

A Taxonomy for Improvement Frameworks

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Abstract

The success of quality management and process improvement initiatives in revolutionizing performance excellence has driven an explosion of standards, models, bodies of knowledge, and statutes and regulations. Companies must deal with hundreds of requirements imposed by a diverse set of standards-setting bodies. Even if they wish to, organizations cannot simply ignore the “quagmire” of standards and models that have been published [Paulk 2004]. Some are explicitly required by customers; some are implicitly required by the market; some may be imposed by statute or regulation; some are simply recognized as being useful in building or maintaining competitive position. While the authors of these frameworks certainly hope that potential users will perceive the value added, users struggling with implementing a variety of improvement requirements and priorities can find the situation frustrating. A need expressed by some in the multi-model environment is for the ability to compare the many different frameworks that may be imposed on an organization. The purpose of this paper is to describe a taxonomy for improvement frameworks that will support an understanding and comparison of a diverse set of frameworks. Discussing taxonomy issues can drive a better understanding of the underlying concepts and architecture of improvement frameworks, while at the same time not adding to the quagmire. This taxonomy is expected to evolve over time as the community gains knowledge and insights into successful improvement factors.

1 INTRODUCTION

The success of quality management and process improvement initiatives in revolutionizing performance excellence has driven an explosion of standards, models, bodies of knowledge, and statutes and regulations. While much of the success of the Industrial Revolution has been credited to Taylor’s scientific management, industrial engineering, and the continuing evolution of quality and process concepts, companies must now deal with hundreds of requirements imposed by standards-setting bodies of various kinds. The ImproveIT report [Dorling 1991], which inspired the ISO/IEC 15504 standards for process assessment, listed 25 schemes for process assessment. Moore describes 315 standards, guides, handbooks, and other prescriptive documents maintained by 46 different organizations [Moore 1999]. Sheard lists nearly 40 frameworks, most of which are related to others, some of which are superseded but may still be in use [Sheard 2001]. The Software Engineering Institute hosted a workshop on process improvement in the multi-model environment (PrIME) in May 2008 that attracted over 80 professionals concerned with the issue of integrating multiple frameworks [PrIME].

Even though they may wish to, organizations cannot simply ignore the “quagmire” of standards and models that have been published. Some are explicitly required by customers; some are

implicitly required by the market; some may be imposed by statute or regulation; some are widely recognized as contributing to competitive position. While the authors of these frameworks certainly hope that potential users will perceive the value added, users struggling with implementing a diverse set of improvement requirements and priorities can find the situation frustrating. Life would be much simpler if the various models and standards could be integrated into a single document that could be used for “one stop shopping.” This strategy drove the CMM IntegrationSM (CMMI[®]) effort, which integrated the Capability Maturity Model[®] for Software, EIA 731 (Systems Engineering Capability Model), and the Integrated Product Development (IPD) CMM [Chrissis 2006]; it is now driving the Enterprise SPICE initiative [Enterprise SPICE].

At the same time, successful frameworks motivate the development of derivative works. The Software CMM inspired the development of the Systems Engineering CMM, the People CMM [Curtis 2001], and many other maturity models. It also contributed to the development of ISO/IEC 15504 (Process Assessment) [ISO 15504], which was intended to harmonize the many different standards and models that existed. ISO/IEC 15504, in turn, has inspired Automotive SPICE, Banking SPICE, Medi SPICE, etc., as well as Enterprise SPICE. CMMI for Development has spawned sister “constellations” for Acquisition and Services. Efforts to integrate seem to inevitably lead to fragmentation as the good ideas embodied in the integrating framework are applied both to a broader set of targets than was originally envisioned and to the needs of specific audiences.

