SOFTWARE PROCESS IMPROVEMENT IN A SOFTWARE DEVELOPMENT ENVIRONMENT

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ABSTRACT

SOFTWARE PROCESS IMPROVEMENT
IN A SOFTWARE DEVELOPMENT ENVIRONMENT

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A software process improvement study is presented. The literature on software development processes and their improvement is reviewed. The current peer review process at Software Engineering Directorate of the X Company, Ankara, Türkiye (XCOM) is studied and the static software development metrics based on a recent proposal have been evaluated. The static software metrics based improvement suggestions and the author's improvement suggestions discussed with the senior staff are compared. An improved peer review process is proposed. The static software development metrics have been evaluated on the improved process to see the impacts of the improvements. The improved process has been already implemented at XCOM and preliminary results have been obtained.

Keywords: Software Process Improvement, Review, Metric, Verification

ÖZ

BİR YAZILIM GELİŞTİRME ORTAMINDA YAZILIM SÜREÇ İYİLEŞTİRME

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Bir yazılım süreci iyileştirme çalışması sunulmaktadır. Yazılım geliştirme süreçleri ve bunların iyileştirilmesi konularındaki literatür incelenmiştir. Daha sonra Ankara'da bulunan X Firmasının Yazılım Mühendisliği Direktörlüğünde uygulanan eş düzey gözden geçirme süreci incelenmiş ve yakın zamanda önerilmiş bir yönteme göre statik yazılım süreci metrikleri hesaplanmıştır. Bu metriklere dayanan iyileştirme önerileri ve yazarın ortaya koyup kıdemli personelle tartıştığı iyileştirme önerileri değerlendirilmiştir. Bu iki yaklaşım karşılaştırılmıştır. Son haline getirilen iyileştirme önerileri sürece uygulanmış ve iyileştirilmiş eş düzey gözden geçirme süreci ortaya konmuştur. Daha sonra uygulanan iyileştirme önerilerinin etkisini görebilmek için statik yazılım geliştirme metrikleri iyileştirilmiş süreç için de hesaplanmıştır. İyileştirilmiş süreç firmada uygulanmış ve ilk sonuçları alınmaya başlanmıştır.

Keywords: Yazılım Süreç İyileştirme, Gözden Geçirme, Metrik, Doğrulama

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LIST OF ABBREVIATIONS AND ACRONYMS

AI	Action Item
AQAP	Allied Quality Assurance Provision
CMM	Capability Maturity Model
CMMI	Capability Maturity Model Integrated
GQM	Goal Question Metric
IEC	International Electro technical Commission
ISO	International Organizational for Standardization
PR	Peer Review
SEPG	Software Engineering Process Group
SG	Selçuk Güceğlioğlu
SPI	Software Process Improvement
SQE	Software Quality Engineer
XCOM	Software Engineering Directorate of the X Company

CHAPTER 1

INTRODUCTION

The software business's significant impact on today's economy generates considerable interest in making software development more cost effective and producing higher quality software [23] since the well-managed software development is a strategic competency for many organizations.

"Software development is in constant change and new software development strategies, methods, processes, and tools for software development are constantly introduced and taken in use; simultaneously, the growth and importance of software has accelerated, and software has become a fundamental part of whole range of different products." [24]

Software development is complex which causes some problems. First, software development requires both human and technology resources which makes it expensive. Second, the most of software projects cannot be completed on time and within the budgets and the required quality of the work products cannot be achieved which results with the customer dissatisfaction. These problems can also result in employee dissatisfaction.

To provide effective management for software development considering its complexity and to solve the problems, some methods are needed.

Software Process is defined as "A set of activities, methods, practices, and transformations that people use to develop and maintain software work products." [26]. Improvement of software development processes has been a popular subject. CMMI [2] and the ISO/IEC IS 15504 [25] are the major Software Process

Improvement (SPI) models. The main goals are reducing cost, increasing quality, completion of software projects on time, and providing customer and employee satisfactions.

Generally, based on XCOM's process definition, Software Development Process has the following sub-processes and activities as given in Table 1.

Table 1 Software Development Process

Process	Sub-Process	Activities	Outputs
Development Process	Planning	Development Planning Integration Planning Test Planning	Software Development Plan System/Software Integration Plan Software Test Plans
	Requirements Engineering	Develop Customer Requirements Develop System Requirements Develop Software Requirements	Software System Requirements Software Requirement Specification
	Architectural Design	Determine Architectural Solution Develop Architectural Design	Software Design Description System/Sub-systemDesign Description Software Architectural Design
	Detailed Design	--	Software Design Description System/Sub-systemDesign Description Interface Design Description
	Implementation and Unit Testing	Implementation Unit Testing	Source Code Unit Test Results
	Integration	Software Integration System Integration	Integrated Product Product Integration Instructions Verificaiton and Validation Results and Reports
	Testing	--	System/Software Test Cases and Procedures System/Software Test Results Test Cases/Test Procedures
	Develop Product Support Documentation	--	Training Documents User Manuals Maintanence Manuals
	Problem Resolution	--	Revised Products

Verification is performed for each work product of the development process to ensure that these products meet their requirements. The peer reviews are an important part of the verification and a proven mechanism [2]. The main objective of peer review is to remove the defects in the product efficiently.

The software process improvement study presented in this thesis has been carried out for the peer review process at the Software Engineering Directorate of the X[*] Company, Ankara, Türkiye (XCOM). XCOM is appraised as a SEI CMMI [2] Level 3 company, holds ISO-9001:2000 [32] and AQAP-160 [31] Certificates.

XCOM has significant experience and capabilities in the areas of Command, Control, Communications, Computers and Intelligence and avionics systems, real-time software development, Independent Verification and Validation and Tactical Data Links in the Turkish Defense Industry.

