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Sw Quality Process Models: An Appraisal

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Abstract

The quality of the software is measured and maintained by the quality models like the Maccalls, Bohem, FURPS, ISO, and CMM. We have given an appraisal of software quality models. The theoretical appraisal is given to select the model on the theoretical base and to augment the theoretical augment the empirical analysis is used. For a given quality criteria the theoretical dealings measure the process quality models. And the experiential appraisal is also developed for evaluating the performance of the models. The theoretical and experiential both procedures evaluate degree which is used in process to measure the quality of the software. Different and many organizations are developing the software these organizations are using different software models. For better quality of the software different models are suggested. We have made a theoretical and the experiential evaluation to measure the quality of the software's.

Keywords: Software; Sw quality process; Quality system

Introduction

The anticipated work is summarized for the proportional estimate of SW quality models. For both the experiential and the theoretical evaluation the process are distinct. The delegate software set is chosen for evaluating the procedures. For specifying the content of quality (relevance to the user need) software results, scope is applied. These procedures evaluate the SW quality models on the experiential base [1].

To measure the notion of the quality the SW quality process are evaluated these processes are selected. For the theoretical evaluation some measures are established for analyzing the content of model theoretically.

The theoretical evaluation defines that either the model is based on the sound theory or not. It also verifies that the measures are not based on exceptions. On the other side the experiential evaluation is applied practically. Validation of the model is done by implementing the model [2]. This defines that the given theory shows a relationship with the observations of real world.

The theoretical evaluation cannot prove the correlation with the real world. The only experiential evaluation also does not identify that the observed process were genuine. So for getting the benefits of both approaches are utilized.

The both approaches for evaluating can be used independent for the success of validation study. So it is advantageous to execute this analysis independently as it's possible.

For integrated approach the results for both approaches can be combined and we can calculate the total validation for the SW quality model.

Theoretical Assessment of SW Quality Models

The theoretical appraisal is an analytical in which the definition of the quality model is used as input and that will result the notion of the quality of the product as the output.

Approaches for theoretical assessment

There are many approaches for measuring the quality but the approach selection is important while considering,

- Contents of model
- Results type of user

Theoretical approach uses the fundamental contents for the model which are theory based so it gives the strongest quality level. The results of this approach cannot be compared. The disadvantage of theoretical approach is that when the model narrates to an indulgent of quality it wants to access the detail of elements of model.

Set of condition is defined for this approach. On the basis of these conditions and requirements the model can be examined. If the SW Quality model is theoretically ideal and it represents all requirements then this model provides some quality measures. So for good quality requirements should be complete and correct [3].

Incomplete requirements set can be used as sample for infinite set. After the analysis the results are compared and the assessment can be made. This approach is indirect measurement of models. This approach does not address the theory directly, only the documents can be utilized by the user. The results by this approach are dependent on the procedure which is selected for the evaluation. While using the analytical method the correctness can be measured in the forms (Table 1).

- Satisfied
- Partially satisfied
- Not satisfied

Approach of user class based appraisal

While developing any software project number of user classes can be identified. Each and every user class performs same roles that an individual performs with content of quality model. This significance can be articulated that requirements are positioned on a SW quality model. Different user classes can share any requirement. Every user class also has a set of requirements. Complete set of requirements for model evaluation is the union of requirements the union of each user class requirements.

For CMM (capability maturity model) software managers, process group's members, practitioners, all are interested to improve the quality

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of software. They all are the audience [4].

User classes are given in the Table 2.

Set of requirements is known as stated in the ideal process quality model and the set of user classes is also known.

Figure 1 illustrates the relationship between user classes and the requirements [5] (Table 3).

There is no upper limit that a unique software process model exists only so we can say that R ⊆ S. It is required to maximize the degree to which the association of R concurs with the association of S [6].

R1, R2, R3 represent the user classes Table 1. Table 4 gives the relationship.

T is also other subset of R which has those requirements which are not necessary for R1, R2, R3.

