prioritize improvements where business performance needs are greatest.
- Pursue business value and improved performance – maturity levels should not be the first emphasis.

All successful process improvement programs require a purpose with prioritization of process improvements where needs are the greatest. As such, the CMMI must fit into a business strategy.

Declaring a CMMI maturity level to be a business objective is misleading and obscures the real intent. It is the implementation of practices within the maturity level that can improve business performance.

Unfortunately, many organizations have focused on achievement of a CMMI maturity level as a primary business goal. Such an approach moves the CMMI from a means to achieve an end, to the end goal itself. This approach has led many organizations to spend considerable resources developing processes that are cumbersome or inefficient, do not reflect the business context of implementation, and lack meaning to those who are required to execute them. They exist only because "the CMMI said we had to do this." Consideration of organizational or project performance improvement needs is either done in an ad hoc manner, or is not considered at all.

The resulting organizational standard process, although compliant with the CMMI, may not reflect the actual processes performed on projects, and is likely to be of little value to the organization or organization's projects. The "new CMMI processes" will very likely lead to longer development times and cost more than they otherwise should have if processes were aligned with performance, or existing processes were codified and more widely adopted. Processes, and verification of compliance to them, can become more of a burden than a benefit if the focus on effective results is lost. Use of these standard processes is likely to be resisted by much of the organization, leading to a lower morale and disenchantment with the overall improvement effort. It is also possible to actually *decrease* the performance of projects, and the organization, by going about improvement in this manner.

Effective implementation is achieved by asking how CMMI or achieving a maturity level can help the organization achieve its business goals.

- What processes in an organization need improvement?
- What systemic issues drive excessive rework?
- Are projects not achieving cost and schedule targets?
- Are plans unrealistic?
- Are customers reporting defects in delivered products?
- Are changes to work products not adequately managed?
- Are requirements changes leading to cost overruns and delayed product deliveries?
- Where are the bottlenecks and waste in the value stream?

The practices in the CMMI are meant to address these types of issues and more. The CMMI models contain best practices for project management, developing products and services, acquisition, service delivery, process management and support areas such as configuration management, quality, and measurements. Aligning the CMMI best practices where they best serve defined business goals and strategy is the key to successful, cost-efficient business improvement.

2.2 Organizational Leadership

Successful CMMI-based process improvement involves leading change in an organization. The role of management commitment has been frequently cited as the key factor in effective change management.[4] How senior and middle management demonstrate their commitment to CMMI sets the tone for the rest of the organization to buy into the proposed improvements. Lack of management commitment leads to change resistance in an organization, or half-hearted efforts that are doomed to fail.

Organizational Leadership

- Prominent executive sponsorship and commitment are crucial for organizational changes to stick.
- Hold people accountable for improvement progress – get the organization involved.
- Understand and be able to articulate the CMMI commitment.

Demonstrating commitment to CMMI-based process improvement requires more than a verbal commitment, or funding a process group and delegating all CMMI responsibility to that group. Commitment is demonstrated in a number of ways:

- Upper management must buy in to CMMI being worth the effort to implement by understanding what CMMI is and is not. Executives cannot really sell the idea to the workforce until they buy the idea themselves as a real way to improve performance and add value.
- Senior leadership should frequently communicate with the workforce stakeholders to explain the context and mission of the CMMI initiative, including the rationale for using CMMI as it relates to business strategy. Stakeholders include those who will actually use the processes as well as functional management and program management. Periodically reporting status and success stories reinforces this message.
- Management must provide adequate resources, including skilled people, funding, and tools necessary to perform the process improvement work. Assigning well-respected opinion leaders in the organization to key roles in the process improvement task helps demonstrate the importance of the initiative.
- It is important for management to set an example by its own behavior that the rest of the organization can follow. This includes demonstrating an understanding and taking ownership of the new processes, as well as fulfilling its role in process execution. This influence cannot be overstated: People watch what executives do more than listen to what they say.
- Management needs to enforce the desired behavior in staff, especially in times of stress. Rewarding desired behavior is an excellent motivating tool in an organization. This can be done by setting performance goals, rewarding when goals are achieved, and providing public recognition of success.
- A real CMMI effort takes time and money. Decision makers must have a realistic understanding of this before committing to use CMMI, and be able to articulate/communicate why it is important to use CMMI from the top to the bottom of the organization. After committing they must stay the course and not continuously reassess the CMMI decision.

Ultimately, an organization takes its cue from senior management on what is and is not important. True management commitment mobilizes the organization. Half-hearted commitments are easily seen as transparent and ignored appropriately. Unless executives “walk the walk” as well as “talk the talk,” the organization will not buy it.

2.3 Improvement Velocity

Organizations contemplating CMMI often ask how long it will take to achieve a desired maturity level. Data collected on this topic exhibits great variation.[5] A number of factors influence the rate of process change, or improvement velocity, that an organization can absorb. Those factors include:

- Understanding the relationship of process improvement and performance improvement
- The effectiveness of change leadership
- The current process state of the organization
- The capability for rapid or organizational learning
- The improvement method or strategy
- The underlying “systemic” domain knowledge that currently exists
- Project profile: size, complexity, duration, etc.

Improvement Velocity

- Plan for change. Consider the state of the organization. Prioritize improvements where they are most needed.
- Manage process improvement like a program.

A better question to ask is "what are the most meaningful changes needed in the organization, and what is the time frame in which the organization needs those improvements to be implemented successfully?"