In XCOM, Software Quality Assurance Department is responsible from peer review process. At the initialization of the project, the Quality Systems Director assigns Software Quality Engineer (SQE) to the project activities for peer reviews, evaluations, test monitoring and audits. For peer reviews, SQE performs the following activities:

- Schedules a peer review for each product to be released
- Participates and assures that peer reviews are performed per regulatory documents and report the results of peer reviews.
- Defines the readiness and completion criteria for each peer review
- Tracks the action items identified during the peer reviews to closure.
- Plans and participates in peer reviews and inspections of the products delivered by the subcontractor to assure that subcontractor's products satisfy prime contract requirements, if applicable
- Ensures that verification and validation are implemented to verify that product satisfies the defined requirements and the intended usage
- Reviews the product measurements and goals within the scope of the project

One of the most important projects is Avionics Software Development and Verification according to RTCA DO-178B [30]. In this project, all of the products must be verified, approved, and released after peer reviews are completed and closed. When the development process as given in Table 1 is inspected we notice that peer review process is referred from each sub-process, at each activity since the outputs of

the development process must be peer reviewed. Since the numbers of the software quality engineers are not sufficient, peer review process can easily become bottleneck activity in the overall development process. That is why this activity is usually considered as excess process by project managers and developers. For this reasons, this process usually needs to be improved.

In a recent study, Güceğlioğlu [1] has derived quantitative measures for the static aspects of software development processes. His metrics have been inspired by software product quality measurement standards, ISO 9126 [12] and have been used and evaluated in various subsequent studies [14] [15] [16].

The aim of this study is twofold: One, to improve the peer review process applied in a software development firm, and two, to compare the ad-hoc improvement with the approach based on Güceğlioğlu's metrics, with the aim of providing a modest contribution to the assessment of the latter approach for static process evaluation. .

For process improvement, the author's own experiences in the firm being studied, as well as the opinions of supervisors and co-workers are used to identify problems and propose solutions.

Thus, the research questions considered in this study are:

- Can the problems observed in an actual software development firm regarding the peer review process be improved using an ad-hoc approach?
- How does an ad-hoc improvement approach compare with the results of Güceğlioğlu's re-enactment software process modeling and assessment technique?

To answer these questions, the author's observations, document inspections, interviews with co-workers, and supervisors were used for:

a. Process Modeling,
b. Problem Diagnosis, and
c. Improvement Suggestions.

Based on the AS-IS and TO-BE process models, Güceğlioğlu's [1] metrics have been calculated and their implications have been compared with the results of the ad-hoc improvement exercise. These metrics will be referred as SG metrics.

Improvements have been based on the evaluations of the author and her colleagues in the company. Güceğlioğlu's evaluation scheme has also been applied and compared with the improvements arising from practical concerns.

. The organization of the thesis is as follows:

The review of relevant literature review is given in Chapter 2. In Chapter 3, first the subject of case studies in information systems will be reviewed, as this study can be considered as such; then the current process (AS-IS) model is presented and discrepancies between regulatory documents and current process are given. Next, SG metrics are calculated for each sub-process. Then, the improvement suggestions agreed with the senior staffs and metric-based improvement suggestions are discussed. In Chapter 4, the improved process model is given and SG metrics are also calculated for each sub-processes of process to see the impacts of the software process improvements. Finally, an evaluation is presented and the study is concluded in Chapter 5.

[*] The XCOM did not give permission to reveal its identity. Therefore, the company will be referred as "XCOM" throughout the document.

CHAPTER 2

LITERATURE REVIEW

Technology is growing up very fast and the competition between the companies becomes strong likewise. Now, more than ever, organizations want to develop, deliver and maintain their products and services better, faster, and cheaper [2] with desired high software quality.

> *"In today's software marketplace, the principal focus is on cost, schedule, and function; quality is lost in the noise. This is unfortunate since poor quality performance is the root cause of most software cost and schedule problem."*
>
> *Watts S. Humphrey [3]*

In agreement with Watts S. Humphrey's emphasis, during the past few years, considerable attention has been devoted to software process modeling [4] for better software development models to produce quality work products. Waterfall, evolutionary, prototyping, spiral, and eXtreme Programming are some of the major process models. All of these models are used to represent a software process model with particular perspective and provide partial information about that process [5]

All of these models are used to represent a software process model with particular perspective and provide partial information about that process. It is understandable that they may not be used as a definitive process model. They can be used modifying them according to organization's specific needs and structure.

It is known that the quality of a software product is related with the quality of the processes and process assets used to create the product [6]. According to that more organizations are looking at SPI as a way to improve cost, predictability of

project costs and schedules, quality and productivity, cycle time, customer and employee satisfaction [7], acquisition and maintenance efforts.

Therefore, the organization encourages participation in process improvement activities by those who will perform the process [2] since without support from the very top, it is generally impossible to make significant changes [8] which result with failure or success.

There are three distinct levels of SPI which organizations need to spend a concerted effort for: The organization, the team, and the individual [9]. At the organization level, the starting point of the SPI studies is to perform an assessment of the current process to define the powerful, weak and indistinct parts of the organization's processes and process assets which need to be improved. During these activities organization's needs and objectives are also considered. At the end of this assessment, improvement suggestions are discussed and as a result of discussions, SPI plan is prepared which includes information about how to implement organizational SPI, action plan and deployment plan. Depending on these activities, the roles and the responsibilities are assigned. When we consider the team level and the individual level it is observed that the context of the SPI must be understood, action plan must be reviewed, and deployment of SPI must be performed efficiently.

In the assessment of the current process, first process measurement is performed. The main reason behind this idea is to compare the organizational objectives and the measurements data. After this data is analyzed, improvements are defined. At this point it is observed that most of the companies do not measure their process or do not have accurate measurement data. As given in CMMI® 09 March 2004, Software Engineering Process Group (SEPG) 2004 [10] what people have really done regarding Measurement and Analysis is:

- Most organizations develop a rationale for their measures, but they do not consider what they need,
- Few organizations really analyze their measures to support business objectives and organizational needs,and
- Most organizations do not have any measurement specifications.

Effective measurement processes provide the companies to understand their capabilities, in this way, they can develop develop achievable plans for SPI [11] Otherwise, the results of meaningless measurements continue to be disappointing.