So,

R = R1 ∪ R2 ∪ R3 ∪ T

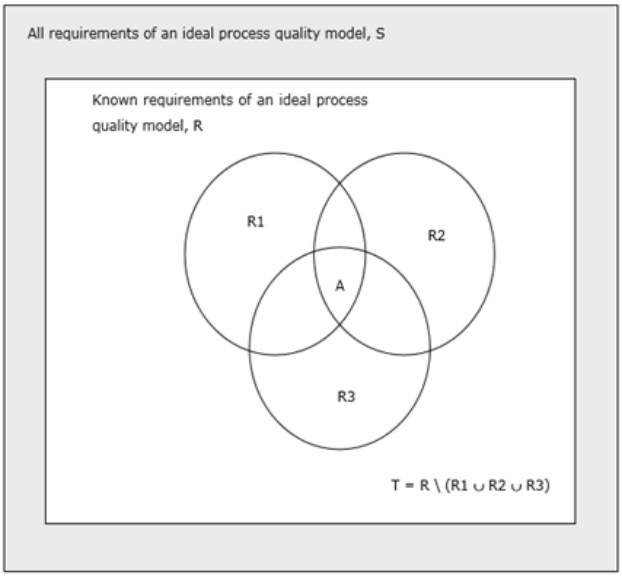


Figure 1: Relationship b/w user class and requirements.

Forms	Remarks
Satisfied	Model completely satisfy all requirements
Partly satisfied	Model satisfies the part of the requirements.
Not satisfied	Model does not satisfy the idea in the requirements.

Table 1: Form of correctness.

User classes	Description
UC1	SW developers
UC2	Manager
UC3	Customers

Table 2: User classes.

S	All requirements in ideal process
R	Requirements known in ideal process.
T	Requirements mapped with no user class
R1, R2, R3	Requirements mapped to specific class
A	Common requirements for all classes

Table 3: Key words for requirements.

R1	UC1(developers)
R2	UC2(process manager)
R3	UC3(customer or client)

Table 4: Relationship b/w user classes and requirements.

A = R1 ∪ R2 ∪ R3 T

A = R \ (R1 ∪ R2 ∪ R3) R1 ⊆ R R2 ⊆ R R3 ⊆ R T ⊆ R ∀x. x ∈ T → (x ∉ R1) ∧ (x ∉ R2) ∧ (x ∉ R3)

In the figure the intersecting part of R1, R2, R3 where all are overlapping is the subset of user requirements. This part shows that the issues related to quality are common for all groups in working unit.

So these requirements should be fulfilled by the SW quality model.

The requirements of each class which are not common are for that class users only and issues of quality for these requirements require level of specialization. These are domain specific requirements.

Idyllically, T = ∅.

Irrelevant requirements are always null because these are cost inefficient.

Experiential Assessment Approach

The main purpose of this approach is to verify the theoretical model on experiments base. The methods in the theoretical approach are implemented. It ensures that the theory correct in the real world. In term of the notion of the quality the experiential approach improves the SW quality processes.

Approaches to experiential assessment

It is not sufficient that the theoretically model is valid it should be suitable for practical use and should produce the valid results. By number of case studies the experiential assessment of a SW quality model is done. The case studies and model definition are inputs of the approach and the quality of the input process is the output of the approach.

The comparative analysis is made on the performance of the output. The quality measure of different models for single process is compared by this approach [7].

The comparative performance is observed in this approach the evaluator is not the content of quality in this approach. Indirect similarity is measured in the contents of quality if two models are producing the similar results they share the common contents. If the results of all SW quality models are same then the any process can be chosen and there is no difficulty to choose any SW quality model for quality. In 2nd case if the results are not similar then we are required to choose that model which is more appropriate in the contents of quality.

Results to obtain by experiential assessment

The results by this approach can be divided in two main categories.

1. Model content dependent

2. Model content independent

Model content dependent results are useful for the analysis of SW quality model. The comparative assessment of model cannot be done in this way. A set of SW quality models and processes is defined in analytical approach. Each and every model is decomposed in individual elements which gives the detail used in that model.

The results are taken when the case study is complete and the form of results could be one for each element. This form could be like:

- Fulfilled
- Partly fulfilled
- Not fulfilled

These results are combined into set. Rating for the process quality is approved by use of the structure of model. The result set and quality measures of the process depend on model contents. For comparison of models the contents of the models are translated. For achieving this, mapping is done b/w each element of the model to the element of a standard model. Subjective measures are difficult to determine correctly.

So we can aspect that the experiential assessment procedure will give way these results [7].

