An Evaluation and Improvement Model for Key Factors Integration of
Tennis Information Management

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Abstract: It is widely acknowledged that Key Factors Integration (KFI) has an important significance for the overall success of Tennis information management. More and more organizations consider KFI as the main problem areas in the Tennis information projects fields. Moreover, nowadays there are evidences that Key Factors Integration can contribute to improved Tennis information management level. However, they suffer from various issues that limit their adoption by organizations that are interested to assess and improve their Tennis information management capability. Therefore, the research presented in this paper proposes a new Tennis information management Improvement model. This study aims to provide an overview on what, why and how we build the evaluation and Improvement model for Tennis information management. The intention is to provide a foundation for future development in the area of Tennis information management.

Key words: Key Factors Integration (KFI), tennis information management, evaluation and improvement model

INTRODUCTION

System and software development projects have been plagued with problems since the 1960s (Wahyudin et al., 2008). Since then, Key Factors Integration (KFI) (Zhang, 2009) has become one of the central research topics in the field of software engineering. Although progress in KFI has been painfully slow with software development projects continue to experienced problems associated with KFI, research effort in the area continues to be done. These researches are mainly motivated by the list of potential benefits expected to be brought about by the successful implementation (Moser et al., 2008) of an improved Tennis information management. It is widely acknowledged that Tennis information management has an important implication for the overall success of the projects (Hu, 2012a). Moreover, there is now empirical evidence, such as demonstrated in Hu (2012b), that support the claimed benefits of KFI in improving a software project by improving productivity (Caglayan et al., 2009) assuring quality and reducing project risk (Ratzinger et al., 2008).

A Tennis information management is a structured set of activities which are followed to gather, evaluate, document and manage requirements for a software or software containing throughout its developments lifecycle. There exist KFI standards that set out general principles and give detailed guidance for performing the Tennis information management. Examples of KFI standards include the IEEE Guide for Developing System Requirements Specifications and the IEEE Recommended Practice for Software Requirements Specifications (Hu and Guo, 2013). However, these standards offer no aid for selecting appropriate methods or for designing a Tennis information management optimized for a particular organization. An expert panel consists of both practitioners and academics agreed that Tennis information management remains the most problematic of all software engineering activities. Moreover, results of three surveys involving software development companies in UK confirmed that these companies still considered KFI problems very significant.

Another survey, clearly demonstrate that Tennis information management Improvement is an important issue. Consequently, many organizations seek to improve Tennis information management by adopting a generic Software Reconciliation (SR) (Korhonen and Salo, 2008) standards and frameworks such as Software Institute’s (SI’s) Capability Evaluation and Improvement Model (CEIM) (D’Ambros et al., 2009) and Capability Evaluation and Improvement Model for Integration (CEII) and Six Sigma. However, a European survey of organizations engaged in SR programs during the 1980s confirmed that the SR models then available offered no cure for Key Factors Integration problems. These enthusiastic adopters of SR programs found that while SR brought them significant benefits, their problems in handling requirements remain hard to solve.

This and several other problems related to the process have motivated the development of several Tennis information management Improvement models.

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They include the Key Factors Integration Good Practice Guide (KFIGPG); the Requirements Capability Evaluation and Improvement Model (R-CEIM); the Key Factors Integration Process Evaluation and Improvement Model (KFIIPM) and the Market-Driven Key Factors Integration Process Model (MDKFIIPM). However, these models also suffer from problems and issues that could hinder organizations from adopting them. The models not only are integrated with the obsolete and unsupported CEIM or SW-CEIM since the release of the new evaluation and Improvement model CEIMI, but they are also either too complex or applicable to only limited type of Tennis information management and application domain or exist in draft form and yet to be completely developed and validated.

Inspired by the strengths of the existing generic SR and Tennis information management Improvement models, we started a study to build a new, complete model that can be used to assist organizations in assessing and improving their Tennis information management evaluation and Improvement levels. The model is known as DPAI that stands for Determination Process Assessment and Improvement Model. Based on prior work, to our knowledge, the new KFI evaluation and Improvement model component of the DPAI has been completely and consistency provided with detailed, explicit guidance and advice on KFI practices and that centre Improvement on KFI best-practices, which is presented within the CEIMI-D standard. Therefore, the evaluation and Improvement model can be used to interpret the implementation of RD and KFIQM process areas of CEIMI-D perhaps without being dependent highly on consultants. Also, our model can provide insights into the effects of SR to software organization mainly in the country that are yet to be certified, in particular with the CEIMI-D certification.

