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Is CMMI® an Applicable Framework That Can be Used to Improve New Technology Venture Processes?

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Abstract

Continuous process improvement (CPI) has improved product and business performance in many industries and business sectors, but it has not been widely adopted in the new technology venture (NTV) sector. Firms in the NTV sector have rapid response environments guided by overarching first-to-market imperatives. These firms are also characterized by heroic efforts and chaotic ad hoc processes. However, CPI-adopting sectors, such as the aerospace industry, with similar environments, market imperatives, and characteristics, have tested the plethora of CPI initiatives and found the application of the Capability Maturity Model Integration (CMMI®) framework valuable when striving to improve product and business performance. This success has lead to the consideration of CMMI®'s applicability to the NTV sector. This paper examines CPI initiatives, including CMMI®, and investigates whether CMMI® is a plausible framework that can be applied to the NTV sector. This paper also describes how and why new technology ventures may benefit from the adoption of CMMI®. A CPI framework applicability evaluation is conducted to establish CMMI®'s plausible application to the NTV sector. As such, it may provide the impetus for further research to test its validity as a tool to improve the success rates of new technology ventures.

Introduction

At the turn of the last century, Frederick Taylor revolutionized the workplace with his prescriptions of work organization, task decomposition, and job measurement to increase organizational productivity and efficiency (1911). Today, after years of evolutionary improvements to Taylor's basic ideas, continuous process improvement (CPI) initiatives routinely improve product and business performance in many industries (Harry and Schroeder 2000; Harter, Krishnan, and Slaughter 2000; Davenport et al. 2001; Amaratunga, Sarshar, and Baldry 2002; Harter and Slaughter 2003; Kristensen and Westlund 2004; Paulk 2004; Rahman and Bullock 2005; Hutchinson 2006; Bailey et al. 2006). However, a full century later, firms that engage in the development and commercialization of new technologies have yet to widely embrace CPI. These firms have rapid response environments guided by overarching first-to-market imperatives, and they are also characterized by heroic efforts and chaotic ad hoc processes. All CPI frameworks specifically address these latter two characteristics.

While the NTV sector lacks wide CPI adoption, other industries with similar environments, market imperatives, and characteristics have examined and tested the plethora of CPI initiatives and found the application of the Capability Maturity Model Integration (CMMI®) framework valuable when striving to improve product and business performance. These industries are aerospace, telecommunications, and engineering-to-order (ETO) (Griffin 1997, Phillips and Shrum 2000; Chapman et al. 2001; MacCormack and Verganti 2003; Brun and Saetre 2008; Veldman and Klingenberg 2009). All of these adopting sectors were once new technology ventures and, arguably, could still be considered as such. The success of CMMI® CPI initiatives in these industries has led to the consideration of CMMI®'s applicability to the NTV sector.

CMMI® Defined

CMMI® is a CPI framework that evaluates how efficiently a firm is able to design, manufacture, and deliver technology products. This is done in two fundamental steps. First, an appraisal is conducted to determine the relative maturity of the new technology development process. Once the maturity level is determined, CMMI® provides a forward methodology that guides process managers and engineers step by step toward initiatives that result in more mature processes. CMMI®'s five process maturity levels are initial, repeatable, managed, and optimizing. Each level is defined in Table1.

1) Initial	The process is characterized as ad hoc, and occasionally even chaotic. Few processes are defined; success depends on individual and sometimes heroic effort.
2) Repeatable	Basic project management processes are established to track cost, schedule, and functionality. The necessary process discipline is in place to repeat earlier successes on projects with similar applications.
3) Defined	The process for both management and engineering activities is documented, standardized, and integrated into a standard new technology development process for the firm. All projects use an approved, tailored version of the firm's standard NTV development process for developing new technology.
4) Managed	Detailed measures of the NTV development process and product quality are collected. Both the NTV development process and products are quantitatively understood and controlled.
5) Optimizing	Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.