Process improvement, if not managed carefully, can be a voracious consumer of resources. (Many of the techniques for economical implementation of CMMI are discussed in Section 3 of this paper.) Managing process improvement as if it were a project in the organization applies rigor to the improvement effort and provides management visibility of progress, improving the likelihood of success.

- Identify a good program manager to run the process improvement project.
- Establish a budget and schedule with milestones that balance prioritized improvement needs with the capacity of the organization to absorb change.
- Create an improvement team charter and organization chart; assign roles and responsibilities.
- Conduct formal startup and periodic program reviews like other projects in the organization.
- Involve process users and not just process directors or creators

Any program, including a process improvement program,that uses effective program management techniques enhances its chance of success. Programs that start well usually end well; programs that start poorly usually end poorly.

2.4 Making Performance Improvement Intrinsic to the Job

Dr. W. Edwards Deming noted that "Quality is everyone's responsibility," and further stated, "Quality is not an act, it is a habit." These same principles apply to process improvement.

Making Performance Improvement Intrinsic to the Job

- Process improvement is everyone's responsibility.
- Engage practitioners.
- Involve respected experts and opinion leaders.

Process groups are often established in organizations to facilitate process improvement efforts. Process groups can lead the project that develops and deploys improved processes in an organization. However, process groups cannot successfully perform this activity without the active participation of practitioners and managers at all levels in the organization. The most useful processes are often developed by engaging the practitioners who actually perform the work, not an "ivory tower" of process experts disconnected from the real issues faced by projects. Processes and assets developed in isolation without involvement of the workforce are likely to be neither effective nor accepted. Ultimately, the defined process is owned by the organization, not the process group that facilitated its development.

An organization wherein all employees take responsibility for the process and its continued improvement (via process improvement suggestions, lessons learned, shared experiences, exposure to new technologies) is an organization that is more likely to achieve success. One effective way to achieve this is to set personal objectives for each employee to contribute toward process improvement initiatives.

The treatment of process improvement as a secondary job by senior leadership and key personnel in an organization can crush an improvement effort. Staffing process groups (or any other project) based on availability rather than qualifications will not succeed. Respected experts with strong practical experience not only possess the skills needed to find best value in process implementations, but can also be opinion leaders that give credibility to CMMI and process improvement within the workforce.

3.0 ECONOMICAL IMPLEMENTATION OF CMMI

Investments in CMMI or other process improvement strategies should be justified by corresponding returns in improved business performance. With this document, the authors seek to provide guidance to help organizations, and the industry at large, maintain the CMMI emphasis where it belongs: improvement in business results and project performance, achieved economically.

The CMMI model does not offer a cookbook implementation methodology. What it does provide is a set of ingredients that an organization can use to create its own recipe for success. Every business is different. The CMMI is designed to offer implementation flexibility that is expected to be shaped uniquely for each business and project.

Section 3 of this document examines key considerations for the economical implementation of the CMMI, including:

- Use the CMMI as an integrating framework
- Develop and deploy processes effectively
- Tailor the CMMI implementation appropriately
- Implement CMMI in a practical way
- Make an informed decision on high maturity
- Conduct appraisals economically

For each topic, common pitfalls are identified that can often distract organizations from realizing the greatest benefits from their CMMI investments. Recommendations and guidance are provided to help organizations implement CMMI effectively by maintaining focus on business value.

Take what you can from this guidance. Far from being an exhaustive list, and expected to be interpreted, tailored, and applied much as the CMMI model itself, it is hoped this will provoke thoughtful dialog within companies and the community on the "Economics of CMMI."

3.1 Use CMMI as an Integrating Framework

Common Issues	Recommendations
• Multiple parallel improvement strategies are being pursued (e.g., CMMI, ISO, Lean, Six Sigma) but are not well integrated and coordinated at the organizational level.	• Create one set of organizational process standards supporting multiple improvement strategies. Use the process management practices in CMMI to create a process architecture and framework supporting multiple process guidance sources.
• Not all functional organizations engage in integrated process improvement, resulting in sub-optimized processes or disjoint initiatives.	• Integrate stakeholders and cross-functional processes using CMMI to identify issues early in the product life cycle.

Create One Set of Organizational Process Standards

The CMMI is one of several sources that provide process guidance for an organization. Other examples include Lean Thinking, Six Sigma, the Information Technology Infrastructure Library (ITIL), and ISO standards. These frameworks/approaches vary widely in their content. Some are domain-specific, such as CMMI, ISO standards, and ITIL. Some include defined appraisal or certification methods, such as the CMMI and ISO standards.

An economical approach for an organization to take is to create one set of process standards that map back to these individual process requirements, rather than to create multiple standards or establish competing process improvement initiatives. CMMI models have been applied successfully in many multiple-approach improvement efforts. Examples include the use of CMMI models in Lean efforts, the integration of Six Sigma tools and methods, and the concurrent use of ISO standards with CMMI models. Some organizations have conducted SCAMPI[SM] appraisals against multiple reference models concurrently, such as CMMI and ISO 9001. The Software Engineering Institute (SEI) is also conducting research into multi-model improvement initiatives.

All process improvement areas should be integrated into one process improvement organization and not spread throughout disjoint functional areas. Lean, Six Sigma, and other initiatives should be an integral part of the company's process group, and headed by a senior manager that knows how to execute programs.