One of the needs expressed at the PRIME workshop was for the ability to compare the many different frameworks that may be imposed on an organization by its customers, regulatory agencies, or the market, along with those frameworks that the organization may have identified as adding value to its internal process definition and improvement activities. The purpose of this paper is to describe a taxonomy for improvement frameworks that will support understanding and comparing diverse frameworks. My specific interest is in software engineering, therefore the focus of this discussion will be on frameworks important for the software industry, but it is my intent that this framework will be useable in other industries, including manufacturing and services. Discussing taxonomy issues can drive a better understanding of the underlying concepts and architecture of improvement frameworks, while at the same time not adding to the quagmire. This taxonomy is expected to evolve over time as the community gains knowledge and insights into successful improvement factors. To track this ongoing work, see <URL: <http://www.cs.cmu.edu/~mcp/papers/taxonomy.html>>.

2 THE CONTEXT OF STANDARDS AND MODELS

In addition to frameworks that may be externally imposed and that organizations may be rated against in some fashion, the taxonomy should also address general Total Quality Management (TQM) philosophies, such as those of Deming, Juran, and Crosby [March 1996], as well as Business Process Reengineering (BPR) [Hammer 1993], and Six Sigma[®] [Harry 2000]. The

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taxonomy should address the criteria for quality awards such as the Malcolm Baldrige National Quality Award in the United States [Baldrige]. It should include process management standards such as ISO 9001 (Quality Management Systems—Requirements) [ISO 9001].

The taxonomy should address discipline-specific frameworks, such as CMM IntegrationSM (CMMI[®]) [Chrissis 2006], ISO/IEC 15504 (Process Assessment) [ISO 15504], the eSourcing Capability Model for Service Providers [Hyder 2006], the eSourcing Capability Model for Client Organizations [Hefley 2006], and the People CMM[®] [Curtis 2001]. The taxonomy could be used to categorize tightly focused standards in “ilities” such as security (ISO 27001), but the primary purpose of the taxonomy is to characterize reasonably broad-based improvement frameworks.

This paper builds on preceding work by Halvorsen and Conradi, who published a taxonomy to compare SPI frameworks that addressed 25 characteristics that are likely to be important to potential adopters [Halvorsen 2001]. Their taxonomy includes five categories of attributes.

- The General category describes general attributes of a framework, including its geographic origin and spread (where it originated and is used), its scientific origin (its background, whether it is derived from another framework), its stability as a supported entity, whether it is prescriptive or descriptive, and its adaptability (i.e., support for tailoring and customization).
- The Process category describes how the framework is used, including whether assessments are carried out internally or by external group, what guidelines are provided to help implementation and institutionalization, whether improvement initiatives are primarily top-down or bottom-up, and the analysis techniques used, e.g., statistical process control or questionnaires.
- The Organization category describes the attributes of organization and environment where framework is used, including key stakeholder, the organization size, and the logical connection between engineering factors and business factors.
- The Quality category includes the quality perspective (who determines the concept of good quality), progression of the improvement effort (e.g., flat, staged, or continuous), how improvement is measured and what are influential factors, and how the framework can be used to compare different units against what aspects of process.
- The Result category characterizes the outcome originating from framework adoption, including certification, estimates of the cost of implementation, and any validation of the framework.

There are far more improvement strategies and frameworks than I will attempt to describe in this paper. As partial a step as this taxonomy may be, however, it may begin to address Bendell’s observation [Bendell 2005] that there is no generally accepted map of the best practice initiatives or of the selection criterion for an organization to choose between them or structure an individual approach. While it will not attempt to directly help organizations select an improvement taxonomy (which is arguably a fruitless goal when many standards and frameworks are imposed on the organization), I hope it will help potential users understand the intent of different frameworks more consistently. This taxonomy divides its attributes into three major categories: the expected user community and its improvement drivers and strategies, the framework architecture and structure, and the diagnostic methods associated with the framework.

3 THE USER COMMUNITY FOR THE FRAMEWORK

The expected user community and its improvement drivers and strategies contains four attributes: audience, work orientation, support infrastructure, and drivers for adoption. These attributes are elaborated below. Topics subsumed into these attributes include the purpose, general improvement strategy, the leverage point for improvement, and the improvement target of the framework. Halvorsen and Conradi's attribute of scientific origin is not included in the taxonomy. I believe the relationships with current works are more useful than historical origins, at least from a taxonomy perspective. Even biological taxonomies are emphasizing similarities over ancestry in recent work [Zimmer 2008].