METHODOLOGY

The DPAI has two main components: the Tennis information management evaluation and Improvement model and the Tennis information management assessment method. The Tennis information management Evaluation and Improvement Model is known as the EIM-KFI, which stands for Process Evaluation and Improvement Model for KFI, while the Tennis information management assessment method is known as FA-KFI, which stands for Flexible Assessment method for KFI. Hence, the two main steps of the DPAI development stage comprise building the EIM-KFI evaluation and Improvement model and building the FA-Tennis information management assessment method. These two steps have their own activities in building each of the DPAI components. The activities in creating the Tennis information management evaluation and Improvement model were emulated from the ways the existing generic and specific Tennis information management Improvement models were built. To develop EIM-KFI, the evaluation and Improvement model framework was first created. Then, it was followed by the identification of the structure and components of the evaluation and Improvement model. Finally, the EIM-KFI is completed after each component in the model has been defined with detailed information. The development of the model framework, structure and detail components was guided by five identified success criteria: Completeness, consistency, practicality, usefulness and verifiability as explained in our other paper.

Motivations for developing the model: Inspired to offer a solution to organizations interested to improve their Tennis information managements, we performed an empirical study to justify our then future research work, which is to develop this model. To our surprise, results of the study involving software development companies appraised with various evaluations and Improvement levels of CEIMI-D indicate that high-evaluation and Improvement ratings do not correlate with better performance and do not indicate effective, high-evaluation and Improvement practices. Possible reason for this include what Humphrey stressed that “... with increasing marketplace pressure, organization often focus on evaluation and Improvement levels rather than process capability... we now see cases where high-evaluation and Improvement ratings do not indicate effective, high-evaluation and Improvement practices. It is not that their appraisal process is faulty... that organizations are dishonest, merely that the evaluation and Improvement framework does not look deeply enough into all organizational practices”. When further investigated, we found out that many “good” practices were omitted from the CEIMI because they could not be generalized to the broad audience of the model as stated by Moore. In the case of Tennis information management, omissions can be seen in practices of Requirements Development Process Area (RPDA) when compared with the Tennis information management practices or activities commonly found in the literature.

Apart from the earlier mentioned motivations, we are also interested to offer a way out of the following issues that surround the CEIMI-D:

- The CEIMI-D does not define KFI evaluation and Improvement the way it should be defined based on
industry standard and practices. In the staged representation, CEIMI-D splits the entire KFI domain into two PAs in two separate evaluation and Improvement levels, with the order Key Factors Integration Process Area (KFIQM PA) first then followed by Requirements Development Process Area (RD PA). Hence, this order of KFI implementation and institutionalization is not always logical and can create issue. For example, if an organization does not have an institutionalized way of eliciting requirements (at evaluation and Improvement level 3), by right the organization would not have any requirements to be managed at lower evaluation and Improvement level 2. In the continuous representation, for another example, there might be a case where an organization with a high capability for KFIQM (for example, 5) has a low capability level (for example, 0) for RD PA is not always logical

• Thus, to create a comprehensive software, or KFI, process Improvement approach that would satisfy the demanding ISO 9000 or CEIMI assessors, organizations are forced to depend highly on paid consultants or CEIMI training and/or experiences of their team members or reference books, causing the cost associated with the model to be very high

Despite those issues that surround the CEIMI-D, we chose to build our model based on this known evaluation and Improvement framework for several reasons as detailed in the next sub-section.

Rationales for developing the KFI evaluation and improvement model based on ceimi-D: Even though software engineering has witnessed the development of several other generic SR standards and models we limit our model’s compatibility to CEIMI-D version 1.3 which was released in November 2010. Mainly because of the easy accessibility of this model compared to other models. Basing our model on the latest version of a known formal software reconstruction framework offers the practitioners several advantages. Amongst the rationale for basing our model on this evaluation and Improvement framework is that:

• The CEIMI framework is being adopted worldwide and is one of the few process models that attempts to define evaluation and Improvement levels of IT-related processes. The CEIMI also remains a de facto standard for “software-intensive system development”