Table 1. Characteristics of the Five Process Maturity Levels (Paulk et al. 1993)

NTV Sector Recognizes that Efficient, High Product Quality Processes are Vital

The new technology venture (NTV) sector has seen and contributes to increasingly demanding global markets and an accelerating pace of technological change. These have led researchers and practitioners to recognize that firms engaging in new technology ventures need to compete both in terms of product quality and product development speed to achieve the first-to-market objective. Firms that achieve high product quality, and are first-to-market, anticipate that these competitive advantages may result in higher business performance (Porter 1998).

Researchers have put forth models to improve performance that tend to focus on the management of the new technology venture. These models include the identification of phases, integration of different phases, and project team autonomy (Chapman et al. 2001) rather than on the continuous improvement of the new technology venture process itself. While firms engaging in new product development share the first-to-market objective evident in the NTV sector, they also tend to have product families that clearly justify CPI. In contrast, new technology ventures often use a first- or early-generation process with unproven product or business-level viability. Thus, it would be of interest to learn if the up-front investment of time and resources required by CPI results in a justifiable payoff for firms engaging in new technology ventures, as evidenced in the aerospace, telecommunications, and ETO sectors. If this study confirms these results, it could be used to support the use of the CMMI® CPI framework in the new technology venture sector and achieve systematic product and business performance improvements. In turn, practitioners will be equipped with a rigorously time-tested tool to aid in the systematic increase of successful new technology launch rates.

Definitions: Process, NTV Specified End Result, and the Concept of CPI

Gabriel Pall defines a process as the logical organization of people, materials, energy, equipment, and procedures into work activities designed to produce a specified end result (1987). The authors define the specified end result for the NTV sector to be a new, technologically advanced product designed to create a new market. Newly devised technology used in a product for the first time is a distinguishing characteristic of NTV processes. For example, the process that produced the world's first neon red phone, subsequently sold at Walmart for a discount price, may fit the definition of a new product in the generic new product development sector, but in fact its process is well defined, many generations old, and does not fit within the new technology venture sector. In contrast, the process that produced the world's first cellular phone fits the authors' definition of an NTV process since it was a first- or early-generation process that incorporated newly devised technology, and its end result aimed to create an entirely new market.

The concept of process improvement, which was developed in the quality movement, requires that the existing process be stabilized. It then becomes predictable, and its capabilities become accessible to analysis and improvement. Continuous process improvement occurs when the cycle of stabilizing, assessing, and improving a given process becomes institutionalized (Davenport and Short 1990). However, it could be argued that the process stabilization imperative of CPI is at odds with firms that engage in NTV development, since by its very nature such a process is a first- to early-generation process that may require extensive redesign until the new technology and resultant product are deemed viable.

In fact, simple new product development processes that have no new technology requirements may struggle to justify the up-front CPI costs in a first-generation process because early design changes may be easily and readily made without sacrificing product viability or quality. In sharp contrast, the highly complex processes characteristic of NTV development environments may easily justify the up-front costs associated with CPI initiatives, because their configuration management is confounded by even small design changes early in the development life cycle (Campbell 1989; Macala 1996). Perhaps the more complex the process, the more important it is to install stable processes early in the development life cycle. Evidence that highly complex processes may justify the up-front costs associated with CPI initiatives is documented in the aerospace, telecommunications, and ETO environments (Griffin 1997; Chapman et al. 2001; MacCormack and Verganti 2003; Brun and Saetre 2008). Would CPI initiatives that work in these arenas prove applicable in the NTV development sector?

The CPI Landscape and Applicability to Various Industries and Business Sectors

A number of models and standards exist that are focused on continuous process improvement, and which are applicable in a variety of industries and business functions. Most have their roots in the management and improvement of manufacturing processes, but have evolved to successfully accommodate a variety of settings including administrative, service, healthcare, and financial institutions, among others. Generalization of these continuous improvement frameworks has been proven effective, from manufacturing to service organizations committed to continuous improvement (Sinn et al. 2008).