The CMMI product suite is unique in the world of improvement approaches and frameworks. CMMI constellations provide practices and guidance for forming a mature "organization for improvement," with models containing domain-specific best practices (development, services, and acquisition), and SCAMPI appraisal methods offering robust assessment mechanisms that can incorporate "non-CMMI" attributes.

The Process Management process areas (OPF, OPD, OPP, OT, and OID) provide a proven basis for setting up the "organization for improvement." When other process areas, such as MA and CAR, are considered, the necessary process infrastructure is in place to initiate and continuously improve an organization. These process areas have been implemented within Lean and Agile frameworks.[6] Other frameworks, such as Six Sigma, have also been easily assimilated into implementation of the Process Management process areas.[7]

Overall, there appears to be a strong emerging case for consideration of the CMMI as a foundation for integration of multiple improvement approaches or frameworks. The CMMI's support for definition of a mature organization for improvement, provision of domain-specific best practices, flexibility in interpretation (based on informative components, required components – goals, and expected components – practices), and robust appraisal methods greatly reduces the risk in ensuring a solid foundation for continuous, measureable improvement.

Integrate Stakeholders and Cross-Functional Processes

The success of capability maturity models in various domains has led to an integrated process framework in CMMI that can be applied across functional disciplines to coordinate improvement initiatives. CMMI practices supporting stakeholder involvement, concurrent engineering, and teaming further strengthen its effectiveness as an integrating cross-functional framework. This can produce more effective processes with higher quality and reduced rework by ensuring cross-functional issues are identified and resolved early in the product life cycle. Involving senior management, functional management, functional practitioners, and program management in the process improvement activity optimizes results and avoids disruption that can occur if only part of the organization is engaged. Integrating all improvement initiatives at the enterprise level can also provide significant cost savings compared to separate improvement initiatives.

[SM] SEI and SCAMPI are service marks of Carnegie Mellon University.

3.2 Develop and Deploy Processes Effectively

Common Issues	Recommendations
• Processes too closely aligned with CMMI model may be inappropriate for the organization.	• Integrate CMMI with current practices. Design process architectures around how work is actually performed and managed.
• Processes developed in isolation from projects don't reflect reality and aren't accepted.	• Involve practitioners and subject matter experts to help develop, deploy, and maintain processes that are practical and useful.
• Too much change at once overwhelms the organization.	• Manage the improvement initiatives. Consider process improvement life cycles. Pilot changes and evaluate effectiveness before deploying.
• Process descriptions are too verbose, disorganized, or overly dependent on manual effort to be useful to projects.	• Maintain perspective. Remember who processes are for, and why. Keep end users in mind as the primary target for useful, concise process descriptions ready to be followed

Integrate CMMI With Current Practices

Effective CMMI-based process improvement involves integrating the CMMI practices with processes currently being used in the organization (whether documented or not). Some organizations mistakenly abandon their process and declare the CMMI to be "the new process." The CMMI is not a process. It cannot be implemented as written, and must be actualized. The CMMI needs to be adapted to each organization's culture. Some vendors offer to sell organizations "a ready-made CMMI-compliant process" or, alternatively, to "define a process for the organization." This is rarely effective. Any new "process" must reflect the way the organization does business and be aligned with the organization's business needs or it will not be followed by practitioners.

Integrating CMMI practices into existing organizational process standards (and process architecture if it exists) is a more economical and sound path to process improvement. This paradigm involves comparing the way work is performed in the organization to the practices identified in the CMMI, identifying any gaps, and targeting those gaps for process improvement. Change is difficult in an organization. Integrating new practices into existing standards lessens the scope of the change for affected practitioners. If no organizational standards exist, the Organizational Process Definition process area provides guidance for defining a process architecture and subsequently documenting processes.

Involve Practitioners and Subject Matter Experts

Processes are inevitably more effective and better accepted when they are developed in conjunction with those closest to the work being performed. When defining processes, the likelihood of success is greatly increased by involving subject matter experts in the organization. This helps ensure the buy-in of these respected opinion leaders to the new processes, and also helps ensure that the new process represents the way the organization actually functions. Processes written by process groups in isolation are not usually accepted by practitioners in the organization, and often betray a lack of understanding of how work is actually being performed.

It is often helpful to establish a small group of experts who will run the process group long term, and rotate others in as needed for 12 to 18 month durations before they return to programs. This can be structured as career path development for those hoping to move up in the company. This keeps the

process group fresh on the real problems of execution and returns process-experienced individuals back into the organization.

The staff in an organization should be trained to follow the organization's standard process. They need not necessarily be trained in CMMI. It is the process group's job to ensure that the documented processes are CMMI-compliant. Although the process group requires CMMI training, it is adequate for users to know their processes are CMMI compliant. This helps maintain focus on value of the organizational processes, and can save the organization from incurring significant training expenses.

Manage the Improvement Initiatives

Identifying a process development life-cycle model supports the planning and management of process improvement. Project life-cycle models can also be applied to the development and deployment of processes. Be cautious of a "big bang" approach (waterfall), wherein a mass of process is deployed at the same time. This can be disastrous from a change management perspective, and can risk losing gains already achieved. An incremental or spiral approach involving cycles of process deployment is more effective in allowing early successes, mid-course corrections, and lessening the sense of dramatic change among the users. Some process groups have had success in using Agile methods to document and deploy processes.[8]

Be sure that the improvements really are improvements! Utilize pilots and evaluate effectiveness to validate that improvements consistently produce better results than previously achieved. Lean/Six Sigma principles and methods, such as Define-Measure-Analyze-Improve-Control (DMAIC) and Value Stream Mapping, can help ensure that changes are for the betterment of the business, not just different.