ISO and CMM are well-founded SPI models for Software Quality System [22] CMM was the first developed maturity model and CMMI has replaced it. CMMI is a process improvement maturity model which includes best practices that address development and maintenance activities that cover the product lifecycle from conception through delivery and maintenance [2]

Based on the CMMI [2], many organizations have performed significant improvements. For example, the performance results for IBM Australia Application Management Services are as follows [28]: Cost: On-budget delivery improved from over 90 percent to nearly 100 percent, Schedule: On-time delivery remained well over 90 percent, Productivity: Over 20 percent improvement in account productivity, Quality: 40 percent reduction in all production problems, and Customer Satisfaction: Customer satisfaction remained well over 80 percent as the organization moved from SW-CMM maturity level 3 to CMMI maturity Level 5.

Another example is Lockheed Martin Systems Integration - Owego, NY [29] which has improved software productivity from a 1992 baseline by approximately 60 percent and reduced software-defects-per-million-delivered-SLOC from a 1992 baseline by over 50 percent at SW-CMM maturity level 5 to over 140 percent at CMMI maturity level 5.

The ISO 9000 family of standards represents an international consensus on good quality management practices and ISO 9001 is the standard that provides a set of standardized requirements for a quality management system, regardless of what the user organization does, its size, or whether it is in the private, or public sector [27].

SPI models provide a model to improve processes. Therefore, SPI methodologies are a guideline for analyzing and improving software processes and they can not be used to define the weak and indistinct parts of the organization's processes and process assets.

Goal Question Metric (GQM) and Six Sigma are the widely used SPI methodologies. GQM methodology introduced and described by Basili and Rombach [13]. GQM is architecture for stating goals and refining them into specific questions which provide a specification for the data needed to help address the goal about the characteristics that need to be measured [17]. Six Sigma originated at Motorola in the early 1980s [18]. In ten years (1987-1997), Motorola increased sales 5 times, profits

6 times, and stock over 7 times [20]. Then, the large manufacturing companies such as General Electric and Allied Signal first used Six Sigma processes to collect data, improve quality, lower costs, and virtually eliminate defects in fielded products [19]. Six Sigma uses Statistical Process Control methods: Define-Measure-Analyze-Improve-Control and Design for Six Sigma- Approach that incorporates various methods [21].

There is no magic SPI program that can help organizations to perform better software development process. Organizations should consider their needs, culture, and objectives. It is not possible to make sure that selected SPI program will be resulted with failure or success.

Güceğlioğlu [1] has presented a new SPI approach for measuring the process quality evaluating metrics based on static descriptions of software development processes on the ISO/IEC 9126 Software Product Quality Model [12].

The model provides suggested set of process quality metrics such as complexity, reliability, functionality, testability etc. Güceğlioğlu [1] suggests that an organization can benefit from product based models and also process quality based measurements for selecting the most suitable alternative using the analogy of software product evaluation via product metrics. The model can also be used by itself in the process improvement studies and by means of the model; organizations can measure impacts of the process improvement studies on their process quality [1]

Güceğlioğlu's [1] methodology is based on evaluating processes using following metrics;

1. Maintainability Metrics
    a. Analyzability Metrics
        i. Complexity
        ii. Coupling
2. Reliability Metrics
    a. Fault Tolerance Metrics
        i. Failure Avoidance
    b. Recoverability Metrics
        i. Restorability
        ii. Restoration Effectiveness

3. Functionality
    a. Suitability Metrics
        i. Functional Adequacy
        ii. Functional Completeness
    b. IT Based Functionality Metrics
        i. IT Usage
        ii. IT Density
    c. Accuracy Metrics
        i. Computational Accuracy
    d. Interoperability Metrics
        i. Data Exchangeability
    e. Security Metrics
        i. Access Auditability
4. Usability
    a. Understandability Metrics
        i. Functional Understandability
    b. Learnability Metrics
        i. Existence in Documents
    c. Operability Metrics
        i. Input Validity Checking
        ii. Undoability
    d. Attractiveness Metrics
        i. Attractive Interaction

These metrics are operationally defined in Appendix F.

CHAPTER 3

CURRENT PROCESS MODEL AND IMPROVEMENT SUGGESTIONS

3.1 INTRODUCTION

In this chapter current peer review process will be presented and measured using Güceğlioğlu's [1] process quality measurement model.

3.1.1 Objective of the Study

This study firstly aimed to reveal and improve the peer review process applied in XCOM and compare it with its definition in the regulatory document. In the first phase of the study, the peer review processes and the projects of two different virtual implementation of this process were investigated. The major target of the investigation was to observe the current peer review process and to improve it. Moreover, within the scope of the study problems were defined in the implementation of this process. In addition, ad-hoc improvement with the approach based on Güceğlioğlu's [1] metrics will be compared.

3.1.2 Case Study Plan

3.1.2.1 Research Method

To reach the objective of the study, the engineering and quality policies of XCOM have been studied using company's processes (Engineering Process, Quality Assurance Process, Configuration Management Process, Verification and Validation Process, and Measurement and Analysis Process) and process assets (Methods,

Forms, Procedures, Instruction Documents, and Templates) documents and interviews with quality department and supervisors were used.

After this, interviews with team leads, project managers, and functional team members were made to define general problems in this process and to gather the improvement suggestions. Using the information obtained in these interviews, the author's observations and document inspections, the peer review process is observed and modeled as AS-IS model. Then, Güceğlioğlu's static process evaluation methodology [1] is applied to AS-IS model. The measurement results are also used for defining the improved process.

The measurement methodology is applied on the TO-BE model, too to see the impact of the applied improvement suggestions. The improvement is discussed using both AS-IS and TO-BE measurement results.

3.1.2.2 Projects

The projects investigated in the first phase of the study were big in size. Total number of personnel involved is 120, including 45 qualified software engineers.

One of the projects involved validation and verification in which XCOM participated as subcontractor. In this project, thousands of test cases were generated and peer reviewed.

In case two, XCOM was responsible for implementing and testing 300.000 lines of code.

Each work product in these two projects were reviewed, verified, approved and released after peer reviews were performed and approved. During these activities problems were identified by interviewing the staff, considering process and process assets, monitoring process, XCOM's objectives and needs and customer needs.

3.2 CURRENT PEER REVIEW PROCESS AT XCOM

In this section, AS-IS Peer Review Process applied in XCOM is presented. Also, On-Paper process is inspected considering AS-IS process.