• Process quality measures on the level of model element for process and process quality model.

• Process quality measures on the level of complete model for process and process SW quality model.

• Conformance of measure for case study process to every case study models in a standard format, at the level of the element of standard model.

• Conformance of measure for case study process to every case study models in a standard format, at the level of the complete standard model.

Input resources for experiential assessment procedure

Quality models: Each quality model is known as member of the assessment set of process quality models [8].

Many guidelines are to be monitored while checking for the quality models like:

• Model should be relevant to case study

• Model scope

• Model availability

• Guidelines availability for model application

• Third party resource backing

• How mature the model is

• Stability of the model

• Model Representativeness

• Status of model set

These three quality models were selected on the basis of above guidelines (Table 5). These models are broadly compatible with the evaluation set and with defined evaluation process, so there is no reason that any member from the set of evaluation will be unsuited by this procedure. The given guidelines are applied while measuring the software process model with specific quality model [9].

S.no	Model name
1	ISO 9001:1994/ ISO 9000-3 [8]
2	Spice v1.3 [10]
3	SW-CMM v1.3 [9]

Table 5: The software process model selected.

PReq1	stable process
PReq2	Non trivial process
PReq3	Process is in one production line
PReq4	Multiple workers in the process
PReq5	Software production is main focus
PReq6	Principles of sw engineering are utilized
PReq7	Unified process elements
PReq8	Open for investigation
PReq9	Documentation is available
PReq10	Can be observed
PReq11	Publication info is not restricted
PReq12	Publication not restricted by process
PReq13	It's a real process
PReq14	Software representation
PReq15	Mature process

Table 6: Requirements of a case study process.

Software processes

According to requirements the software process set is selected in 'Appendix N: Case study information'. Every process is in scope of study, and in scope of quality model defined in Table 1. So each process can be used in the experiential assessment procedures. The software process selection is given in Appendix N (appendix summary is given at the end of results below). Two independent processes were selected for the given case study [10]. These requirements were taken in account while working on case study for useable results (Table 6).

Case Study

Case 'A'

The students of the University of Durham implemented the software process while developing a software project in the session 2002-2003 [11]. The software process that these students used was undertaken as case study that is referred to A1, A2, and A3. The level of this organization is that the quality issue does not matter for this organization. Documents of the projects are input in this case study [11,12] and the observation of the process in first time is the experiential implementation.

The process has following characteristics:

- Well defined starts and end points.
- Immutable.
- Fall in the schedule.

Case 'B'

This case is the implementation of the process for the open source GNU GCC project [13]. This is mature project. In this case the latest version that was used in 2017 is discussed. This latest version was launched in 25 May 2017. This case was chosen mainly because the developers were not devolving the new software but they were working on the same software to develop it. In this case the quality is concerned to the organization, and we used this process to our case studies B1, B2, B3. Web site of GCC is Input assets. Because these are open source projects so these are easily available to the researcher.

Case Study Contents

The quality process models are shown in the Table 5 above. In Table 4 pairing for quality process model and software processes is made (Table 7).

Identifier	Name
A	University of Durham [11,12]
B	GNU GCC [13,14]

Table 7: Case studies.

Value	Remarks
n/a	Not applicable
F	Full adequate
P	Partly adequate
L	Large adequate
N	Not adequate

Table 8: Values for spice model.

Value	Remarks
n/a	Not applicable
Satisfied	complete satisfied
Unsatisfied	Wholly not satisfied

Table 9: Values for SW CMM model.

Software process quality model				
processes		1	2	3
	A	1A	2A	3A
	B	1B	2B	3B

Table 10: Set for case studies.

Measurement Scale for Software Quality Models

Model 1: ISO 9001:1994 / ISO 9000-3

The measurement scale is assigned on three bases in this model:

- Satisfied
- Not satisfied
- Not applicable

Satisfied mean that model elements can be satisfied completely by the process. Not satisfied mean that content elements are not wholly satisfied, not applicable mean that it's a discrete manner.

Model 2: SPICE

Case study assigns a value for each element of model (Table 8).

Model3: SW-CMM

Case study assigns a value for each element of model (Table 9).

Results and Discussion

Standardized set of results for case studies (Table 10).