3.1 Target

Audience and purpose. The first important attribute, usually identified in the framework, is who the expected users of the framework are. Depending on how the framework is to be used, this *audience* may be internal improvement groups, executives, clients, regulatory agencies, etc. Multiple audiences may be addressed for varying reasons, e.g., internal improvement groups may use a framework to guide a self-assessment or an improvement program or customers may use a framework to filter potential suppliers. Frameworks will typically identify their *purpose* along with identifying their audience(s). Since different audiences are likely to have different purposes in using the framework, it may be best to express the audience and purpose as a dyad.

Improvement paradigm. El Emam and Goldenson identified two general paradigms for SPI [Emam 1999]. The *analytic paradigm* relies on quantitative evidence to determine where improvements are needed and whether an improvement initiative has been successful. The *benchmarking paradigm* depends on identifying an "excellent" organization in a field and documenting its practices and tools; in a more general formulation of the benchmarking paradigm, the best practices of world-class organizations are captured in a reference model or standard. These best practice frameworks typically describe "what" to do without prescribing "how" to do it.

I have used a similar characterization of measurement-based or principle-based for an analytic strategy and best practice or framework-based for a benchmarking strategy [Paulk 2005]. A principle-based strategy, i.e., an analytic strategy, such as Deming's Fourteen Points, applies sweeping principles on process improvement and quality. The principles are generally stated and can be applied in almost any context; the analytic aspect grounds the principles in measurable improvement and is intrinsic to all of the generally accepted strategies that I am aware of. This includes the best practice approaches, which always include measurement and analysis and almost always include some form of statistical thinking. A consequence of the generality of principle-based strategies is that those using them need to be highly skilled in quality management, process definition, change management, negotiation, and related topics to apply the strategy effectively. The analytic paradigm applies the scientific method, which is used anytime anyone tries to solve a problem in a systematic way [Box 1987].

The analytic paradigm for quality improvement originated in Frederick W. Taylor's and Frank B. Gilbreth's school of scientific management and in the work of Walter A. Shewhart in the early 1900s. Hays describes quality improvement as seeking to stabilize processes by eliminating special causes of variation, while scientific management seeks to stabilize processes by breaking

down jobs into simple steps to be performed repeatedly without deviation [Hays 1994]. Today we distinguish between Six Sigma, which focuses on reducing process variation, and lean, which focuses on minimizing waste and promoting work standardization [Kubiak 2003]

Many different sets of principles may underlie an analytic approach. Deming listed 14 Points and described a system of profound knowledge for improvement [Deming 1986, Deming 1994]. Juran emphasized fitness for use and the cost of quality [Juran 1992]. Crosby emphasized cost of quality measures and the quality management maturity grid [Crosby 1979]. The Six Sigma philosophy is to minimize variation, while the Lean philosophy is to reduce waste [Mullenhour 2005]. While analytic strategies have more similarities than differences, the different emphases cannot be dismissed, and it should be noted that a taxonomy that lumps these strategies together as “analytic approaches” does not capture vital information about the different schools of thought. This may be intrinsic to a simple taxonomy, but I will not attempt in this iteration to characterize the analytic strategies in more detail than this.

A framework-based strategy specifies best practices that have been demonstrated to add value in a particular context and which have been explicitly stated in models and standards. Improvement based on ISO 9001, CMMI, and the eSCM-SP are examples of framework-based strategies.

The analytic and benchmarking strategies can be complementary, and both lead to a measurement-based strategy. Processes (and systems) are measured and compared to objectives set by management in order to identify which processes need to be improved. Measurement trends are used to confirm and quantify improvements. Framework-based strategies naturally evolve toward measurement-based strategies tailored to the business needs of the organization as the foundational capabilities described by the framework are successfully put in place. By focusing on its business objectives, an organization can leverage its existing work on other improvement initiatives, supporting the development an integrated improvement strategy.