AS-IS Peer Review (PR) Process includes the following sub-processes:

1. SQE Check,
2. Prepare Peer Review,
3. Individual Check,

4. Internal Review Meeting, and
5. Peer Review Closure.

The details of the activities for each sub-process are given in Appendix A and process models of the sub-process are given in Appendix B. Below, brief outlines of the sub-processes are presented with short descriptions and comparison of AS-IS and On-Paper sub-process in tabular form.

3.2.1 AS-IS SQE Check Sub-Process

3.2.1.1 Input(s)

1. Draft Product(s).
2. Type of Work Products.
3. Checklists.
4. Standards.
5. Organizational Policies and Templates.
6. Proposals and Agreements.
7. E-mail for PR Request.
8. Project Plan.

3.2.1.2 Entry Condition(s)

1. Draft Product(s) is/are mature enough for PR.

3.2.1.3 Description

1. Request Peer Review.
2. Check Draft Product(s) according to basic verification criteria.
3. Send Draft Product(s) to its author to complete the product for review.

3.2.1.4 Roles

1. Project Team.
2. Author.
3. SQE.

3.2.1.5 Output(s)

1. Draft Product(s).
2. Type of Work Products.

3. Checklists.
4. Standards.
5. Organizational Policies and Templates.
6. Proposals and Agreements.
7. E-Mail.

3.2.1.6 Comparison of AS-IS and On-Paper SQE Check Sub-Processes

AS-IS sub-process is presented together with on-paper processes to see differences at a glance. The AS-IS SQE Check Sub-process with differences and problems encountered with respect to On-Paper SQE Check Sub-process is given in Table 2.

Table 2 Comparison of AS-IS and On-Paper SQE Check Sub-Processes

Step	AS-IS	Differences and Problems Encountered
Input(s)	1. Draft Product(s)	Same as on-paper and there is no problem.
	2. Type of Work Products	
	3. Checklists	
	4. Standards	
	5. Organizational Policies and Templates	
	6. Proposals and Agreements	
	7. E-mail for PR Request	
	8. Project Plan	
Entry Condition(s)	1. Draft Product(s) is/are mature enough for PR	Same as on-paper and there is no problem.
Description	1. Request Peer Review	Same as on-paper, but there are missing activities in this sub-process. However, during SQE check, Review Team should also be checked to ensure that skills and experiences of staffs are convenient enough to find all defects in the product(s). Lack of senior staffs (i.e. domain experts) is a key issue at this point. Since there is not enough knowledge, defects can be easily missed even when peer reviews are held. These activities are performed in Prepare Peer Review sub-process, but senior staffs and PR needs are not considered and SQE check for these missing activities is also missing.
	2. Check Draft Product(s) according to basic verification criteria	
	3. Send Draft Product(s) to its author to complete the product for review	
Roles	1. Author.	Same as on-paper and there is no problem.
	2. SQE.	Same as on-paper and there is no problem.
	3. Project Team.	Same as on-paper and there is no problem.

Table 2 (cont'd)

Step	AS-IS	Differences and Problems Encountered
Output(s)	1. Draft Product(s)	Same as on-paper and there is no problem.
	2. Type of Work Products	
	3. Checklists	
	4. Standards	
	5. Organizational Policies and Templates	
	6. Proposals and Agreements	
	7. E-mail	

3.2.2 AS-IS Prepare Peer Review Sub-Process

3.2.2.1 Input(s)

1. Project Plan.
2. Draft Product(s).
3. Standards.
4. Checklists.
5. Related Documents.
6. PR Report.

3.2.2.2 Entry Condition(s)

1. SQE check is complete.
2. PR package is ready.

3.2.2.3 Description

1. Scan Project Plan (to identify review team).
2. Establish Review Team.
3. Identify Peer Review time and location.
4. Identify Peer Review Package and related documents and take them under control.
5. Fill out Peer Review report.
6. Send Peer Review package to review team via e-mail.

3.2.2.4 Roles

1. SQE
2. Project Team
3. Review Team
4. Author

3.2.2.5 Output(s)

1. E-mail for PR.
2. PR folder (It includes PR Report, Draft Products, checklists, standards, and related documents).

3.2.2.6 Comparison of AS-IS and On-Paper Prepare Peer Review Sub-Processes

Table 3 presents the differences and problems encountered with respect to On-Paper Prepare Peer Review Sub-process.

Table 3 Comparison of AS-IS and On-Paper Prepare Peer Review Sub-Processes

Step	AS-IS	Differences and Problems Encountered
Input(s)	1. Project Plan 2. Draft Product(s) 3. Standards 4. Checklists 5. Related Documents	Same as on-paper and there is no problem.
	6. PR Report	Same as on-paper and there is no problem, but this form is updated manually.
Entry Condition(s)	1. SQE check is complete	Same as on-paper and there is no problem.
	2. PR package is ready	
Description	1. Scan Project Plan (to identify review team).	This activity should be performed in SQE Check sub-process and senior staffs and PR needs should be considered. Also, Project Plan does not include reviewer list.
	2. Establish Review Team.	This activity should be performed in SQE Check sub-process and senior staffs and PR needs should be considered.
	3. Identify Peer Review time and location.	This information is controlled manually and there is no information to learn how many PR is performed at the planned date and there is no repository.
	4. Identify Peer Review Package and related documents and take them under control.	Same as on-paper and there is no problem.
	5. Fill out Peer Review report.	This form is filled manually and copy-paste errors are occurred.
Description	6. Send Peer Review package to review team via mail.	SQE preparation time is entered to one MS Office excel sheet, but it is possible to specify that there can be missing or wrong data since this excel is not updated simultaneously.
Roles	1. Author.	Same as on-paper and there is no problem.
	2. SQE.	Same as on-paper and there is no problem.
	3. Project Team.	Same as on-paper and there is no problem.

Table 3 (cont'd)

Step	AS-IS	Differences and Problems Encountered
Roles	4. Review Team.	Review Team should be established in SQE Check sub-process by considering senior staffs and PR needs.
Output(s)	1. E-mail for PR	E-mail is prepared manually and this can cause missing/wrong information about PR. Also, these e-mails are not stored anywhere except personal e-mails.
	2. PR folder (It includes PR Report, Draft Products, checklists, standards, and related documents)	Same as on-paper and there is no problem.