Maintain Perspective

Effective process descriptions are constructed in a form most natural and useful to those expected to follow them, and written in a manner that users can understand and apply. Poorly written process documentation may be unusable by projects, and unenforceable by Quality Assurance and management. Ambiguous or inconsistent process documentation may lead to excessive nonconformance reports written by Quality Assurance, and frustration when projects try to follow processes that they do not understand. A common mistake is to write massive textual process documents that practitioners don't have time to even read, much less understand and follow – looks good on paper and for external appraisers, but to the implementers it's nothing more than shelfware. Good process documentation shares the same characteristics of good requirements: clearly and properly stated, complete, concise, consistent with each other, uniquely identified, appropriate to implement, verifiable (auditable), traceable. Consider a variety of representations most easily understood and used by practitioners, e.g., hierarchical drill-down, graphical, tool-based, searchable. Write processes in language users are familiar with, and not the terminology of the CMMI model. Make it easy for the users of the processes, not the developers of the processes.

Processes should be integrated naturally with project workflows and work products, and supported by templates, assets, tools, and automation where practical. Expecting busy project staff to stop what they're doing so they can manually put process artifacts in the right place for auditors isn't likely to be effective or given much priority. Processes, assets, and tools should be designed to support project execution. Projects know what's useful, what they still need, and what's a foolish obstacle – if you don't know the difference, ask!

3.3 Tailor the CMMI Implementation Appropriately

Common Issues	Recommendations
• Organizations adapting to CMMI, instead of adapting CMMI to their business.	• Tailor CMMI model implementations to the business context. Adapt CMMI implementations to meet the needs of the business.
• Forcing a "one size fits all," CMMI implementation on the diverse projects in the organization.	• Recognize the needs of different types of projects. Allow and encourage project tailoring of the organization's process.

Tailor CMMI Model Implementations to the Business Context

Many organizations have treated the CMMI as a standard, or a requirements document, instead of a model for process improvement. Symptoms of this rigid approach include:

- Discarding processes and methods that are already in place in an organization.
- Lifting the CMMI practices word for word from the model, and declaring this to be the organization's "new process."

Just as no two projects are exactly the same in an organization, and the organization's standard process is expected to be tailored to each project, no two businesses are exactly the same and the CMMI is expected to be tailored to meet the unique needs of each business.

Some factors that influence the tailoring of CMMI implementation include:

- Organizational size
- Business objectives
- Customer market needs
- Project lifecycle models and development methods (e.g., incremental, spiral, agile)
- Problems the business may be experiencing
- Processes that are already being performed (whether documented or not)
- Company culture
- Process performance or product quality constraints

CMMI is intended to be applicable to both large and small organizations and projects. Model practices can be interpreted, scaled, and applied for these contexts as appropriate. CMMI has been implemented and used successfully in many small businesses, and on projects with just a few people.[5]

Recognize the Needs of Different Types of Projects

Project tailoring of the organization's processes needs to be allowed and encouraged. When starting to define and deploy process standards, it is not uncommon for organizations to label all process standards as "mandatory," or "untailorable." This usually creates an overly burdensome and costly set of processes for projects to follow. Most projects have unique characteristics that require some tailoring of organizational standards. Encourage adaptation and innovation, within essential boundaries and constraints. Processes should be carefully defined to allow projects the flexibility they need to perform for different customers and different circumstances, but still maintain CMMI compliance. Creating Process Application Expert Teams to help the project teams tailor is one approach to optimize project needs within organizational constraints. Other approaches include defining processes at a low enough level to be instructive, but high enough to not be overly constrictive (this includes appropriate use of expert mode

versus novice mode process definitions.) CMMI requirements are embodied in the specific and generic goal statements. The CMMI specific and generic practices are "expected," not "required." This allows organizations to implement alternative practices that provide an equivalent effect toward achieving CMMI model goals. This flexibility is encouraged, but is often underutilized by organizations that fear deviating from the model as written.

CMMI facilitates organizational learning. Project best practices, assets, and measures are collected by the organization and made available to improve future projects. This need not constrain projects to what has been done before and is "safe;" some of the best business successes can be achieved by encouraging risk-taking and new ways of doing business. Tailoring guidelines and constraints can establish basic boundaries of what is, and is not, acceptable, based on the degree of process risk anticipated.

Seldom are organizations so homogeneous that a "one size fits all" process is suitable to be followed by all projects. Organizations may have predefined tailoring templates that are readily adaptable to a variety of business models (e.g., development, services, sustainment, R&D). Not only does this help give projects an effective starting point for tailoring, with processes that are already more closely designed to how the project will be executed, it helps to encourage process value and minimize rework on new projects.

3.4 Implement CMMI in a Practical Way

Common Issues	Recommendations
• Size of the model can be overwhelming for newcomers to CMMI.	• Start simply and bite off manageable chunks. Identify areas where the needs are greatest. Understand model dependencies to take best advantage of related process areas and generic practices.
• Confusion about generic practices causes process rework.	• Interpret and apply CMMI generic practices with good judgment. Find practical solutions for GP implementation and appraisal that support the work actually being done.
• Inability to estimate process improvement effort causes cost and schedule problems.	• Learn from experience. Collect measures to understand improvement cost and effort. Use training and other resources to minimize misunderstandings that cause rework.