The improvement paradigm could be considered an architectural attribute rather than a user community attribute, and I initially placed it there. Since this is a taxonomy for improvement frameworks, however, all the classifications are in one “branch” of the taxonomy. The strategy chosen affects the credibility of the entity adopting the framework, however, since anyone adopting any of these frameworks will at some point in time need to consider analytic issues in continuing improvement... unless, of course, the objective is solely the dysfunctional one of getting a certificate to hang on the wall. The improvement need is likely to drive consideration of analytic strategies such as Six Sigma and Lean to achieve business objectives in a complementary approach to improvement. Multi-model improvement strategies are both ubiquitous and challenging, even for world-class organizations.

Leverage point. People, procedures and methods, and technology and tools are frequently identified as the three main supports for process improvement [Paulk 1995]. While *people*, *process*, and *technology* are primary leverage points for improvement, the business strategy followed by the organization is also crucial for success, i.e., whether the emphasis is on operational excellence, product leadership (features and innovation), or customer intimacy (customization and service) [Treacy 1997]. Both *innovation* and *relationships* can be a fruitful leverage point for improvement from a business perspective.

Improvement entity. The primary target for improvement frameworks is the *organization*. An organization is an entity that builds products and/or provides services. An organization may be a

company or a business unit with a company, enterprise, or conglomerate. Some attributes within an improvement framework may be most effectively addressed at the enterprise level; at the very least, the organization must be aligned with enterprise-level strategies and objectives. While it might be useful in some cases to characterize a framework as applying to an enterprise as distinct from an organization, I have been unable to identify any specific examples where this was useful. Potential enterprise level strategies, such as the People CMM, ISO 9001, and the Baldrige Award, are applied primarily at the organization level, although there are instances where the People CMM and Software CMM have been applied at an enterprise level, e.g., Telcordia Technologies [xxx] and Tata Consultancy Services [xxx].

A more useful distinction is to consider frameworks that apply at a smaller level of granularity: the *project / engagement / team* or the *individual*. An example of a project targeted improvement strategy is Humphrey's Team Software Process [Humphrey 1999], which in turn builds on an improvement strategy targeted at individuals, the Personal Software Process [Humphrey 1995]. The organization is, however, the "natural" target of most improvement frameworks. While differences should be noted if they occur, and these differences can be documented in the work orientation section of the taxonomy, they are rare enough that I have chosen not to create a separate attribute for the improvement target.

3.2 Work Orientation

Some frameworks, such as CMMI for Development, are *project oriented*. They use project and program related terms in describing how the work is managed. By definition, a project is a temporary endeavor undertaken to create a unique product, service, or result, and a program is a group of related projects managed in a coordinated way [PMBOK 2004]. The emphasis is therefore on work items that have a distinct beginning and end.

In contrast, some frameworks, such as the eSCM for Service providers, are *engagement oriented*. An engagement focuses on the relationship between a client and a service provider [Hyder 2006]. Relationships are open-ended; they do not necessarily have a defined end-point.

Frameworks may also have an *operations orientation*, as for example, in a manufacturing environment. Early versions of ISO 9001 could be characterized in this way, although the current 2000 version would be best characterized as neutral [ISO 9001].

Many frameworks, such as the Baldrige Award criteria, are *neutral* – they do not assume a particular orientation in terms of how the work is performed. Improvement frameworks may therefore be characterized in terms of their orientation towards how work is performed as oriented towards projects, engagements, operations, or neutral.

Discipline specific. While many frameworks, such as the Baldrige Award, are intrinsically general, many frameworks incorporate *discipline-specific* best practices. Examples include the Software CMM (software engineering), CMMI (systems engineering), ISO 9001 (quality management systems), the People CMM (human resources), and ISO 27001 (systems security engineering). From the user's perspective, this is probably the most important attribute of the framework, assuming a discipline is specified. Although this attribute may not be applicable for many frameworks, it is a crucial piece of information when it is and should be elaborated in detailed in the architectural category of attributes.