3.2.3 AS-IS Individual Check Sub-Process

3.2.3.1 Input(s)

1. Draft Product(s).
2. Standards.
3. Checklists.
4. Related Documents.
5. PR Report.

3.2.3.2 Entry Condition(s)

1. PR E-mail is taken and accepted.
2. PR package is ready.

3.2.3.3 Description

1. Read PR E-mail and take information about PR.
2. Review the Draft Product(s).

3.2.3.4 Roles

1. Reviewer(s) (as a member of Review Team).

3.2.3.5 Output(s)

1. Reviewers' comments.

3.2.3.6 Comparison of AS-IS and On-Paper Individual Check Sub-Processes

The AS-IS Individual Check Sub-process and On-Paper Individual Check Sub-processes are presented in Table 4 together to see differences at a glance.

Table 4 Comparison of AS-IS and On-Paper Individual Check Sub-Processes

Step	AS-IS	Differences and Problems Encountered
Input(s)	1. Draft Product(s)	Same as on-paper and there is no problem.
	2. Standards	
	3. Checklists	
	4. Related Documents	
	5. PR Report	
	6. E-mail for PR	
Entry Condition(s)	1. SQE check is complete	Same as on-paper and there is no problem.
	2. PR package is ready	
Description	1. Read PR E-mail and take information about PR	Each member individually examines the Draft Product(s) against appropriate review checklists, applicable standards prior to the review meeting according to their peer review roles and responsibilities assigned and take their comments in the Draft Product(s) to discuss in Peer Review Meeting. There is a problem about reviewers' comments since reviewers do not enter their comments anywhere. Also, some of reviewers' comments are forgotten during PR and PR Meeting takes long time. In addition, Review time is entered to one MS Office excel sheet, but it is possible to specify that there can be missing or wrong data since this excel is not updated simultaneously.
	2. Review the Draft Product(s)	
Roles	1. Reviewers	Review Team should be established in SQE Check sub-process by considering senior staffs and PR needs.
Output(s)	1. Reviewers' comments	There is no special method for preparation of reviewers' comments and as a result, these comments are not kept anywhere.

3.2.4 AS-IS Internal Review Meeting Sub-Process

3.2.4.1 Input(s)

1. Draft Product(s).
2. Standards.
3. Checklists.
4. Related Documents.
5. PR Report.
6. Reviewers' Comments (hard copy or soft copy).

3.2.4.2 Entry Condition(s)

1. Individual Check is completed.
2. Peer Review is ready at PR time.

3.2.4.3 Description

1. Check whether Peer Review is ready or not at PR time.
2. Postpone/Cancel Peer Review Meeting.
3. Start Peer Review Meeting.
4. Write total preparation effort to PR Report.
5. Review Reviewers' comments and investigate action items.
6. Write action items to Action Item (AI) Form.
7. Conclude the PR Meeting.
8. Update PR Report.
9. Save and Exit.

3.2.4.4 Roles

1. SQE.
2. Author.
3. Reviewer(s) (as a member of Review Team).

3.2.4.5 Output(s)

1. PR Report.
2. AI form.
3. Exit Decision.

3.2.4.6 Comparison of AS-IS and On-Paper Internal Review Meeting Sub-Processes

AS-IS sub-process is presented in Table 5 together with on-paper processes to see differences and problems at a glance.

Table 5 Comparison of AS-IS and On-Paper Internal Review Meeting Sub-Processes

Step	AS-IS	Differences and Problems Encountered
Input(s)	1. Draft Product(s)	Same as on-paper and there is no problem.
	2. Standards	
	3. Checklists	
	4. Related Documents	
	5. PR Report	
	6. Reviewers' Comments (hard copy or soft copy)	Same as on-paper, but reviewers' comments are prepared as either hard copy or soft copy, but they are not stored.
Entry Condition(s)	1. Individual Check is completed	Same as on-paper and there is no problem.
	2. Peer Review is ready at PR time	
Description	1. Check whether Peer Review is ready or not at PR time	Same as on-paper and there is no problem.
	2. Postpone/Cancel Peer Review Meeting	Same as on-paper and there is no problem.
	3. Start Peer Review Meeting	Same as on-paper and there is no problem.
	4. Write total preparation effort to PR Report	Total preparation effort is entered, but it is possible to specify that there can be missing or wrong data since effort is not recorded simultaneously. Also, all metrics are entered to different documents and it is really difficult to manage and maintain these data.
	5. Review Reviewers' comments and investigate action items	It is very hard to define AIs since all documents are examined carefully during PR Meeting. Discussions take long time.
	6. Write action items to AI Form	All AIs are discussed during PR Meeting and discussions takes long time.

Table 5 (cont'd)

Step	AS-IS	Differences and Problems Encountered
Description	7. Conclude the PR Meeting	Same as on-paper and there is no problem.
	8. Update PR Report	PR Report is updated manually and updates can be forgotten.
	9. Save and Exit	Same as on-paper and there is no problem.
Roles	1. Author.	Same as on-paper and there is no problem.
	2. SQE.	Same as on-paper and there is no problem.
	4. Review Team.	Same as on-paper and there is no problem.
Output(s)	1. PR Report	Same as on-paper and there is no problem. (This form is prepared manually.)
	2. AI form	Same as on-paper and there is no problem. (This form is prepared manually.)
	3. Exit Decision	Same as on-paper and there is no problem.

3.2.5 AS-IS Peer Review Closure Sub-Process

3.2.5.1 Input(s)

1. Draft Product(s).
2. Updated Product(s).
3. AI Form.
4. PR Report.

3.2.5.2 Entry Condition(s)

1. Author updates the Draft Product(s) according to AI taken during PR and Updated Product(s) is/are ready for AI check.

3.2.5.3 Description

1. Take Updated Product(s) according to action items from author.
2. Check Updated Product(s) by comparing Draft Product(s) and Updated Product(s).
3. Update AI Form and PR Report.
4. Close PR and Send Updated Product to release.
5. Investigate issues or new AIs to identify action.
6. Send Updated Product(s) to author to update.

