A Taxonomy of SPI Frameworks

Christian Printzell Halvorsen, Reidar Conradi
Norwegian University of Science and Technology (NTNU)
N-7491 Trondheim, Norway
Phone: +47 73 59 34 44 Fax: +47 73 59 44 66
{cph, conradi}@idi.ntnu.no

Abstract

There exist a number of different approaches, often called *frameworks*, supporting *software process improvement (SPI)*. Their differences and similarities has been the subject of some debate. This paper discusses four different classes of methods, which can be used to compare SPI frameworks. One of these methods is a new taxonomy proposed in this paper.

1. Introduction

Focus on *software process improvement (SPI)* is growing. The underlying assumption of SPI is that product quality is influenced by the quality of the process used to produce it:

$$\textbf{Quality}(\textit{Process}) \Rightarrow \textbf{Quality}(\textit{Product})$$

This causal relation may seem trivial at first, but in reality there are numerous variations in the approach to SPI. These approaches are often called *SPI frameworks* and they generally describe how organizations can assess current process quality, as well as how they can improve it. Most frameworks are rather comprehensive and differences in content are evident in a number of aspects, e.g. focus, goals, adaptability and so on. There are even subtle differences in their interpretation of words like *quality* and *process*.

However, the SPI framework differences may not be apparent at first, and because the frameworks are so comprehensive, it is costly to investigate them all. The result is that the differences, which set one framework apart from another, are not clear. Evidently, systematic methods to compare the frameworks are needed. The question is how this can be done *efficiently*, *objectively* and in a way that is *possible to validate*.

1.1 Why Compare SPI Frameworks?

Comparing SPI frameworks can be rewarding from an academic view. However, focus should not be on the frameworks themselves, but on real improvements resulting from their adoption. SPI framework comparisons should therefore provide practical insight and guidance when selecting which framework to employ in a software-producing organization. It should be clear that no single "right" comparison method exists for this purpose, and a combination of methods may be necessary depending on the context. The primary usability requirements to be considered are:

- *Knowledge-level* – The amount of detail in the comparison should correspond to the knowledge-level of the user.
- *Point of view* – The comparison method can be general or take the standpoint of a specific framework and view others in terms of that.

How these requirements are satisfied depends on the reason for comparing the SPI frameworks. An organization *without* prior SPI knowledge may wish to institutionalize improvement work because of competitive pressure or certification requirements – but which framework is appropriate? On the other hand, an organization *with* an SPI framework in place may wish to adopt more than one approach – but how can this be done with the least amount of redundancy? In the latter case working knowledge about one specific framework exists, but knowledge about other approaches may not be as thorough.

2. Comparison Methods

There is an increasing amount of literature comparing the major SPI frameworks. Most is written in the last three years and generally cover only a small number of frameworks, e.g. [1][2][3].

From our review of other comparison work we have recognized four main classes of comparison methods. These will be described shortly in the following subsections.

2.1 Characteristics Comparison Method

A comparison method well suited for a general overview is the use of *characteristics*. The characteristics can be nominal, ordinal or absolute and should preferably be objective, measurable and comparable. However, the main point is that they represent areas of interest for the SPI framework investigation.

The frameworks are compared in terms of the defined characteristics and the results can be presented in a tabular format. This gives us a compact and high-level comparison method with little details. Such details must be collected elsewhere, e.g. using another comparison method.

The taxonomy we propose in section 3 is based on the characteristics comparison method.

2.2 Framework Mapping Comparison Method

Framework mapping is the process of creating a map from statements or concepts of one framework to those of another. This requires that the actual frameworks are rather formalized, i.e. consist of a more or less defined set of statements or requirements.

In the characteristics method the goal was to describe important attributes of each SPI framework, i.e. areas of interest. However, the purpose of mapping is to identify overlaps and correlation between frameworks and create a map of these. There can exist strong, weak or no correlation as suggested by Tingey [3]. Furthermore, the mapping can be done on either a high or a low level depending on the amount of detail included. In either case, it is more low-level than characteristics and thus not very useful for a general overview.

Framework mapping is especially useful when an organization employs two or more different SPI frameworks, as corresponding statements can be identified and redundancy reduced. Thus the extra effort needed to employ more than one framework is minimized.

2.3 Bilateral Comparison Method

In a *bilateral comparison* two frameworks are compared textually. The difference between this comparison method and the two previous ones is its textual nature. A bilateral comparison is often a summary or explanation of findings from other the comparison methods.

The bilateral comparison can take on the point of view of one framework and describe another in terms of it. This is convenient for people with detailed knowledge of one framework, because they can easily get insight into another using familiar terms.

The amount of detail included in a bilateral comparison can vary widely, depending on the purpose for which it is written. Frequently the level of detail is somewhere in between that of the characteristics and the mapping approaches.