Sector specific and related frameworks. Frameworks such as ISO 9001 frequently have *sector-specific* variants. Sometimes these variants are discipline specific, such as ISO 90003 (Guidelines for the application of ISO 9001 to computer software). In some cases, the sector-specific variants correspond to verticals, such as aerospace (AS9100), automotive (QS-9000 and ISO/TS 16949), and telecommunications (TL 9000). Listings of such related frameworks can be useful to the user of the taxonomy, particularly if their interest is focused in the related area.

3.3 Support Infrastructure

As Moore points out, there is a chasm between the innovators and early adopters and the majority of the community that may be affected by a “new” technology [Moore 1991]. This technology transition insight has implications for adoption of models and standards, since a number of enabling mechanisms expedite adoption, including the existence of:

- ownership: agencies responsible for developing and maintaining the improvement framework
- user groups
- conferences and publications, including case studies of adoption and improvement
- training materials: books, continuing education courses, videos
- Web page: for the sponsor of the work and supporting materials
- penetration: breadth of adoption (world-wide vs national or regional)

3.4 Drivers for Adoption

The simplest drivers for adoption of an improvement framework are *customer* and *regulatory* requirements. If you have no option, the adoption decision is trivial. If a framework is very widely adopted, then *market* pressure can force adoption, even if a formal requirement is not externally imposed. This can be observed for ISO 9001 and CMMI, for example, and even analytic strategies such as Six Sigma. The most effective improvement frameworks are those adopted because they help an organization achieve its *business objectives*. While external requirements do not preclude this idealized driver, external drivers can drive dysfunctional behavior [Austin 1996], so understanding the predominant driver for adoption can drive an appropriate degree of skepticism.

3.5 Summing Up the User Community Attributes

The user community attributes are summarized below:

Attribute	includes
Target	audience and purpose improvement paradigm... analytic / benchmarking leverage point... process / people / technology / innovation / relationships improvement entity... organization / project / engagement / team / individual
Work orientation	project / engagement / operations / neutral discipline... <i>to be specified</i> sector... <i>markets and verticals to be specified</i> related frameworks... <i>to be specified</i>
Support infrastructure	ownership user groups conferences and publications training materials penetration Web page
Drivers for adoption	customer / regulatory / market / business objectives

4 FRAMEWORK ARCHITECTURE

The architecture of the improvement framework has a significant impact on its use. In the simplest terms, the larger and more complex a framework is, the more it costs to implement the framework and to assess compliance with its requirements. To large degree, the architecture also drives the rating scale used in assessments. Content as an attribute is also assigned to this category in the taxonomy, but it is acknowledged as being difficult to address.

4.1 The Rating Scale

As already discussed, improvement strategies may use either an analytic or benchmarking approach. Analytic approaches measure success in terms of progress in achieving business or improvement objectives. Benchmarking approaches measure compliance in implementing the reference framework. Best practice frameworks typically do not specify performance levels for specific tasks (e.g., 5500 transactions per quarter or 4 function points per month). Framework-based strategies provide more guidance to the user than principle-based strategies, but both require skilled personnel to implement effectively.

In some cases, such as for ISO 9001, compliance is measured as a *binary* pass/fail – you either satisfy all the requirements of the standard or not. While “minor non-conformances” may be allowed, the ultimate rating is binary.

Another approach is to allow credit for each implemented requirement. The Baldrige Award uses this approach in its *point scale* of 1000 potential points, although winning the award goes above and beyond a simple point scale.

The Software CMM introduced the concept of *organizational maturity* as an ordinal scale for measuring capability (while the five maturity levels in the Software CMM were inspired by Crosby's maturity grid, Crosby did not formalize his maturity concept as a way of measuring organizational capability). Many of the dozens of "maturity models" inspired by the Software CMM do not have a crisp operational definition of what a maturity level is. Although they may claim to use the Software CMM maturity concepts, their targets and work orientation may be quite different (e.g., operations rather than project processes).