3.2.5.4 Roles

1. SQE.
2. Author.

3.2.5.5 Output(s)

1. Updated Product(s).
2. Signed AI Form and PR Report.

3.2.5.6 Comparison of AS-IS and On-Paper Peer Review Closure Sub-Processes

AS-IS and On-Paper sub-processes are given together in Table 6 to see differences and problems.

Table 6 Comparison of AS-IS and On-Paper Peer Review Closure Sub-Processes

Step	AS-IS	Differences and Problems Encountered
Input(s)	1. Draft Product(s)	Same as on-paper and there is no problem.
	2. Updated Product(s)	
	3. AI Form	
	4. PR Report	
Entry Condition(s)	Author updates the Draft Product(s) according to AI taken during PR and Updated Product(s) is/are ready for AI check	Same as on-paper and there is no problem.
Description	1. Take Updated Product(s) according to action items from author	Same as on-paper and there is no problem.
	2. Check Updated Product(s) by comparing Draft Product(s) and Updated Product(s)	Same as on-paper and there is no problem.
	3. Update AI Form and AI Report	Same as on-paper and there is no problem, but these forms are updated manually.
	4. Close PR and Send Updated Product to release	PR is closed from hard copy records and Author update time and SQE closure time are missing or there can be wrong data since this data is not updated simultaneously.
	5. Investigate issues or new AIs to identify action	Same as on-paper and there is no problem.
	6. Send Updated Product(s) to author to update	Same as on-paper and there is no problem.
Roles	1. Author.	Same as on-paper and there is no problem.
	2. SQE.	Same as on-paper and there is no problem.
Output(s)	1. Updated Product(s)	Same as on-paper and there is no problem.
	2. Signed AI Form and PR Report	Same as on-paper and there is no problem. (This form is prepared manually.)

3.3 IMPROVEMENT SUGGESTIONS BASED ON THE ASSESSMENT OF THE AS-IS PROCESS

In this section, improvement suggestions based on the assessment of the AS-IS Process will be presented. The reasons for improvement suggestions are also discussed. We can summarize these reasons as follows:

1. **Reasons based on the internal review meeting time:**

   In the internal review meeting of the peer review, all reviewers go through their comments and serve them to peer review participants. At this point, there is a problem between the reviewers' comments and the transformation of these comments to action items. It is observed that reviewers' comments are not checked by the author before the internal review meeting. So, peer review participants discuss each comment of the reviewers and take appropriate action items in internal review meeting. For these reasons, discussions take a long time.

2. **Reasons based on the size of the product(s) to be reviewed:**

   When the size of the product(s) to be reviewed is increased, it is observed that efficiency of the individual check and peer review is decreased. For this reason, defect removal may not be performed and product(s) are released with defects.

   In addition the internal review meeting time is also related with the size of the peer review package. When the size of the product is increased, the internal review meeting takes a long time.

3. **Reasons based on maturity of the products:**

   The peer review is requested by development team. Before PR request team lead must be sure that product(s) to be reviewed is/are mature enough for peer review.

   Immature product(s) cause inefficient peer reviews which means missing efforts, money and poor quality work products.

4. **Reasons based on lack of senior staff as a reviewer:**

   During peer reviews, it was suggested that each PR was performed for one author's products to increase the defect removal. For this way, every reviewer

took attention to one method and possible continuing defects made by author. After peer reviews were closed, the products were released. Then, it was observed that Software Change Requests were opened to remove remaining defects in the products. At this point, it was investigated and the results were observed: Some major defects were not found during peer reviews depending on the lack of domain knowledge, project scope, and experience of the reviewers which resulted with reworks.

5. **Reasons based on lack of peer review process training:**
   In so many project it was observed that staff learns their work performing them without any training. It caused not to develop the skills and knowledge of the staff. The trainings are the one of the important part of the process to implement them. During implementation of the process, everyone must know what they do. Trainings also provide the staff better learning and better implementation.
6. **Reasons based on collected metrics:**
   In the process model of the AS-IS process (refer to Appendix B) it is observed that the metric for the peer review process is trying to be collected, but all of them are tracked in hard copy and there is no standard way to collect this metric. So, evaluation of these data cannot be performed efficiently.
7. **Based on the records prepared manually and kept as hard copy records:**
   As a result of peer reviews, PR Report and AI Form are constituted. These forms are prepared manually and they do not have any version information. So, these records should be updated automatically.

Process improvement studies have been started to solve these problems. As a first step process document and the current implementation of the process have investigated. At this point interviews and negotiations have been performed with staffs who apply this process on their projects. Then, the results were shared with senior staffs and the improvement suggestions have been gathered.

The fundamental suggestions for a better peer review process, compiled by interviewing the senior staff including the author are as given below:

Suggestion for Internal Review Meeting time:

The company specific PR Tool should be generated and used for peer reviews. Using this PR Tool, reviewers enter their comments during individual check before the internal review meeting. Then, the author of the product checks the reviewers' comments and give his/her responses to each comment including decision options which are "Agree", "Disagree", "Duplicate", and "Investigate and Discuss in Peer Review". Also, reviewers check the responses of the author before internal review meeting. This phase shall be the pre-requisite for Internal Review Meeting sub-process. Consequently discussions shall only be performed between reviewer who owns the comment and the author before PR meeting.

1. **Suggestion for the size of the product(s) to be reviewed:**

   The peer review is requested by project team. At this point, team leader should consider the size of the product to be reviewed negotiating the author of the product. Therefore, individual check is performed efficiently by reviewers.

2. **Suggestion for the size of the product(s) to be reviewed:**

   The peer review is requested by project team. At this point, team leader should consider the size of the product to be reviewed negotiating the author of the product. Therefore, individual check is performed efficiently by reviewers.

3. **Suggestion for the maturity of the products:**

   The informal reviews should be performed to evaluate the products, in order to decrease the number of defects that have to be found in peer reviews and make the products mature. The major objectives are to:

   - Find defects in earlier phase,
   - Improve the products,
   - Consider alternative implementations, and
   - Evaluate conformance to standards and specifications.

   Even informal reviews are not obligatory, they may be held at any stage of development of tests to take early precautions. It is suggested to be held for

complex products, new team participants and sharing ideas, knowledge and experience.