• The CEIMI framework is based on best practices derived from many years of empirical study and contains guidelines for KFI practices. Even though these KFI practices are treated differently from the standards KFI components found in the literature and lack implementation details, the Tennis information managements are integrated with software development

• The CEIMI-D is designed to be tailored and adapted to focus on specific needs as it is a normative model. As suggested by Philips, community that is interested in focusing at specific area of process Improvement may need to “provide interpretive guidance or expanded coverage of specific practices and goals” for the area. This is basically what we aimed to achieve in our model

• While our model can be used independently to assess Tennis information management evaluation and Improvement (or capability), basing it on CEIMI-D will enable practitioners to use it in conjunction with an ongoing CEIMI-D program

Our model, the DPAI, taps into the strengths of the CEIMI-D and reflect the update made to the frame-work to form a specialized best practice KFI model. Like the other Tennis information management Improvement models, our model will take practitioners from a high level view of the KFI practices, through to a detailed description and to a process assessment method to guide companies towards satisfying their specific Tennis information management Improvement and general company goals.

Rationales for developing the KFI assessment method based on existing methods: The Tennis information management evaluation and Improvement model is built based on the CEIMI-D and initially SCAMPI Class C seems appropriate for the reference model as according to the SCAMPI is “applicable to a wide range of appraisal usage modes, including both internal process Improvement and external capability determinations”. But, SCAMPI Class C method (just like CEIMI group of standards) was initially written for large organization and is consequently difficult to apply in small company settings because of its complex requirements and the need to commit significant resources to achieve the CEIMI certification. On the other hand, both MMA and ADEPT methods have a set of guidelines for conducting CEIMI or CEIMI conformant software process assessment, respectively and focus on small companies.

However, both SCAMPI Class C and MMA methods focus only at reviewing an organization’s processes. Whereas, the ADEPT provides additional steps for
establishing process improvements initiatives and to see the progress that could have been accomplished from implementing the initiatives. Hence, the approach in the research is to combine several features and functions of these three assessment methods in a single assessment method. The aim is to optimize the applicability and usefulness of the developed assessment method. Moreover, the new Tennis information management evaluation and improvement model is a specialized reference model. Hence, a specialized process assessment that can help organizations particularly small companies, examine their Tennis information management against the model should be developed too. This approach is actually very similar with the way MA-MPS is developed for MR-MPS Process Reference Model. The term assessment used in this thesis implies that an organization can perform informal assessments to and for itself. These assessments are intended to motivate organizations to initiate or continue the Tennis information management improvement programs.

OVERVIEW OF THE KFI EVALUATION AND IMPROVEMENT MODEL

The new proposed model, DPAI, is a specialized Tennis information management improvement and assessment model. The model aims to be recognized as an applicable model to organizations which develop system and software products. The DPAI also defines rules to implement and assess itself, hence it support and assures a coherent use according to its definitions. As mentioned earlier, DPAI has two components: EIM-KFI reference model and the FA-KFI assessment method. Both model components are currently described in a single document called a DPAI model guide, which was given to the expert panel during the validation stage.

The EIM-KFI reference model contains the requirements that organizations must implement to be compliant with the DPAI Model. As mentioned earlier, the theoretical base used to create the EIM-KFI is the CEIMI-D. EIM-KFI therefore does not present a ‘new’ framework. We place it within the formal evaluation and improvement framework to guide practitioners towards improving their Tennis information management using a proven and familiar methodology. EIM-KFI contains definitions of the Tennis information management evaluation and improvement levels. It also provides interpretive guidance and expanded coverage of practices and goals for the Tennis information management. FA-KFI assessment method describes assessment requirements, assessments stages and steps, assessment indicators and assessors’ requirements. While FA-KFI is applicable to organizations developing software or software containing product, it is mainly oriented to the Small and Medium-size Enterprises (SMEs). The FA-KFI assessment stages and steps are based on characteristics of several process assessment methods. However, details of this assessment method are not covered in this study.

EIM-KFI MODEL DESCRIPTIONS

The EIM-KFI is a direct adaptation of the CEIMI-D continuous representation where as organization progresses in capability for a tennis information management, this mean the organization is becoming more mature in the Tennis information management. The EIM-KFI initially has 6 evaluation and improvement levels numbered 0 through 5, which were adapted from the six capability levels of the CEIMI-D version 1.2 explained in our other paper and thesis. However, to ensure that the proposed model can complement the latest version 1.3 that was released in November 2010, EIM-KFI has been tuned to contain four KFI evaluation and improvement levels only: 0 (Incomplete), 1 (Performed), 2 (Managed) and 3 (Defined).