Start Simply and Bite Off Manageable Chunks

Some organizations find themselves overwhelmed by the size of the CMMI model, and deciding where to begin their process improvement activity. The model architecture and formatting conventions are structured to support learning in stages by "peeling the onion" at increasing levels of detail. Normative material (required specific/generic goals, expected specific/generic practices) is supported by informative material (subpractices, notes, examples, elaborations, etc.) where more information may be needed for context, a full understanding of model intent, or to provide guidance for typical CMMI implementations.

Whether using the staged or continuous representation, organizations should identify which process areas to start with based on business needs. To apply these process areas practically, an organization should take advantage of the relationships between process areas, and between the generic practices and the process areas. Many process areas help establish an initial organizational capability, which can then be utilized and leveraged in other process areas as appropriate through the CMMI generic practices.

For example, how an organization approaches project planning will align with the data used to monitor and control the project. Requirements development and requirements management are closely coupled. A number of the process areas also relate to the generic practices that are included in all process areas. Implementing the Project Planning process area strategically can provide Generic Practice 2.2 coverage for all process areas. Similarly, implementing the Process and Product Quality Assurance process area strategically can provide Generic Practice 2.9 coverage for all process areas. The CMMI model front matter provides a good description of these model relationships and dependencies, which must be understood to establish an effective sequence of process improvement priorities.

Interpret and Apply CMMI Generic Practices With Good Judgment

CMMI generic practices can be problematic, since ineffective implementations can be propagated across multiple process areas and difficult to fix after the fact. The sheer quantity of GP instantiations across PAs (over 50% more instances than for SPs) can be reflective of the relative effort needed. For these reasons, GP implementation strategies should be considered early, and interpreted with business value in mind. Rather than "institutionalization," think of generic practices as tools to help manage the desired process outcomes. Consider the intent of each GP, what it means in context of the PAs being implemented, and the model dependencies affected. Maintain focus on business value: how does this help the business, what are the desired outcomes, and how can processes be reinforced such that projects can consistently deliver these outcomes? The CMMI model front matter, and other published guidance, can provide ideas to optimize GP implementations without getting lost in a brute force, "cookie cutter" mentality.

Learn From Experience

As the process improvement project executes, collecting measures will help determine progress as well as understanding its ability to perform. Maintaining these measures in an appropriate measurement database supports project estimates to complete and establishing baselines for future process improvement initiatives. Establishing an appropriate Work Breakdown Structure will support collection of meaningful measures for different work activities performed (e.g., writing processes, change control activity, maintaining the process asset library, appraisal activity).

Like the staff on all projects, those assigned to process improvement tasks also require training to perform their activities effectively. Many well-intentioned but undertrained process groups have misunderstood the CMMI and implemented overly burdensome or ineffective processes in their organizations. Ensuring the key players in process improvement receive CMMI training will help prevent costly missteps in process implementation.

Learning from the experiences of other organizations is generally helpful, but must always be taken in context. A rich set of resources is easily available, including internet web sites, publications, presentation briefings, newsgroups, and asset libraries. Attending CMMI-related conferences (e.g., SEI SEPG Conference, NDIA CMMI Technology Conference and User Group) provides a means to network with people from other organizations implementing CMMI practices, and to gather practical lessons learned.

3.5 Make an Informed Decision on High Maturity

Common Issues	Recommendations
• Misunderstanding high maturity leads to folklore about overly burdensome processes.	• Separate fact from fiction. Take training to understand what high maturity is and is not. Couple examples from training with organizational opportunities to improve performance.
• Focus on high maturity level ratings over actual improvement undermines successful implementation.	• Focus on process improvement, not maturity levels.
• Concern that implementing high maturity requires excessive rework of maturity level 2 and 3 processes.	• Anticipate process evolution. Recognize that process improvement to higher maturity is a natural progression. Evolution requires change. Anticipating high maturity futures when establishing early maturity level processes can reduce rework.
• Unmeasurable quality and process performance objectives.	• Derive measurable quality and process performance objectives from high level business objectives.
• Settling for maturity level 3 and losing opportunities for greater business leverage.	• Make an informed decision. Seek first to understand high maturity, and then determine if it makes sense for the business.

Separate Fact From Fiction

A subset of the best practices contained in the CMMI Models has been labeled "high maturity" (the maturity level 4 and 5 process areas).[*] These "high maturity" processes contain specific practices that require organizations to identify quantified business objectives and flow the objectives down to projects in the organization. Projects may identify their own quality and process performance objectives as well. Performance is managed at the project and organizational levels to determine the capability of achieving the objectives. Statistical analysis and causal analysis techniques are used to manage project performance towards achievement of the objectives.

High maturity has always generated much passion and debate. Over the years, many voices have weighed in on the perceived investment versus benefits from pursuing high maturity. This contention dates back to the Software CMM®, when few high maturity organizations existed, and exactly what was meant by "high maturity" was unclear. The CMMI Project and SEI have taken steps to clarify the intent and expectations of high maturity. Training material specific to high maturity was developed to assist CMMI users and the associated community of instructors and lead appraisers. SCAMPI Lead Appraisers are now required to become certified as High Maturity Lead Appraisers, further promoting consistent expectations.

[*] Although this section uses maturity levels 4 and 5 as the high maturity context, the same issues and recommendations may be applied when considering capability levels 4 and 5 in individual process areas.