2.4 Needs Mapping Comparison Method

Needs mapping is not a direct comparison between frameworks. Instead, it considers organizational and environmental needs that must be considered when selecting which SPI framework to adopt. The requirements imposed by such needs are often highly demanding and can limit the choice of framework severely. Nonetheless, they are of utmost importance and must be considered carefully. Here are some examples:

- Certification requirements, for example to ISO 9001, often imposed on a subcontractor.
- Top-level management requires that the chosen SPI approach should be incorporated in a Total Quality Management (TQM) strategy.
- Financial limitations.

There certainly exist other examples as well, and they can vary substantially from organization to organization, or depend on the business environment. Furthermore, the needs may vary over time as the organization or environment evolves.

3. The Proposed Taxonomy

We present a list of 25 characteristics, i.e. areas of interest, relevant for discussing differences between SPI frameworks. Because there are so many characteristics, they have been grouped in 5 categories to enhance comprehensibility and readability (cf. Figure 1).

3.1 General Category

This category describes general attributes or features of SPI frameworks, frequently related to how they are constructed or designed:

- *Geographic origin/spread* – Where did the framework originate and where is it used today?
- *Scientific origin* – The scientific background on which the framework is based, e.g. another SPI framework.
- *Development/stability* – It is desirable to employ an evolved and relatively stable framework. This is achieved through experience feedback from real use over a number of years.
- *Popularity* – A popular framework tends to receive better support and further development than an unpopular framework.
- *Software specific* – Some frameworks are especially geared towards software engineering, others are more general and must be adapted.
- *Prescriptive/descriptive* – Prescriptive frameworks prescribe mandatory requirements/processes. Descriptive frameworks describe a state or certain expectations to be met without assigning specific actions to be taken.
- *Adaptability* – The degree of flexibility in the framework, e.g. does it support tailoring and customization for specific uses?

3.2 Process Category

The process category concerns characteristics that describe how the SPI framework is used:

- *Assessment* – Is an assessment scheme part of the

General	Process	Organization	Quality	Result
Geographic origin/spread Scientific origin Development/stability Popularity Software specifc Prescriptive/descriptive Adaptability	Assessment Assessor Proc. improvement method Improvement initiation Improvement focus Analysis techniques	Actors/roles/stakeholders Organization size Coherence	Quality perspective Progression Causal relation Comparative	Goal Process artifacts Certification Cost of implementation Validation

Figure 1 - Categorization of Characteristics in the Proposed Taxonomy

framework and if so, what is assessed?

- *Assessor* – The assessment can be carried out internally by the organization itself or by an external group.
- *Process improvement method* – What kind of guidelines are included to help implementation and institutionalization of process improvement?
- *Improvement initiation* – Where in the organization is the improvement work initiated, e.g. top-down or bottom-up?
- *Improvement focus* – The SPI activities regarded as the most important by the framework.
- *Analysis techniques* – Does the framework utilize any quantitative or qualitative analysis techniques, e.g. statistical process control or questionnaires?

3.3 Organization Category

The characteristics in this category are directly related to attributes of the organization and environment in which the SPI framework is used:

- *Actors/roles/stakeholders* – Who are the primary people, groups and organizations affected by the improvement process and what roles do they hold in this process?
- *Organization size* – The framework may be more or less suitable for an organization of a certain size, e.g. depending on the required and available resources.
- *Coherence* – Is there a logical connection between engineering factors and factors related to the business or organization[1]? Coherence can exist internally in the organization or externally between the organization and its environment.

3.4 Quality Category

Characteristics in this category are related to the quality dimension of the frameworks:

- *Quality perspective* – The concept of good quality depends on whom you ask, e.g. management, customers or employees.
- *Progression* – Does the framework measure quality progression in a flat, staged or continuous manner?
- *Causal relation* – How does the framework measure an improvement in quality, i.e. what factors are assumed to influence quality?
- *Comparative* – Can the framework be used to compare different organizational units, either internally or externally? If so, which aspects are compared?

3.5 Result Category

The term *result* is loosely used in this category, meaning the outcome originating from the SPI framework adoption:

- *Goal* – The primary objective or end result of using the framework.
- *Process artifacts* – The artifacts created in addition to the actual product as a result of adopting the framework.
- *Certification* – Does the framework include an assessment leading to certification according to ISO or a national standard body?
- *Cost of implementation* – Are there any estimates on how much an adoption and implementation of the framework will cost?
- *Validation* – What kind of validation efforts have been made to evaluate what improvements the framework leads to? Such validation should exclude external success factors, as they would have been achieved even if the SPI framework was not adopted.

4. Conclusion

The goal of comparing SPI frameworks is to provide practical insight and guidance when selecting which SPI framework to adopt in a software-producing organization. Such guidance is needed because of the multitude, diversity and comprehensiveness of existing frameworks. A natural question is whether those SPI efforts that report only a limited degree of success, have adopted the wrong frameworks.