(2) Descriptions-statements that explain what the practice is and why the practice is performed. Like the CEIMI-D capability levels, the EIM-KFI evaluation and improvement levels consists of a generic goal and its related generic practices which can improve organizations’ Tennis information management. At each KFI evaluation and improvement level, organizations need to implement several KFI practices to achieve the KFI goal for the specific level. Unlike CEIMI-D that separate goals and practices into generic and specific goals and practices to be satisfied by several process areas for a specific capability level, in this model, we consider all practices as KFI practices since this model focuses at a single process area only.

A KFI practice is an essential task that must be performed as part of Tennis information management. Practices may be performed formally or informally. However, it does not mean that it is done frequently or that most practitioners will necessarily perform the practice. Each KFI practice in the EIM-KFI has its practice guideline. Each KFI practice has a set of consistent components as follows:

- Purpose-describes the aim that the practice is intended to achieve
- Descriptions-statements that explain what the practice is and why the practice is performed
- Sub-practices-statements that provide guidance for interpreting and implementing the practice. They are
meant only to provide ideas that may be useful for
Tennis information management Improvement

• Typical Input/Output-lists examples input necessary
  for a practice to begin and output produced by the
  practice. Input should not be optional component
  and output, generally, should be produced by one
  and only one practice. The examples are called typical
  output because there are often other outputs that
  may not listed

• Techniques-list all techniques to performing the
  practice or different forms the output of the practice
  may take. A practice may have none, one, or more
  related techniques. A technique must be related to at
  least one practice. The techniques listed in this
  document are intended to cover the most common
  and widespread use in the community

• Elaborations-statements that provide more details or
  information about the practice and its components.
  Explanations of techniques may be provided in this
  component

Data stream classifying method: Let us notice that there
are different categories of orders: integrity, production,
derivation, reaction and transformations. Integrity orders
consist of a constraint assertion. Derivation orders are
used to derive conclusion whenever the conditions hold.
Production orders produce actions if the conditions hold,
while post-conditions must also hold after the execution
of actions. A reaction order is a statement of programming
that specifies the execution of one or more actions
in case of occurrence of a triggering event and
satisfaction of its conditions. Optionally, after executing
the action, post-conditions may need to be satisfied.
Orders can be also extracted from existing programs codes
that are not expressed in any specific order dialect by
using program slicing techniques.

Data Stream classifying method expands the concept
of ε-neighborhood and core-objects in Information
Integration with a fading function to maintain up-to-date
information.

A ε-neighborhood is defined by Information
Integration as being a set of points that have a
distance to another point less than the
user-defined parameter ε. More specifically, given point
p and dataset D, the ε-neighborhood of p (Nε(p)) is
equal to: Nε(p) = {q∈D|dist(p, q)≤ε}. The Euclidean
distance between point p and q.

A core-object is defined as a set of points within a
ε-neighborhood that contain more points than the
minimum point parameter. If p is part of a core-object,
Information Integration will expand the group around p.

The basic structure of the method is as follows:

• Information Integration takes the ε and minimum
  point parameters and then chooses a point p that has
  not been visited

• Information Integration calculates Nε(p). If the size of
  Nε(p) is greater than minimum points, Information
  Integration expands a group around p. Otherwise, the
  point is considered noise

• Information Integration iterates to a new unvisited
  point and repeats the process

Although, Information Integration was originally
developed for a batch environment, it has provided an
inspiration for stream classifying methods.

The fading function is defined as:

\[ f(t) = 2^{-\lambda t} \]  
\[ \lambda > 0 \] represents the decrease factor and \( t \)
represents the time.