The term "framework" refers to models and standards that have a variety of issuing bodies, scopes, architectures, and rating methods. In addition, they have been devised with both internally and externally derived criteria (Paulk 2004). These frameworks include:

Externally Derived

- Malcolm Baldridge National Quality Award criteria (Baldridge 1987)
- Standards such as ISO 9000 (Quality Management Systems – Requirements) (ISO9001 2000)

Internally Derived

- Total Quality Management (TQM) (Crosby 1979; Juran 1992; Deming 1994)
- Lean (Womack and Jones 2003)
- Six Sigma (Harry and Schroeder 2000)
- Process improvement models such as CMMI® (Chrissis, Konrad, and Shrum 2003)

Literature presents attributes of effective continuous process improvement that leads to high product quality, process performance, and business performance. In particular, the value of frameworks such as 1) TQM, 2) Lean, 3) Six Sigma, and 4) Capability Maturity Model Integration (CMMI®) have been widely acknowledged (Cortada 1995; Clark 2000; Harry and Schroeder 2000; Harter, Krishnan, and Slaughter 2000; Issac, Chandrasekharan, and Anantharman 2003). This paper synthesizes the existing literature base in these four frameworks, among others, to determine the most applicable CPI framework with which to assess new technology venture (NTV) development processes.

Synthesis of Existing Literature to Identify Core Broad-based Interrelated CPI Areas

TQM, Lean, Six Sigma, CMMI®, ISO 9000, and the Baldridge Award, along with the more generic practices of strategic planning, assessment, data collection, documentation, and the development of standard operating procedures, form a foundational core of broad-based interrelated areas resident in continuous process improvement initiatives. All of these recognized performance improvement frameworks began in a particular industry or business sector such as manufacturing or aerospace software development, and evolved over the ensuing years into models for organizational performance improvement for many types of organizations. These include for-profit entities in manufacturing, technology development, service, healthcare, and education, as well as non-profit organizations (Sinn et al. 2008). The frameworks and generic practices, with their predecessor and inter-relationships, are depicted in Figure 1.