Case studies (1A, 2A, 3A)

Results set A: ISO 9001: 1994

Each element of ISO 9001:1994 is trivially mapped to itself.

Management responsibility: Satisfied 3 (60.00%), Unsatisfied: 2 (40.00%).

Quality system: Satisfied: 0 (0.00%), Unsatisfied: 3 (100.00%).

Contract review: Satisfied: 2 (50.00%), Unsatisfied: 2 (50.00%).

Design control: Satisfied: 7 (77.78%), Unsatisfied: 2 (22.22%).

Document and data control: Satisfied: 2 (66.67%), Unsatisfied: 1 (33.33%).

Purchasing: Satisfied: 1 (20.00%), Unsatisfied: 2 (40.00%), N/A: 2 (40.00%).

Control product: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Product traceability: Satisfied: 1 (100.00%), Unsatisfied: 0 (0.00%).

Process control: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Inspection and testing: Satisfied: 1 (14.29%), Unsatisfied: 6 (85.71%).

Inspections and measuring: Satisfied: 0 (0.00%), Unsatisfied: 2 (100.00%).

Test status: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Nonconforming control: Satisfied: 0 (0%), Unsatisfied: 2 (100%).

Corrective and preventative action: Satisfied: 0 (0.00%), Unsatisfied: 3 (100.00%).

Handling, and packaging: Satisfied: 6 (100.00%), Unsatisfied: 0 (0.00%).

Quality records: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Quality audits: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Training: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Servicing: Satisfied: 0 (0.00%), Unsatisfied: 0 (0.00%), N/A: 1 (100.00%).

Statistical techniques: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Case study 1A: ISO9001/ISO 9000-3 ISO9000-3

Management responsibility: Satisfied: 2 (28.57%), Unsatisfied: 5 (71.43%).

Quality system: Satisfied: 0 (0.00%), Unsatisfied: 5 (100.00%).

Contract review: Satisfied: 2 (50.00%), Unsatisfied: 2 (50.00%).

Design control: Satisfied: 17 (65.38%), Unsatisfied: 9 (34.62%).

Document and data control: Satisfied: 3 (33.33%), Unsatisfied: 6 (66.67%).

Purchasing: Satisfied: 0 (0.00%), Unsatisfied: 3 (100.00%).

Control product: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Product traceability: Satisfied: 2 (40.00%), Unsatisfied: 3 (60.00%).

Process control: Satisfied: 4 (66.67%), Unsatisfied: 2 (33.33%).

Inspection and testing: Satisfied: 8 (80.00%), Unsatisfied: 2 (20.00%).

Inspection and measuring: Satisfied: 5 (71.43%), Unsatisfied: 2 (28.57%).

Test status: Satisfied: 2 (40.00%), Unsatisfied: 3 (60.00%).

Nonconforming control: Satisfied: 12 (70.59%), Unsatisfied: 5 (29.41%).

Corrective and preventative action: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Handling and packaging: Satisfied: 4 (80.00%), Unsatisfied: 1 (20.00%).

Unsatisfied	55 (44.72%)
Satisfied	61 (49.59%)
n/a	7 (5.69%)
total	123 (100%)

Table 11: Overall results of case study1A: ISO9001/ISO 9000-3 ISO9000-3.

Unsatisfied	163 (46.82%)
Satisfied	167 (47.49%)
n/a	18 (5.17%)
Total	348 (100%)

Table 12: Overall results of case study 2A: SPICE.

Unsatisfied	152 (48.87%)
Satisfied	133 (42.77%)
n/a	26 (8.36%)
Total	311 (100%)

Table 13: Overall results of case study 3A: CMM.

Quality control record: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Quality audits: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Training: Satisfied: 0 (0.00%), Unsatisfied: 1 (100.00%).

Servicing: Satisfied: 0 (0.00%), Unsatisfied: 0 (0.00%), N/A: 7 (100.00%).

Statistical techniques: Satisfied: 0 (0.00%), Unsatisfied: 2 (100.00%).

All number of satisfied, N/A, and unsatisfied and process quality model that are mapped are in Table 11.

Case study 2A: SPICE

The data can be provided on demand in order to save the space. All number of satisfied, N/A, and unsatisfied and process quality model that are mapped are in Table 12.