Data-Stream also modifies the core-object concept of
Information Integration, creating a core-group with three
additional attributes: radius, center and weight. The radius
must be less than or equal to ε and the weight of a group
must be greater than the user-defined parameter μ. The
weight \( w \), center \( c \) and radius \( r \) of a core-small-group are
more formally defined at time \( t \), for a set of close points,
\( p_0, p_1, ..., p_n \) with time-stamps \( T_0, T_1, ..., T_n \) as:

\[ w = \sum_{i=1}^{n} f(t - T_i) \]  
\[ c = \frac{\sum_{i=1}^{n} f(t - T_i)p_i}{w} \]  
\[ r = \frac{\sum_{i=1}^{n} f(t - T_i)dist(p_i, c)}{w} \]

where, dist \( (p_i, c) \) is the Euclidean distance between
the point \( p_i \) and the center \( c \).

Because Data-stream operates in a stream
environment, the core-groups need to change dynamically
as time passes. To facilitate this, a potential core-groups
or p-small-group is introduced. P-small-groups are similar
to core-small-groups, except they differ in that the center
and radius values are based on the weighted sum and
squared sum of the points \( (\overline{CF}^D \) and \( \overline{CF}^R \)). Also, the
weight must be greater than or equal to \( \beta \mu \) where \( \beta \)
defines the threshold between p-small-groups and outliers
such that \( 0 < \beta < 1 \). \( \overline{CF}^D \) and \( \overline{CF}^R \) are calculated using the
equations:
The center and radius values to be:

\[ c = \frac{\bar{CF}}{w} \]  

and:

\[ r = \sqrt{\left(\frac{CF}{w} - \frac{CF}{w}\right)^2} \]

Although, the p-small-group permits the model to be updated dynamically, it generally will not provide a representative view of a workflow as new points appear. To handle this concept drift, Data-Stream also introduces the outlier-small-group (or o-small-group) and an outlier-buffer that temporarily stores o-small-groups and allows them to become p-small-groups. The operation of Data-Stream is as follows:

**Initial step:** Perform Data Analyzing on a set of initial points to generate starting p-small-groups

**Online Steps,** when a new point \( p \) arrives in the stream:

- The method attempts to merge \( p \) with the closest p-small-group. If the radius of the potential small-group is less than or equal to the value of \( \varepsilon \), the point is merged.
- If the point is not merged to a p-small-group, it tries to merge \( p \) with an existing o-small-group. If the radius is less than \( \varepsilon \), it is merged with the o-small-group. Then if the o-small-group now has a weight large enough to become its own p-small-group, it is removed from the outlier-buffer and added to the model as a p-small-group.
- If the point cannot be merged to an existing o-small-group, it creates a new o-small-group and gets placed in the outlier-buffer.

After the merging phase of the Data-Stream method, the lower weight limit is calculated for all o-small-groups in the outlier buffer. This is done using the equation:

\[ \xi(t_c, t_b) = \frac{2^{-\lambda(x-t_c)^2} - 1}{2^{\lambda t_b - t_c}} \]

where \( \lambda > 0 \) represents the decrease factor, \( t_c \) and \( t_0 \) represent the current and starting time for the o-small-group and \( T_p \) is the predetermined time-period.

- If the weight of a particular group is less than the lower weight limit, the o-small-group can be removed from the outlier buffer.

**CONCLUSION**

In this study, we describe what, why and how we construct a specialized Tennis information management Improvement and Assessment model-called the DPAI-with the aim to assist organizations in assessing and improving their Tennis information management based on a proven evaluation and improvement framework. The DPAI has four KFI evaluation and Improvement levels, which is adopted from the latest version 1.3 of the CEIMI-D.

Despite the strengths abovementioned, DPAI is not without weaknesses. One small hiccup of the model is that it appears that training is still needed by the practitioners in order to interpret and understand the model despite the detailed information provided to the model. Moreover, even though the model is recognized by the experts as an adaptation of existing models, standards and assessment methods, yet it is not fully accepted as a model that is simple to understand since it appears to require further examples, templates and elaborations before the model could be used effectively. One probable explanation for the findings is that “developers are rather suspect at using written routines”. In order to rectify these two drawbacks of the proposed DPAI, future research could work on building self-training packages on KFI activities, which is compatible with the model. The self-training packages concept is similar to Action Package and Self-Training Package. Providing training packages alone however may not be sufficient to eliminate the skepticisms that practitioners might have with the detailed guidelines of DPAI.

Therefore, future research also should work on exploring Experience Management (EM)-like software tool to support the self-training packages in quest to help software developers self-trained the proposed DPAI or any other model-based process Improvement approach.
REFERENCES