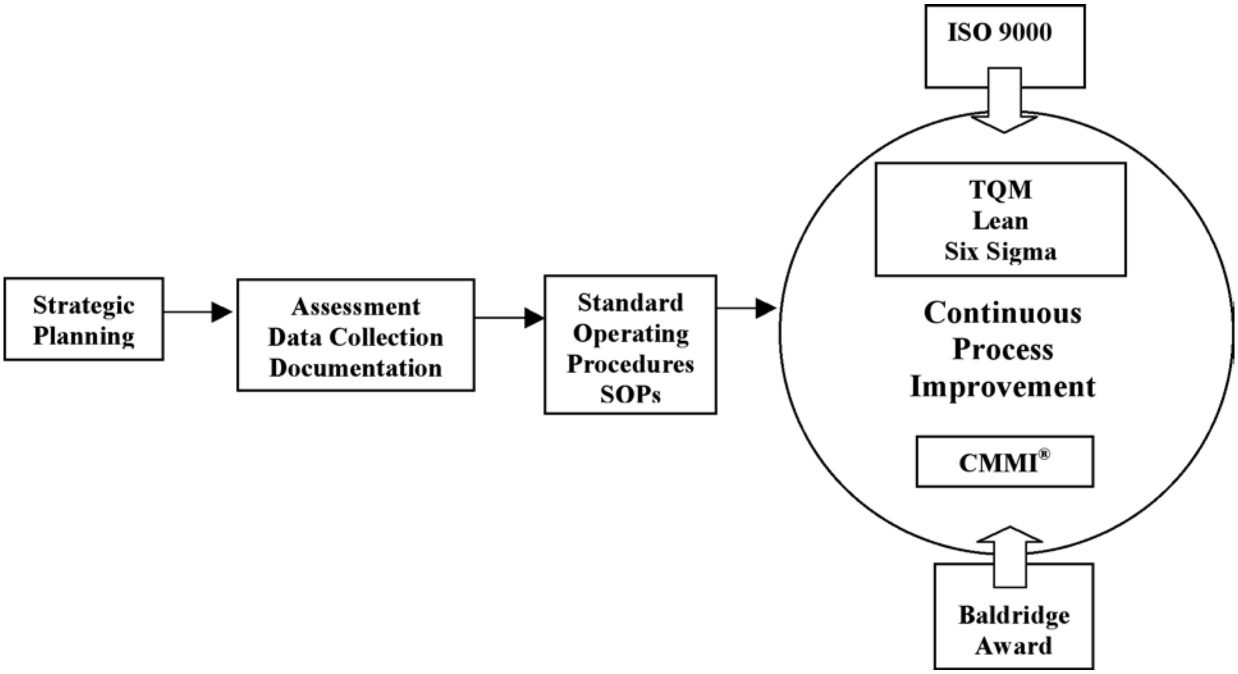

Figure 1. Core Areas Used to Achieve Continuous Process Improvement

Strategic Planning, Assessment, Data Collection and Documentation, SOPs

Strategic planning has always been part of the vision-determining mechanism and guide for the future for all continuous process improvement frameworks. Its essential attribute is that a firm must become increasingly systematized using a fundamental methodology that assesses and determines the direction of work to be pursued for improvements and changes.

Strategic planning is generally tied to change and improvement, based on a vision for the future. The future and vision being discussed in this case are tied to systems for assessing directions related to change and improvement within the context of broad quality systems. Data must be collected and documented in ways that are appropriate to the specific missions of continuous process improvement. Strategic planning affords a systematic approach to setting goals for the future, determining appropriate measures for success, and planning for needed resources. It is to this end that an appropriate, applicable, and useful framework should be selected given the myriad options (Burgelman 2002).

Assessment, data collection, and documentation are integral components of the early phases of all continuous process improvement initiatives. Once a strategic plan is in place, it is necessary for each firm's leaders and managers to capture knowledge to ensure efficiency and select an appropriate continuous process improvement framework (Burgelman 2002). Standard operating procedures (SOPs) are a core component of any continuous process improvement framework. They are the minimum outcome from any strategic plan that insists its organization's leaders assess, collect data, and document results for some form of analysis that may provide insight into continuous process improvements. SOPs fulfill a number of pervasive needs found in major quality, organizational, and continuous process improvement systems. The SOPs form the basis for implementation of the quality system in all continuous process improvement initiatives and provide steps to follow in disciplined ways to accomplish all functions of the program. Broadly noted, SOPs may take different forms and include written work instructions, flow charts, examples, process maps, and other procedural documentation, which can be accessed and used by all of the firm's participants (Burgelman 2002).

Varying Deployments of Strategic Planning, Assessment, Data Collection, Documentation

The specific ways in which a strategic plan, assessment, data collection, documentation, and SOP practices have been deployed and integrated into each continuous process improvement framework varies. Each framework has its own architects, set of issuing bodies, and standardization entities. Some frameworks rely on externally derived criteria vs. internally derived criteria; some have an intra-relationship focus vs. an inter-relationship focus; some have project success imperatives vs. enterprise-level success imperatives. All the frameworks examined in this research originated in a particular context for a specific industry and business function. All have expanded to a wide spectrum of industries and business functions.

1) The Malcolm Baldridge National Quality Award criteria were externally developed in 1988 as a model for managing quality in a manufacturing organization and recognizing achievements in quality and business performance. This framework examines both intra and inter-relationships in both for-profit and non-profit entities, and is considered to be an enterprise-level framework. The US National Institute of Standards and Technology in the Department of Commerce launched the award in 1987 to encourage US companies to publicize successful quality and improvement strategies, to adopt total quality management, and to encourage competitiveness. Examiners assess their own externally derived criteria and allocate points in seven major areas. Unfortunately, applicant information is confidential. Thus, the required confidentiality agreements ensure that the link between award criteria and resultant product/business performance remains inaccessible, and other firms have no reliable way to replicate results. Lastly, the award criteria have been revised and improved over the ensuing years and have evolved into a model for organizational performance for many types of organizations. Significantly, this evolutionary course has occurred for every recognized performance improvement framework.