Organizations considering high maturity should avail themselves of the SEI training material to ensure an appropriate level of understanding is acquired before embarking on the high maturity journey. This will reduce process rework and frustration. Attending CMMI conferences provides additional opportunities to learn from the experiences of other organizations that have achieved high maturity or are working towards that goal. Examples provided from training and conferences can then be examined in the context of the organization considering high maturity for performance improvement opportunities.

Focus on Process Improvement, Not Maturity Levels

It was noted earlier in this paper that a disproportionate emphasis on maturity levels can undermine the tangible benefits of process improvement. This is especially true of high maturity. High maturity press releases have been used by many organizations to try and win new business by reputation alone. Oftentimes, these organizations have pursued "minimal compliance" roads to high maturity. Such organizations often abandon "level 4 and 5 processes" after the appraisal is completed, leading to customer dissatisfaction when organizational performance did not live up to its high maturity expectations.

The concepts of high maturity speak for themselves. Business objectives are translated into related quality and process performance objectives. These objectives typically fall into categories of cost, schedule, quality, and technical performance. Processes that impact the quality and process performance objectives become the targets for process improvement. In this manner, process improvement is now aligned with business objectives and flowed to projects. Statistical management techniques are used to identify true performance improvements versus perceived improvements that are actually part of routine performance variation. Improvements follow that typically relate to reduced rework, increased productivity, and higher quality products delivered to customers. These factors provide a rich opportunity for process improvement return on investment and higher customer satisfaction. The flow of business objectives to project quality and process performance objectives makes the business objectives real to projects. This enlists the entire organization in helping the business achieve its goals. When all members of an organization understand their roles in helping an organization achieve its objectives, organizational success is more likely.

Anticipate Process Evolution

Process evolution is seldom a short journey. The maturity levels in CMMI delineate a natural improvement progression. Evolution always requires change, and change (at any maturity level) often involves rework of old behaviors in addition to implementing new behaviors. Anticipating future high maturity needs when implementing early process improvements at lower maturity levels can help reduce this rework. For example, when implementing a measurement program at maturity level 2 and building an organizational measurement repository at maturity level 3, build with enough flexibility such that statistical analysis of data does not require an overhaul of the measures and measurement repository. Define clear operational definitions of measures that invite rather than hinder analysis. Reliance on an organizational measurement repository based on spreadsheets may be adequate for maturity levels 2 and 3, but may not be sophisticated enough for understanding organizational process performance at high maturity levels due to the complexity and analysis capabilities required. Spreadsheets may need to be augmented with statistical add-ins. A relational database or data warehouse may offer additional analysis flexibility for stratifying data by program types (or other characteristics) that yield greater insight into performance capability. A balance must exist between today's needs and tomorrow's growth – try not to fall too heavily into one or the other.

Recognize that as organizations evolve, the processes used at maturity levels 2 and 3 will evolve as well. Change is a natural part of process improvement, at any maturity level. Lessons are learned over time, resulting in more efficient processes.

Looking to the future is not usually an easy task, particularly when organizations are just beginning with CMMI. However, forward-thinking organizations that see high maturity in their future can take some actions to minimize process rework. Don't wait until maturity level 3 is achieved to learn about high maturity. The training mentioned earlier and networking with higher maturity organizations can help. Existing statistical process control and Six Sigma activities in the organization may provide a natural building block. Using a High Maturity Lead Appraiser, even when pursuing lower maturity levels, can also provide insights.

Derive Measurable Quality and Process Performance Objectives

The gateway to high maturity involves establishing quality and process performance objectives against which projects can manage and the organization can use to assess its performance capability. Many businesses establish goals that are high level and not quantitative. An example of such a goal might be "Increase Customer Focus." Such a goal is not easily measured by itself. However, that goal could be decomposed into quality and process performance objectives that relate to improving cost and schedule performance, increased quality in products delivered to customer, and improved technical performance.[10] Those objectives tie to the "Increase Customer Focus" goal. Processes that impact the quality and process performance objectives can then be selected, performance capabilities analyzed, and processes quantitatively managed using the high maturity practices.

Make an Informed Decision About Pursuing High Maturity

Many organizations overlook the benefits of high maturity, considering their improvement objectives completed upon achievement of maturity level 3. For these organizations, their rating may indicate only an ability to implement and institutionalize standard processes that are compliant with the corresponding maturity level 2 and 3 CMMI model process areas – but not necessarily whether those processes are effective, or if they can predictably meet or exceed the organization's business performance objectives. This is precisely where maturity level 4 and 5 process areas are targeted.

Although organizations can benefit from applying CMMI at all maturity levels, the high maturity focus on business objectives as "The Driver" of process improvement, at both the organizational and "grass roots" project level, is specifically designed to support measurable improvements in achievement of business objectives. CMMI is non-prescriptive, and organizations can select which business processes are most suitable for applying high maturity practices. Organizations that choose not to implement the high maturity processes are still likely to see improved performance and predictability. Many organizations have found high value in improving processes at lower CMMI maturity levels, in an environment of continuous process improvement. However the high maturity *required focus* on aligning process improvement with business objectives, and quantitatively managing to those objectives, is designed to result in more substantial and quantifiable benefits.[9]

Set the rhetoric aside. Do the background work to understand cost versus benefits. Take related training. Attend conferences. Talk with other users in the CMMI community, including those who have achieved high maturity and those who have elected not to pursue high maturity. Use the Decision Analysis and Resolution (DAR) process area to make a knowledge-based decision that meets the needs of the business.