Case study 3A: CMM

The data can be provided on demand in order to save the space. All number and of satisfied n/a and unsatisfied and process quality model that are mapped are in Table 13.

Case studies (1B, 2B,3B)

Case study 1B: ISO9001/ISO9000-3: All number and of satisfied n/a and unsatisfied and process quality model that are mapped are in Table 14.

Case study 2B: SPICE: All number and of satisfied n/a and unsatisfied and process quality model that are mapped are in Table 15.

Case study 3B: CMM: All number and of satisfied n/a and unsatisfied and process quality model that are mapped are in Table 16.

Result graphs of entire mode

We know that for model satisfaction these three values could be seen:

- Satisfied
- Not satisfied
- N/A

Unsatisfied	53 (43.08%)
Satisfied	70 (56.92%)
n/a	0 (0.0%)
total	123 (100%)

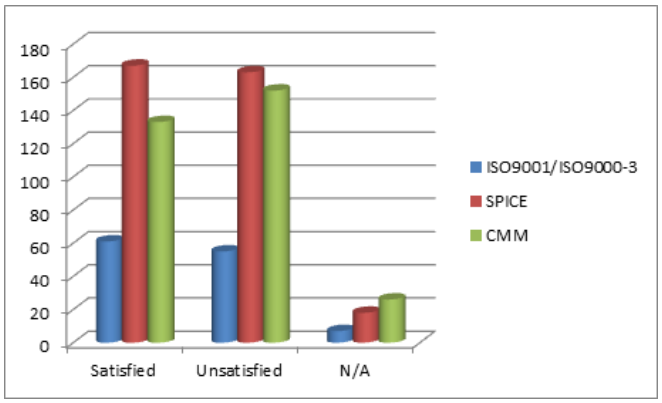
Table 14: Overall results of case study 1B: ISO9001/ISO9000-3.

Unsatisfied	148 (42.52%)
Satisfied	197 (56.60%)
n/a	3 (0.86%)
Total	348 (100%)

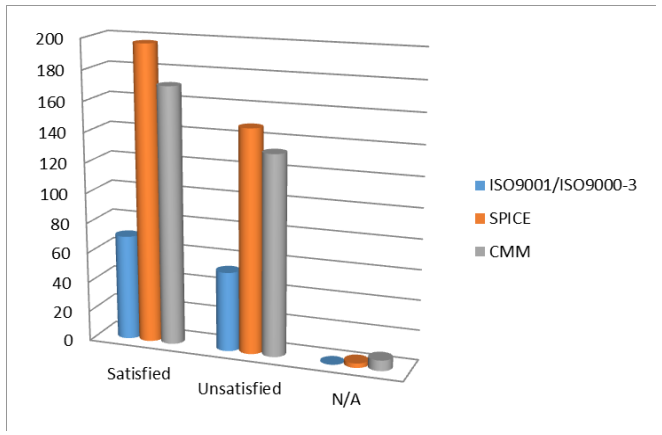
Table 15: Overall results of case study 2B: SPICE.

Unsatisfied	133 (42.77%)
Satisfied	171 (54.98%)
n/a	7 (2.25%)
Total	311 (100%)

Table 16: Overall results of case study 3B: CMM.



Graph 1: Cases study A entire results.



Graph 2: Case study B entire results.

For case study A: Graph 1 indicates the percentage of model necessities. For process A is relatively small, this is very small for results of process assessment [14]. The result range for 'satisfied' models is 42.77% and SW-CMM to 49.59% for ISO 9001:1994 / ISO 9000-3. The SPICE result is found 47.99%.

For case study B: In this graph the range for the 'satisfied' results is

in the range 42.77% for SW-CMM to 54.98% and for ISO 9001:1994 / ISO 9000-3. The range size is 56.92% this cannot be disregard in is very efficient value [15]. The SPICE is found as 56.60% in this case study. In this case study all model behave similarly in content of the quality (Graph 2).

Conclusion and Future Work

In this paper a small node is compared to evaluate the quality process models. Many other finding can be calculated as it's a very vide area for getting the information. More case studies can also be included to get the more appropriate finding. In the same work many other aspects can be used for finding. For assessment more process model can be added in the future work. Formalized techniques may be used to find more formal quality process models also. More techniques can be used for pairing of both the process and quality models. These models can also be integrated for the development of the software's.

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