When learning about SPI frameworks it may be necessary to use a combination of comparison methods, preferably starting on a high level. The most interesting frameworks can then be chosen for further investigation, eliminating the costly task to examine all of them.

We believe that our proposed taxonomy is a suitable starting point for such investigations because it describes the most important areas of interest. A major strength of the taxonomy is its compactness, yet it retains the descriptive power of more elaborate comparison methods. However to comprehend the taxonomy fully, some general SPI knowledge is required. There should be no problem collecting material for further investigation, since literature on the various frameworks is vast.

References

[1] Cattaneo F, Fuggetta A. and Sciuto D. *Pursuing Coherence in Software Process Assessment and Improvement.* Paper submitted to IEEE TSE, September 1998.

[2] Sørumgård Sivert, Verification of Process Conformance in Empirical Studies of Software Development. (Doctoral thesis 1997:14, The Norwegian University of Science and Technology, 1997). 252 p.

[3] Tingey Michael O., *Comparing ISO 9000, Malcolm Baldridge, and the SEI CMM for software: a reference and selection guide.* Upper Saddle River: Prentice-Hall, Inc., 1997.

Category	Characteristic	TQM	CMM v1.1	ISO 9000	ISO/IEC 15504	EF/QIP/GQM	SPIQ
General	**Geo. origin/spread**	Japan/World	U.S./World	Europe/World	World/World	U.S./World	Norway/Norway
	Scientific origin	Quality control	TQM, SPC	-[2]	CMM, Bootstrap, Trillium, SPQA.	Partly TQM	TQM, GQM, EF, QIP, ESSI
	Develop./stability	Entire post-war era	Since 1986	Since 1987	Under development	Since 1976	Under development
	Popularity	High (esp. in Japan)	Top (esp. in U.S.)	High (esp. in Europe)	Growing	Medium	Norway only
	Software specific	No	Yes	No	Yes	Yes	Yes
	Prescriptive/ descriptive	Descriptive	Both	Both	Both	Descriptive	Descriptive
	Adaptability	Yes	Limited	Limited	Yes	Yes	Yes
Process	**Assessment**	None	Org. maturity	Process	Process maturity	None	Customer satisfaction
	Assessor	NA[1]	Internal and external	External	Internal and external	NA[1]	Limited internal
	Process improve-ment method	PDCA	IDEAL	None	SPICE Doc. part 7	QIP	Two-level PDCA
	Improvement initiation	Top-down	Top-down	NA[1]	Process instance	Iterative bottom-up	Top-down and iterative, bottom-up
	Improvement Focus	Management processes	Management processes	Management processes	Management processes	Experience reuse	Experience reuse
	Analysis techniques	7QC, 7MP, SPC, QFD	Assessment questionnaires	ISO guidelines and checklists	Several (manual and automated). Required.	GQM	GQM, QFD, 7QC, 7MP
Organ-ization	**Actors/roles/stake-holders**	Customer, employees, management	Management	Customer, supplier	Management	Experience factory, project organization	Customer, experience factory, project org., sponsoring org.
	Organization size	Large	Large	Large	All	All	All
	Coherence	Internal and external	Internal	Internal and limited external	Internal	Internal	Internal and external
Quality	**Quality perspective**	Customer	Management	Customer	Management	All	Customer, all
	Progression	Continuous	Staged	Flat	Continuous (staged at process instance level)	Continuous	Continuous
	Causal relation	NA[1]	**F'**(*Key process areas*) ⇒ **F**(*Maturity level*) ⇒ **Q**(*Process*) ⇒ **Q**(*Product*)	**F'**(*Quality elements*) ⇒ **F**(*Certification*) ⇒ **Q**(*Process*) ⇒ **Q**(*Product*)	**F'**(*Process attributes*) ⇒ **F**(*Capability level*) ⇒ **Q**(*Process*) ⇒ **Q**(*Product*)	**F**(*Experience reuse*) ⇒ **Q**(*Process*) ⇒ **Q**(*Product*)	**F**(*Experience reuse*) ⇒ **Q**(*Process*) ⇒ **Q**(*Product*)
	Comparative	No	Yes, maturity level	Yes, certification	Yes, maturity profile	No	No
Result	**Goal**	Customer satisfaction	Process improvement, supplier capability determination	Establish core management processes	Process assessment	Organization specific	Increased competitiveness
	Process artifacts	Plans, diagrams	Process documentation, assessment result	Process documentation, certificate	Process profile, assessment record	Experience packages, GQM models	Experience packages, GQM models
	Certification	No	No	Yes	No	No	No
	Implementation cost	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]
	Validation	None	Surveys and case studies	Survey	Document review, trials (case studies and surveys)	Experimental and case studies	Experimental and case studies

Table 1 - The Taxonomy Applied to Six SPI Frameworks

[1] Not applicable
[2] Yet to be determined