2) ISO 9000 (Quality Management Systems), like the Baldridge Award, has externally derived criteria. This framework is an extensive suite of standards dealing with quality management systems, and can be used for external quality assurance purposes. Formerly biased toward a manufacturing environment, the 2000 release removed much of the manufacturing bias and has subsequently been adopted by a wide variety of industries and functions. It addresses the organizational context of processes (inter-relationships) and the enterprise-level viewpoint, including profitability, market share, and the like. Sector-specific variants, such as QS 9000 and TL 9000, provide recommendations for adopting ISO 9001 in specific environments (the automotive and telecommunications industries respectively). Unfortunately, ISO 9000 only defines the minimum qualifications a firm needs to achieve for certification (Bamford and Deibler 1993) and lacks substantial support for continuous improvement (Coallier 1994). The ISO suite of standards originated in manufacturing and was first narrowly applied, then later became widely accepted.

3) The Lean framework derives its criteria internally and is focused on identifying and eliminating waste. The eleven waste categories are: defects, overproduction, queue time, transportation, processing waste, inventory, waste of motion, talent, complexity, redundancy, and communication (Sinn et al. 2008). Its focus is intra-organizational with departmental-, functional-, and enterprise-level performance imperatives. Lean practices make use of the experience and intuition of experts to solve problems. In practice, its commonly used tools include single-piece flow, pulling System (billboards), Just In Time (JIT), Value Chain Management, TPM (Total Production Maintenance), SMED (Quick Die Change), the balanced production lines, prevent errors, workplace organization, 5S, customer value flow analysis, motion analysis, Jidoka (automation), prevention of errors, and more employee training (Zhou, He, and Gao 2006). Lean originated in manufacturing and was first narrowly applied, then later became widely accepted..

4) Similarly, TQM and its more precise derivative, Six Sigma, also have internally derived criteria, but

systematically identify and measure variation, defects, and waste for elimination to achieve sustained improvements. Six Sigma is based on the overarching philosophical tenets of TQM and statistics. Six Sigma uses quantifiable indicators and analysis with minimal dependence on the experience and intuition of experts to solve problems. In practice, it combines many traditional statistical methods and tools such as QFD (Quality Function Deployment), FMEA (Failure Mode and Effects Analysis), SPC (statistical process control), MSA (Measurement System Analysis), ANOVA (analysis of variance), DOE (design of experiments), regression analysis, and hypothesis testing (Zhou, He, and Gao 2006). Six Sigma's focus is intra-organizational, with enterprise-level performance imperatives. TQM and Six Sigma each originated in manufacturing and were first narrowly applied, then later became widely accepted.

5) The Capability Maturity Model Integration (CMMI®) framework requires each firm derive its own set of continuous process improvement criteria. As mentioned in the introduction, each maturity level has defined characteristics whereby each firm's distinctive set of procedures is assessed to determine if it has one of the following levels of process maturity: 1) initial, 2) repeatable, 3) defined, 4) managed, and 5) optimizing. Level 1 is indicative of low process maturity; level 5 is indicative of high process maturity. Its focus is intra-organizational with departmental-, functional-, and enterprise-level performance imperatives. The Software Engineering Institute (SEI) originally developed it, and its first application provided a well-defined approach to continuous software process improvement in the aerospace industry (Harter, Krishnan, and Slaughter 2000; Manzoni and Price 2003). Because of its success in the aerospace software industry, it was adopted by aerospace hardware developers (e.g., jets and sub-components). Additionally, due to CMMI®'s comprehensive nature, more industries, firms, and business functions outside of the aerospace software/hardware industry have begun to use the CMMI® framework to achieve continuous process improvement. These include education, medical and bio-tech, administration, distance learning, university PhD programs, facilities management, automotive, and generic new product development. Clearly, CMMI® has demonstrated its appropriateness and applicability in a wide spectrum of settings (Johnson and Brodman 2000; Amaratunga, Sarshar, and Baldry 2002; Ramanujan and Kesh 2004; Doss and Kamery 2006; Hutchinson 2006; Veldman and Klingenberg 2009).