ISO/IEC 15504 applied the CMM concepts to measure *process capability*. Rather than measuring organizational capability with a single value, ISO/IEC 15504 measures process capability directly and organizational capability with a process capability profile. CMMI integrates both organizational maturity and process capability representations. The CMMI definition of process capability, however, is based on the generic practices defined in the 1995 Baseline Practices Guide [Paulk 1996, Paulk 1999], adapted for the Software CMM v2 effort (among others), and then included in the CMMI continuous representation. The generic practices describing process capability net to a generic goal associated with a maturity level. ISO/IEC 15504 evolved in a somewhat different form, with generic practices replaced by process attributes [Paulk 2007]. Although ISO/IEC 15504 and CMMI both use capability levels to characterize process capability, their operational definitions are somewhat different.

In the case of both organizational maturity in the staged, CMM-like models and process capability in the continuous, ISO/IEC 15504-like models, the key taxonomic distinction is between a multi-level organizational versus process measure. The assumption cannot be made that maturity levels or capability levels in different models describe exactly the same concepts without a close examination. The eSCM models use the capability level terminology but apply it to organizations, implying a less prescriptive improvement roadmap than is the case for maturity levels, so I will use *organizational capability* to characterize a hybrid between organizational maturity and process capability.

4.2 Architecture

Content and components. This section of the taxonomy contains an overall outline of the *content and components* of the framework, expressed in its own terms. For example, ISO 9001 has a number of clauses, which can be listed in this section. The titles of the clauses provide an indication of content without containing the details. Similarly, a listing of the Process Areas in CMMI indicates the topics covered by the model. Along with an enumeration of Generic Practices and whatever other architectural components the framework may include (e.g., the eSCM models break out the pieces of the sourcing lifecycle), this section indicates the size and complexity of the framework.

Size. The operational *size* of the framework can be listed in terms of the number of requirements that must be implemented or assessed. For ISO 9001, for example, size can be measured by the number of "shall" statements in the standard. For CMMI, a reasonable choice is the number of specific and generic practices (an alternative would be the number of specific and generic goals since the goals are the rating components of CMMI, but appraisal data is collected at the practice level, so practices are a better choice).

4.3 Standardized Content

The architecture attribute of the taxonomy describes the content and components of the framework in its own terms. This does not, however, support comparability since frameworks may have quite different architectures and address different, even if overlapping, topics. A *standardized content* taxonomy that described the specifics of what a framework contains could be quite useful, but because of differences in scope, target, and detail, such comparisons could be approximate at best.

Heston and Phifer, in an as-yet unpublished article, look at the multiple quality models paradox from the pragmatic perspective of two large multinationals needing to deal specifically with ISO 9001, CMMI, ITIL, ISO 27001, eSCM-SP, and Six Sigma. They observe that each model has a sweet spot, or set of business issues, for which the model is particularly well-suited. To help integrate their improvement strategies, they identify a set of quality genes underlying the different models. The set of quality genes includes business alignment, strategy planning and execution (leadership), governance, training and development, organizational change management, systems development life cycle, technology management, capacity and availability management, project management, security and threat/risk management, performance management, requirements elicitation and management, relationship management, change and release/configuration management, quality assurance, incident and problem management, process thinking, data-driven process improvement

The Malcolm Baldrige National Quality Award identifies core values and concepts that must be addressed by an organization wishing to win the award. These include visionary leadership, customer-driven excellence, organizational and personal learning, valuing employees and partners, agility, focus on the future, managing for innovation, management by fact, social responsibility, focus on results and creating value, and a systems perspective. The core values and concepts are embodied in seven categories: Leadership; Strategic Planning; Customer and Market Focus; Measurement, Analysis, and Knowledge Management; Workforce Focus; Process Management; and Results.

This attribute of the proposed taxonomy is the most problematic, and the most likely to see significant change over time. An initial cut at this might, for example, break management into several aspects: project / engagement / operational plus leadership / strategic. Saying that the Baldrige Award addresses leadership, while ISO 9001 does not – or that ISO 9001 does so from the specific perspective of the quality management system – surfaces the underlying challenge of a taxonomy of improvement framework. ISO/IEC 15504 was intended to harmonize the quagmire of models and standards but evolved over time to be more of an integrating framework at least partially because synthesizing underlying concepts and content is a daunting task which may not be fully solvable. A useful approximation may be helpful even if it illustrates again that George Box was right in observing that all models are wrong; some models are useful.