3.6 Conduct Appraisals Economically

Common Issues	Recommendations
• Behaviors based on fear of failing ratings instead of motivation to identify weaknesses can drive organizations to put disproportionate effort on appraisal preparation and dry runs.	• Utilize the entire family of appraisal methods (Class A, B, C) appropriately – the right tool for the right purpose. Design an appraisal scheduling strategy to meet the organization's business needs.
• Focusing on appraisal ratings and not acting upon appraisal improvement recommendations undermines focus on process improvement.	• Use appraisals as process improvement opportunities and as a measure of progress.
• Appraisals are expensive and may be seen as a burden to CMMI adoption. Many organizations invest huge costs in appraisal preparation and evidence collection.	• Conduct efficient appraisals. Minimize the creation of evidence repositories and artifacts intended just for appraisals. Use external consulting resources wisely.
• Supplier maturity level ratings may or may not be relevant to the targeted work scope for a planned acquisition. It can be cost-prohibitive to conduct appraisals of multiple potential suppliers to determine process risks.	• Use targeted appraisals to determine supplier process risks most relevant to a planned acquisition. Look beyond ratings to determine suitability of suppliers for the work context.

Utilize the Entire Family of Appraisal Methods (Class A, B, C) Appropriately

There are two general objectives for performing appraisals:

1. Identify opportunities for improvement based on observed weaknesses and strengths.
2. Determine a capability or maturity level as a measure of progress.

The Appraisal Requirements for CMMI (ARC) document defines three classes of appraisals, Class C, Class B, and Class A, to be used in support of accomplishing the above two objectives. From C to A, the appraisals provide more depth of investigation into an organization's process implementation (using increasingly larger appraisal teams, interviews, and evidence review), resulting in increasing levels of confidence in the appraisal findings. Class A appraisals are the only appraisals that can provide maturity or capability level ratings. For internal process improvement, other less rigorous methods may better fit the needs of the business. Class C and Class B appraisals or some other internal or external alternative method (ARC-compliant or not), can be cost-effective ways to identify process weaknesses and implement improvements quickly with significantly less expense relative to a formal SCAMPI-A benchmarking appraisal. A Class C or B appraisal can also be an effective means of determining if progress has been made in implementing process improvements.

Organizations that have a need for a Class A appraisal often develop a strategy of conducting a series of Class C and B appraisals leading up to the Class A. This may be in the best interest of the organization, if the benefits are balanced against the costs and it results in substantial improvement actions being taken – or it may not, if a single or lesser number of appraisals will do. Often, however, a series of C's and B's are done to assess risk of failure, and eliminate any doubt that maturity level ratings will be achieved. In some cases, it may make better business sense to accept a reasonable level of risk by conducting a lesser number of appraisals (e.g., a single SCAMPI-A or a combination of Class C and SCAMPI-A). If the organization does not achieve the desired level, it may choose to leave the results unpublished and schedule a follow-on SCAMPI-A after addressing the weaknesses. Some organizations conduct a

SCAMPI-A scoped to a higher maturity level than they expect to achieve, using the SCAMPI-A as a measure of their progress towards both current and future process improvement plateaus.

Before starting appraisal planning, an organization should consider whether an appraisal is actually necessary and what its purpose should be, and then define an appraisal strategy that aligns with those factors. As with any investment, sponsors should weigh the real (not only perceived) benefits and returns from appraisals to justify the costs. Some organizations take half of a 3-year improvement cycle preparing for a SCAMPI-A appraisal. As such, appraisals can consume precious process group resources that could be applied to needed process improvement activities. Conduct the appropriate number and types of appraisals to best suit the organization's business objectives, needs, and culture.

Use Appraisals as Process Improvement Opportunities and a Measure of Progress

An appraisal is simply a means of measuring an organization's process development and deployment against best practices in the CMMI model to set priorities for business improvement. It is the identification of strengths, weaknesses, and associated improvement recommendations, and not the benchmark ratings, that are most likely to provide substantial and lasting benefits to the organization's business results and operational effectiveness. Appraisals provide an opportunity for an organization to receive objective feedback on process improvement and deployment. They offer a means to elevate improvement opportunities to higher level management such that resources can be strategically allocated. Appraisals can be an important part of an organization's process improvement strategy.

Organizations that place disproportionate focus on using appraisals to generate "level ratings" often do so to the detriment of implementing important process improvements. Organizations that focus primarily on the maturity or capability level rating sometimes hide known weaknesses in their quest for the rating. After the appraisal concludes, the weaknesses go unaddressed and continue to hinder organizational performance. Ratings may have been achieved, but with little effect on improved business results or project performance (in fact, the overall impact may be negative and increase costs). In extreme, but not uncommon, cases, processes that produced the rating are subsequently abandoned by the appraised organization.

Conduct Efficient Appraisals

Appraisals are expensive. Many organizations spend a large percentage of their process improvement budgets funding appraisal-related activities. The cost of actually performing the appraisal, though significant, is a relatively small proportion of an organization's appraisal costs. Many organizations spend much more effort collecting, organizing, and evaluating project implementation evidence in advance of the appraisal. To reduce appraisal preparation cost, some organizations have used in-house or third party tools to integrate appraisal evidence with natural project workflows. Other organizations routinely collect or map project work products to CMMI and conduct regular internal appraisals as part of process deployment monitoring. Some organizations have found the use of standard program structures for organizing and storing data has helped not only in accessing data on the programs, but also in minimizing the appraisal evidence collection effort.