A CPI framework applicability evaluation was conducted that determined that CMMI® provides more comprehensive guidance for improving processes than TQM, Lean, and Six Sigma. Lastly, CMMI®'s applicability and usefulness is rapidly broadening into more business sectors, just as has occurred with all the other recognized frameworks. The CPI framework applicability evaluation begins with a procedure known as mapping to determine if a specific CPI framework is applicable for a given process.

CPI Framework Applicability Evaluation to Determine What Applies to NTV Processes

Scholars and practitioners have long recognized that while each framework had its own genesis, they have each evolved to accomplish a single outcome: continuous process improvement. Consequently, the process of mapping CPI frameworks to determine nesting relationships has become routine in some industries. The aerospace industry, for example, routinely maps CPI frameworks, since various governing agencies and customers may require multiple certifications when competing for Department of Defense contracts (Sheard 2001). As such, the aerospace industry has devised methods to evaluate the applicability and usefulness of CPI initiatives. Recognize that the use of CPI is voluntary for new technology ventures (NTV) in the commercial sector and compulsory in the aerospace industry. However, this distinction may make the aerospace industry's method of CPI analysis for applicability and usefulness more valuable, since it is both rigorous and time-tested. In the commercial NTV sector, each firm decides whether to engage in CPI at all. If the firm does engage in CPI, it typically controls both the CPI appraisal and improvement programs. Therefore the purpose of mapping CPI frameworks in this context is only to justify the use of the most applicable yet comprehensive framework for the continuous process improvement of new technology ventures, and not to serve outside governing bodies. In particular, recognize that because the NTV sector uses first- or early-generation processes indigenous to each firm, this study concerns itself only with CPI frameworks that have internally derived criteria. To wit, TQM, Lean, Six Sigma, and CMMI® are the focus of this study's scrutiny due to the internally derived nature of these frameworks and their successful applications in aerospace, telecommunications, and ETO sectors. These CPI frameworks and their nesting relationships are depicted in Figure 2.

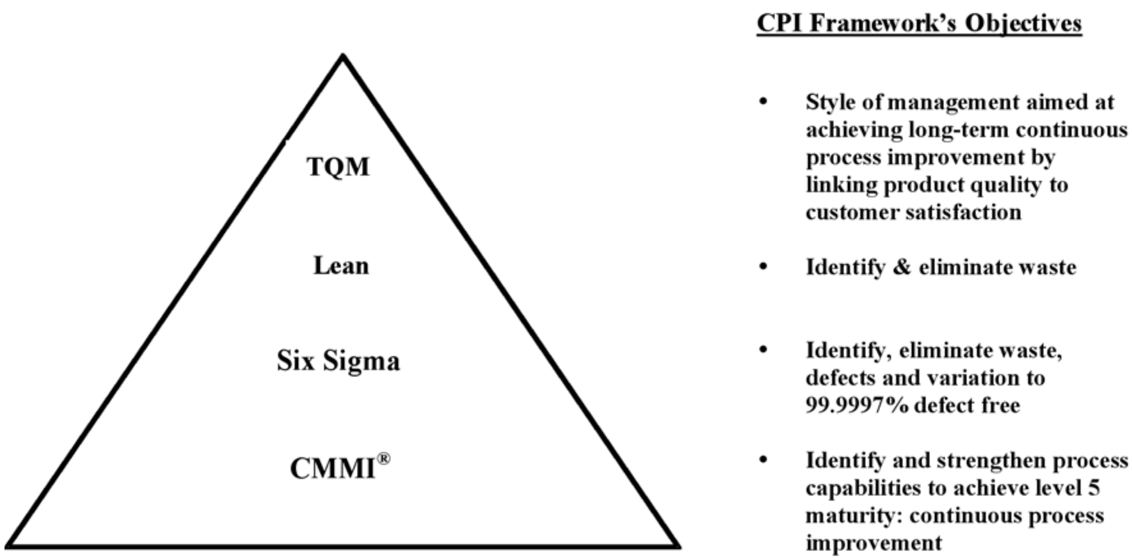

Figure 2. CPI Frameworks' Objectives & Nesting Relationships (Paulk 2004; Sinn et al. 2008)