4. **Suggestion for senior staff as a reviewer:**

   After PR is requested, reviewers are identified. At this point according to characteristics of the products to be reviewed, senior staff should be chosen as a reviewer considering their knowledge about project domain, project scope, engineering, etc.

5. **Suggestion for the peer review process training:**

   Peer Review Process should be introduced to project staffs before they perform the process to achieve the objective of the peer review.

6. **Suggestion for collected metrics:**

   The company specific PR Tool should be generated and this tool should provide an infrastructure to collect PR related metrics. Therefore, peer review process can be evaluated according to collected metrics and the weakness and powerful points of the process can be recognized.

7. **Suggestion for the peer review records:**

   PR records should be prepared and kept automatically. At this point, PR Tool should be used at each sub-process of the peer review process. AI Form and PR Report shall be prepared, updated, and kept using PR Tool and its database. Also, reviewers' comments and author's responses prepared, entered and updated using PR Tool shall be kept by PR Tool and its database.

3.4 MEASUREMENTS FOR AS-IS PROCESS AND METRIC BASED IMPROVEMENT SUGGESTIONS

In this section, the SG metrics values will be presented for AS-IS Process. Measurement details of the activities of the AS-IS Peer Review Process are given in APPENDIX E.

Metric-Based suggestions for the improvement of Peer Review Process will also be presented in this section.

3.4.1 Measurements and Improvement Suggestions for AS-IS SQE Check Sub-Process

In this section, suggestions for the improvement of SQE Check sub-process, based on SG metrics, will be presented considering measurement results which are given in Table 7.

Table 7 Measurements for the AS-IS SQE Check Sub-Process

Metrics	**AS-IS SQE Check Sub-Process (Number of activity = 3)**
Complexity	X(1) = 1 / 3 = 0.33 X(2) = 0 / 3 = 0 X(3) = 1 / 3 = 0.33
Coupling	X = 1 / 3 = 0.33
Failure Avoidance	X = 1 / 3 = 0.33
Restorability	X = 0 / 3 = 0
Restoration Effectiveness	X = 0 / 3 = 0
Functional Adequacy	X = 3 / 3 = 1
Functional Completeness	X = 1 – 0/3 = 1
IT Usage	X = 3 / 3 = 1
IT Density	X = 9 / 9 = 1
Computational Accuracy	X = 3 / 3 = 1
Data Exchangeability	X = 1 / 1 = 1
Access Auditability	X = 3 / 3 = 1
Functional Understandability	X = 3 / 3 = 1
Completeness Documentation	X = 3 / 3 = 1
Input Validity Checking	X = 2 / 3 = 0.67
Undoability	X = 0 / 3 = 0
Attractive Interaction	X = 3 / 3 = 1

Metrics-Based Improvement Suggestions:

Complexity metric (X(1) = 0,33, X(2) = 0, X(3) = 0,33)

Since the complexity metric values of X(1), X(2), and X(3) are low, no further improvements are necessary.

Coupling metric (X = 0,33)

The coupling metric value is low and acceptable, so there is no need to further improve this metric value.

Failure Avoidance metric (X = 0,33)

Failure avoidance metric value is low, but the result is normal since SQE Check sub-process includes the checkpoints for readiness of the peer review package. The other activities of this sub-process are starting and end points of sub-process and adding any checkpoints for these activities are not practical.

Restorability and Restoration Effectiveness metrics (X = 0, X = 0)

Restorability and Restoration Effectiveness metric values are 0. However the result is normal due to nature of the activities. SQE Check sub-process checks the readiness of the peer review and the result of this sub-process are recorded in Prepare Peer Review sub-process. So, further improvements are not practical.

Input Validity Checking metric (X = 0,67)

Input Validity Checking metric value is high and it is acceptable. So, no further improvements are necessary.

Undoability metric (X = 0)

Since the number of the recorded activities is 0, the value measured for undoability metric value equals to 0. The reason is that it is very hard to keep these information and we do not think that they are useful for peer review process, because as we mention in Restorability and Restoration Effectiveness metrics, SQE Check sub-process checks the readiness of the peer review package to decide whether peer review shall be performed or not. So, no further improvements are necessary.

3.4.2 Measurements and Improvement Suggestions for AS-IS Prepare Peer Review Sub-Process

In this section, the suggestions for the improvement of Prepare Peer Review sub-process will be presented considering SG metrics measurement results. Table 8 presents the measurements for AS-IS sub-process.

Table 8 Measurements for the AS-IS Prepare Peer Review Sub-Process

Metrics	**AS-IS Prepare Peer Review Sub-Process (Number of activity = 6)**
Complexity	X(1) = 3 / 6 = 0.5 X(2) = 0 / 6 = 0 X(3) = 2 / 6 = 0.33
Coupling	X = 5 / 6 = 0.83
Failure Avoidance	X = 3 / 6 = 0.50
Restorability	X = 4 / 6 = 0.67
Restoration Effectiveness	X = 4 / 6 = 0.67
Functional Adequacy	X = 4 / 6 = 0.67
Functional Completeness	X = 1 – 1 / 6 = 0.83
IT Usage	X = 3 / 6 = 0.5
IT Density	X = 7 / 7 = 1
Computational Accuracy	X = 2 / 2 = 1
Data Exchangeability	X = 5 / 5 = 1
Access Auditability	X = 6 / 6 = 1
Functional Understandability	X = 4 / 6 = 0.67
Completeness Documentation	X = 6 / 6 = 1
Input Validity Checking	X = 4 / 6 = 0.67
Undoability	X = 3 / 6 = 0.50
Attractive Interaction	X = 1 / 6 = 0.17

Metric-Based Improvement Suggestions:

Complexity metric (X(1) = 0,50, X(2) = 0, X(3) = 0,33)

The complexity metric values are low, so there is no need to further improve these metric values.

Coupling metric (X = 0,83)

The value obtained for this metric is high. However this result is normal due to the nature of activities of this sub-process which initiate all documents like draft product(s), checklists, standards, related documents, and report and send them to other sub-processes. We can not remove or change the documents and their orders. So, further improvements are not practical.

Failure Avoidance metric (X = 0,50)

Failure avoidance metric value is low, but it is acceptable. Because of the fact that the activities which are identified with "No review, inspection, checkpoint or similar techniques" include the checkpoints from previous activities, they do not need any further improvements.