Collecting excessive evidence further adds to appraisal costs. The SCAMPI-A appraisal method requires projects in the appraisal to provide at least one item of direct evidence (tangible results from performing a practice, such as a plan or other work product) and one item of either indirect evidence (a byproduct of performing a practice which substantiates its implementation, such as planning meeting minutes or measures) or affirmation in an interview to demonstrate compliance for CMMI practices. Some practices, by their complex nature, require more than one direct evidence artifact to demonstrate model compliance. It is best to reach an understanding with the Lead Appraiser on how much evidence is expected before evidence collection begins, and resist collection of non-value-added products or evidence beyond SCAMPI method requirements. Many organizations have bypassed collection of indirect artifacts and relied on appraisal affirmations for the second corroborating example of a practice implementation indicator. This can save substantial evidence collection costs. The extent of appraisal evidence needed, the costs of collection, and the tradeoffs on the degree of confidence in the appraisal results are significant factors in making appraisals both effective and cost-efficient.

It can take a change in perspective to think of appraisals as cost-effective investments to identify priorities for improvement actions. Innovative ideas are needed to streamline appraisal preparation and evidence collection in order to optimize business costs.

External SCAMPI Lead Appraisers or process consultants can offer a wealth of expertise and cross-industry experience that may be invaluable for organizations looking for guidance on appraising and process improvement strategies. But this expertise comes at a cost, and consultants do not necessarily corner the market on good ideas; internal staff skilled in CMMI and close to the business can also be an excellent source for identifying improvement opportunities. Consider all available resources and use external consulting resources wisely.

Use Targeted Appraisals to Determine Supplier Process Risks Most Relevant to a Planned Acquisition

A planned project may have dependencies on key suppliers or teammates to deliver critical elements of the product or services needed. Prior to establishing contractual commitments, it is reasonable to consider the process risks associated with the supplier performing this work within the project constraints (e.g., cost, schedule, quality, performance). Do they have mature processes? Do they have successful experience with similar work in the same application domain? Can they reliably meet their commitments within the constraints needed? The CMMI Supplier Agreement Management process area can often be used to consider these issues during supplier selection – but in some cases the risks may be so critical that a CMMI-based appraisal of the supplier processes could be warranted.

Conducting supplier process appraisals can be expensive, especially when multiple potential suppliers are involved. Costs can be managed by effective planning of the appraisal. Determine which processes are most critical to the acquisition, and consider narrowing the appraisal scope accordingly. Smart planning, with a good understanding of model relationships and dependencies (e.g., process areas and generic practices), can obtain good model coverage with just a few prioritized process areas. Judicious application of Class C, B, or A appraisals based on program needs is a practical means of evaluating supplier processes.

Look beyond maturity level ratings when considering supplier capability – they may or may not be relevant to the specific acquisition. Know what to ask for in order to judge the suitability and risks of the supplier's processes, and how well they fit the work planned. Best practices and detailed guidance for the use of CMMI in acquisition are well documented and readily available.[11]

4.0 SUMMARY

Adopting CMMI is an investment in improving organizational and project processes in a disciplined, managed manner to produce tangible performance improvements – cost, schedule, quality, customer satisfaction, or other measures by which an organization gauges its success. Whether an organization achieves these returns on its CMMI investment can depend largely on the guiding principles it establishes and lives by for its CMMI initiatives; factors such as:

- Objectives: Alignment of improvement initiatives with defined business goals and priorities, including a relentless focus on business value and performance improvement.
- Sponsorship: Visible commitment and active leadership by executives; setting expectations and accountability for tangible results, providing adequate resources to implement improvement plans, and regularly monitoring progress against objectives.
- Action: Dissatisfaction with the status quo, being willing to identify and implement the changes needed to address weaknesses and achieve objectives with the velocity needed to rapidly respond to the performance needs of the business.
- Engagement: Participation by the workforce at all levels in improvement initiatives, directly involving practitioners in establishing processes and assets that are practical, useful, and integral for project execution.
- Value: Decision-making based on tangible business value at the organizational and project levels, with measurable performance returns to justify the prioritized investment of resources.
- Motivation: Using CMMI for internal business performance improvement over external marketing; emphasis on continuous process improvement over continuous process compliance evidence.

The Economics of CMMI is a balance sheet for getting best value from CMMI. Implementation strategies, influenced by factors such as those above, can determine whether CMMI investments translate into improved business performance and cost efficiencies, or whether it is simply an added cost of doing business with limited tangible returns. If there is one message NDIA and the authors want readers to understand, it is that this equation is under an organization's control; it is business choices that govern whether value and performance results are realized through CMMI, or not.

CMMI is a tool to improve project performance and business results – not the only answer, not a silver bullet, but recognition of the role effective processes play as a necessary condition for success.

Several suggestions are provided here on approaches to implement CMMI effectively and economically. These are not exhaustive, some topics may be subject to debate, and certainly other alternatives exist. It is primarily the mindset of CMMI business value we seek to influence, and to provoke dialog within companies and across industry on raising expectations for the results achieved through the effective use of CMMI.

We welcome your feedback via the NDIA CMMI Working Group and encourage your involvement in maintaining a community emphasis on the business value achieved through CMMI investments. Visit: http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Pages/CMMI_Working_Group.aspx.

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