Examine Prior Research, Map to Identify Scoping Differences, and Analyze Contexts

The selection and implementation of a voluntarily employed CPI framework is best determined by its applicability and usefulness, as established by (further) examination of prior research, mapping to examining scoping differences, and conducting contextual analyses (Paulk 2004; Sinn et al. 2008). These examinations and analyses were performed, and it was determined that CMMI®'s broader framework (compared to Lean and Six Sigma) and contextual suitability, combined with TQM's overarching philosophical tenets, would be most applicable to the new technology venture sector.

Lean production and Six Sigma management have commonalities that include culture pursuit, ultimate objectives, continuous process improvement, requirement to understand the role of the employee toward success, and strategic requirements (Zhou, He, and Gao 2006). In contrast, the two frameworks' differences include the model of operation and management, recommended starting points and methods to solve the problem, implementation steps, focus of specific implementations and training, cognition of financial effect, process improvement strategies, and specific concerns. These differences, however, are not antagonistic but complementary. If a firm's business process will continuously improve by integrating and applying the two, it will thereby be more responsive to changing market conditions while maintaining the strongest competitive advantages (Chen and Tong 2004). Table 2 depicts generic Lean and TQM/Six Sigma process components and maps their complementary attributes, illustrating how the Lean framework nests within TQM/Six Sigma (Sinn et al. 2008).

TQM/Six Sigma Attribute	Characteristic of TQM/Six Sigma Attribute	How to Accomplish	Complimentary Lean activity
Define	Define the process and the project	Map process	Use the process map to identify all process steps
Measure	Determine step timing, activity costs, flow distances, process parameters	Measure using best practice methods	Determine current time and develop target time for all steps
Analyze	Analyze every measurement for waste, value, and opportunity	Deep Dive the data	Determine the delta and analyze root cause
Improve	Target the high waste measurements and develop a process to mitigate	Try Something – Make a substantiated change; avoid analysis paralysis	Understand and develop and implement improvement strategies for each step of the work process
Control	Ensure process discipline and that the organization does not slip back to the old way/habit	Instill process discipline through leadership; Have visible management attentive to continuous improvement	Ensure that the gains are sustained through management audits and visible management

Table 2. How Lean Maps Within TQM/Six Sigma

When evaluating multiple frameworks to determine applicability and usefulness, an organization faces a number of challenges. First, the scope of different frameworks is likely to differ, with some amount of overlap that must be addressed. Interpreting the framework with the broader scope from the perspective of the framework with the narrower scope is usually appropriate. For example, an organization using CMMI® and Six Sigma should interpret the Six Sigma practices from the perspective of CMMI® (Paulk 2004). Mapping requirements in one framework to the requirements in the other may reveal nesting. For example, the narrower-scope framework will provide more detailed requirements and guidance on implementing parts of the broader framework. Although there may be specific points in the broader framework that are neglected in the narrower, satisfying the more focused framework's requirements can be considered *prima facie* evidence that the broader framework's equivalent requirements are satisfied. Therefore, mapping to reveal nesting is one effective way of addressing framework applicability.

Another way of addressing framework applicability is to determine the contextual requirements for each specific setting. For example, a tenth-generation process derived for a product family may find a Six Sigma CPI framework fits best, while a first-generation process may find a CMMI® CPI framework fits best. This might be the case because Six Sigma strives to remove large variation based upon an established baseline that already exists. In contrast, CMMI® may begin its assessment with no initial baseline in place. CMMI®, then, is a more logical choice to use for the assessment of first-to-early-generation processes found in NTV environments. Consequently, CMMI®'s broader framework and contextual suitability, combined with TQM's overarching philosophical tenets, are used to measure the CPI in this new technology venture study. Similar to Lean's map within Six Sigma, Six Sigma maps within CMMI®. This is depicted in Table 3 (Sinn et al. 2008).