4.4 Summing Up the Architecture Attributes

The architecture attributes are summarized below:

Attribute	includes
Rating scale	binary / point scale / organizational maturity / process capability / organizational capability
Architecture	content and components: <i>to be stated in the terms of the framework</i> size as measured by the number of requirements
Standardized content	standardized content: <i>to be stated in terms of a set of descriptors that is still being debated and developed</i>

5 INFRASTRUCTURE

Attributes related to the infrastructure used in deploying the framework relate closely to the support infrastructure under the user community category, but the emphasis here is on assessment and implementation methods.

5.1 Diagnostic Method

Appraisals can be broken into assessments and evaluations, where assessments focus on process improvement and evaluations focus on conformance to the framework, typically as measured by an objective external entity. Evaluations are essentially synonymous with audits, although the audit terminology is primarily used in with determining binary conformance to a standard. Since assessment results are reported to customers in some approaches, they can suffer from many of the same challenges. This has been observed in the evolution of Software Engineering Institute (SEISM) appraisals. In the early days, assessments focused on interviews to identify improvement opportunities and evaluations focused on artifacts to substantiate implementation. The Standard CMMI Appraisal Method for Process Improvement (SCAMPISM) [SEI 2006] class A method is a highly formal appraisal that emphasizes reliability and consistency, and since the results can be used in source selection and contract monitoring, must address the methodological challenges that were a concern for software capability evaluations in the early 1990s.

5.2 Improvement Method

The standard TQM improvement method is Plan-Do-Check-Act (PDCA). Six Sigma has DMAIC and variations of Design for Six Sigma, e.g., DMADV. SEI uses the IDEALSM model. All are variations on the concepts of the learning organization [Senge 1990], so their value as a taxonomy attribute is questionable, but for this first cut I choose to include it for informational purposes – if for no other reason than to emphasize that improvement is the justification for these frameworks.

5.3 Certification Schemes

Individual. Individuals may be certified or authorized as assessors (e.g., Evaluators, Lead Evaluators), consultants (e.g., Qualified Consultants, Master Black Belts), and implementers

(e.g., Black Belts). Individual-level certifications are frequently accompanied by a professional code of conduct and a formal license (authorization), perhaps with restrictions (e.g., SEI's restrictions for appraisers of high maturity organizations).

Organization. Organizations may be certified as having satisfied the requirements of a particular standard such as ISO 9001. In the case of ISO 9001, the issuing body may be authorized by a national body to issue such certifications. In the case of CMMI certifications, no formal registrar exists since the SEI does not issue certifications, but appraisals by authorized Lead Evaluators are widely considered equivalent to certifications, and the certification terminology is broadly, if imprecisely, used. In some cases, such as for the eSCM-SP, there is a single certification issuing body.

5.4 Summing Up the Infrastructure Attributes

The infrastructure attributes are summarized below:

Attribute	includes
Diagnostic method	<i>to be described in terms used in the framework</i>
Improvement method	<i>to be described in terms used in the framework</i>
Certification scheme	individual... <i>to be described in terms used in the framework</i> organization... <i>to be described in terms used in the framework</i>

6 CONCLUDING REMARKS

“All models are wrong. Some models are useful.” George Box.

“It is not the model that’s as important as your ability to take a model and create value for your organization.” Nabil AbdelMalek.

“The moment a person forms a theory, his imagination sees, in every object, only the traits which favor that theory.” Thomas Jefferson.

This taxonomy is a first cut at identifying and synthesizing concepts that may be useful to both framework authors and implementers who live in the multi-model environment. Like many taxonomies, it has a number of challenges to overcome but hopefully it will still be useful. I expect that it will evolve, and I encourage feedback from those who are interested in supporting that evolution.

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