Low Maturity					High Maturity
Six Sigma Require-ments	CMMI® Level 1 Initial	CMMI® Level 2 Managed	CMMI® Level 3 Defined	CMMI® Level 4 Quantitatively Managed	CMMI® Level 5 Continuous Optimizing
Define	Undefined process and project and yet performed. Ad hoc and chaotic process performance led via heroic efforts.	Infrastructure in place to support process. **Broadly defined process descriptions** in place.	Infrastructure in place to support process. **Precise standardized process descriptions** in place.	Firm and projects have **quantitative objectives** for product quality and process performance. These are based on customer needs and process implementers.	Firms and projects have **quantitative understanding of common causes** of variation inherent in processes. **Continually revised** firm level quantitative process-improvement objectives in place.
Measure	No meaningful measurements of timing, activity costs, flow distances, and process parameters.	Measure against process descriptions.	Measure against tailored set of firm's precise, standardized processes according to own guidelines rigorously produced.	Measure quality and process performance in statistical terms; for selected sub-processes, detailed measures of process performance are collected and statistically analyzed.	Use measurement methods described in level 4. Effects are measured and evaluated against quantitative process improvement objectives.
Analyze	No analysis of waste, value, and opportunities.	Crisis-driven passive analysis; no detailed measures available, thus minimal opportunities to analyze meaningful data.	Some proactive analysis; uses understanding of inter-relationships of process activities and detailed measures of processes.	Diligent, proactive, statistically sound analysis of quality and process data repository…	Analyze as in level 4; Both the defined processes and the firm's set of standard processes are targets of measurable improvement activities.

Improve	No target of high waste measurements and no processes are devised to mitigate.	Only produce outputs per process descriptions; much re-work, scrap, inefficiency, poor quality tolerated.	Produce outputs per standardized process descriptions; some re-work, scrap, inefficiency, poor quality tolerated.	…That support fact-based decision-making. Special causes of process variation are identified and, where appropriate, the sources of special causes are corrected to prevent future occurrences.	Use fact-based decision-making to continually improve using innovative and technological improvements by addressing common causes of process variation.
Control	No controls and no process discipline is ensured.	Controls in place as adherence to process descriptions.	Controls in place as adherence to standardized process descriptions; lead to the **qualitatively** predictability of process performance.	Controls lead to the **quantitative** predictability of process performance via **incremental improvements**.	Controls lead to **quantitatively** predictability of process performance via **continuous improvement**. Addresses common causes of process variation and **changes process**[1].

[1] (to shift the mean of the process performance or reduce the inherent process variation experienced)

Table 3. How CMMI Maps and Nests Within TQM/Six Sigma

Conclusions

Continuous process improvement (CPI) has improved product and business performance in many industries and business sectors. However, it has not been widely adopted in the new technology venture (NTV) sector. This paper sought to establish the plausibility of the CMMI® CPI framework as a viable tool to improve complex, first- or early-generation NTV processes. This paper described how and why CMMI®, which arose out of the aerospace industry, might prove particularly applicable to the NTV sector. Both the aerospace and NTV sectors share highly complex, first- or early-generation processes with overarching rapid speed-to-market imperatives. Since CMMI® initiatives have improved aerospace processes, it was hypothesized that they may improve NTV processes. A CPI framework applicability evaluation was conducted to establish CMMI®'s plausible application to the NTV sector. This paper details this evaluation, which examined prior research, mapped initiatives to determine scoping differences, and analyzed contexts. The evaluation's results established that CMMI® is a plausible CPI framework that may be a viable tool when applied to the NTV sector. Consequently, Western Michigan University plans to design and conduct further research to measure process maturity vs. success in the NTV sector. This new study will determine if high process maturity results in high product and business performance and, in turn, if it results in higher successful launch rates of new technologies. If research results confirm these hypotheses, it will equip NTV practitioners with a new tool, CMMI®. CMMI® is a rigorously time-tested framework that may lead to process improvements, as well as quantifiable product and business performance improvements in the NTV sector, just as it has in the aerospace sector.

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