Restorability and Restoration Effectiveness metrics (X = 0,67, X=0,67)

Restorability and Restoration Effectiveness metric values are high, so no further improvements are necessary.

Functional Adequacy metric (X = 0,67)

Although Functional Adequacy metric value is not low, but the value shows us that there are some activities which are not adequate with their definitions in regulatory documents. These activities should be investigated and it should be decided whether implementation should be updated considering other metrics or regulatory documents should be updated considering implementation of activities.

Functional Completeness metric (X = 0,83)

The value of Functional Completeness metric is not low, but according to this metric definition it is observed that there is an activity forgotten in practice. We should analyze both regulatory documents and implementation of the sub-process as we mention in Functional Adequacy metric.

IT Usage metric (X = 0,50)

IT Usage metric value is low, because some of activities are performed discussing the issues and are not recorded i.e. Identify Peer Review Time and Location. So, further improvements are not practical.

Functional Understandability metric (X = 0,67)

Functional Adequacy metric value is not low, but when the sub-process is inspected it is observed that staff encounters difficulties in understanding the tasks to be performed for some activities and cannot decide the situation which is not clear and requires human intuition at some of activities. The regulatory documents should be updated considering them.

Input Validity Checking metric (X = 0,67)

When we inspect the sub-process it is observed that possible input validity checking is performed. Also, Input Validity Checking metric value is high, so no further improvements are practical.

Undoability metric (X = 0,50)

The value measured for Undoability metric is low, but acceptable. It is observed that further improvements are not practical since the results of some activities are not recorded and inputs of the other activities.

Attractive Interaction (X = 0,17)

Attractive Interaction metric value is low for AS-IS sub-process. The main reason is that all documents are prepared manually which causes errors like copy-paste errors, missing reports, etc. It is very hard to manage updates, deletions, generations or other actions of these documents.

3.4.3 Measurements and Improvement Suggestions for AS-IS Individual Check Sub-Process

The suggestions for the improvement of Individual Check sub-process will be presented in this section. Measurement results are given in Table 9.

Table 9 Measurements for the AS-IS Individual Check Sub-Process

Metrics	**AS-IS Individual Check Sub-Process (Number of activity = 2)**
Complexity	X(1) = 1 / 2 = 0.50 X(2) = 0 / 2 = 0 X(3) = 1 / 2 = 0.50
Coupling	X = 2 / 2 = 1
Failure Avoidance	X = 2 / 2 = 1
Restorability	X = 1 / 2 = 0.50
Restoration Effectiveness	X = 0 / 2 = 0
Functional Adequacy	X = 2 / 2 = 1
Functional Completeness	X = 1 – 0 / 2 = 1
IT Usage	X = 1 / 2 = 0.5
IT Density	X = 6 / 7 = 0.86
Computational Accuracy	X = 2 / 2 = 1
Data Exchangeability	X = 2 / 2 = 1
Access Auditability	X = 1 / 2 = 0.5
Functional Understandability	X = 1 / 2 = 0.5
Completeness Documentation	X = 2 / 2 = 1
Input Validity Checking	X = 2 / 2 = 1
Undoability	X = 0 / 2 = 0
Attractive Interaction	X = 1 / 2 = 0.5

Metric-Based Improvement Suggestions:

Complexity metric (X(1) = 0,50, X(2) = 0, X(3) = 0,50)

The complexity metric values (X1, X2, X3) are low which is desirable. There is no need to further improve these metric values.

Coupling metric (X = 1)

The value obtained for this metric is. However the result is normal due to nature of the activities. Inputs coming from Prepare Peer Review sub-process are the starting point of this sub-process and outputs of this sub-process are inputs of Internal Review Meeting sub-process. We cannot eliminate these documents, so further improvements are not practical.

Restorability and Restoration Effectiveness metrics (X = 0,50, X = 0)

When the sub-process model is analyzed, the first thing that we notice is that there are no formal comment lists prepared by reviewers. It is a weakness of the sub-process, because the reviewers' comments which are evidence of Individual Check sub-process can be needed after PR closure. For this reason Restorability metric value is low and Restoration Effectiveness metric value equals to 0.

It should be considered that sub-process should be updated including reviewers' comments storage. Also, regulatory documents should be updated accordingly.

IT Usage and IT Density metrics (X = 0,50, X = 0,86)

When the sub-process model is analyzed, we observe that reviewers' comments which may not be prepared in computer environment and are not stored anywhere. So, the value of IT usage metric is low. On the other hand, IT Density metric value is not low, because it counts the number of documents developed, updated or deleted by using IT applications. We can improve this sub-process preparing reviewers' comments in computer environment and storing them as mentioned in Restorability and Restoration Effectiveness metrics.

Access Auditability metric (X = 0,50)

Since the reviewers' comments are not kept anywhere, we cannot control the accesses to the data for reading, deleting or updating. So, the value of Access Auditability metric is low. We should keep reviewers' comments as hard copies or soft copies.

Functional Understandability and Attractive Interaction metrics (X = 0,50, X = 0,50)

Functional Understandability and Attractive Interaction metric values are low. When we inspect the sub-process, it is easily noticed that reviewers do not have enough information about how to prepare and keep their comments between Individual Check sub-process and Internal Review Meeting sub-process. Every reviewer performs different implementation which causes wrong data development. Also, it affects both Functional Understandability and Attractive Interaction metric values. So, the sub-process and regulatory documents should be updated including how to handling reviewers' comments.

Undoability metric (X = 0)

The value measured for undoability metric equals to 0. The reason is same as in Restorability and Restoration Effectiveness metrics.

We observed that when we achieve the improvement suggestion as mentioned in Restorability and Restoration Effectiveness metrics, Undoability metric value is improved.

3.4.4 Measurements and Improvement Suggestions for AS-IS Internal Review Meeting Sub-Process

In this section, the measurement results for AS-IS Internal Review Meeting sub-process are given in Table 10. The improvement suggestions based on SG metrics will be presented in this section.

Table 10 Measurements for the AS-IS Internal Review Meeting Sub-Process

Metrics	**AS-IS Internal Review Meeting Sub-Process (Number of activity = 9)**
Complexity	X(1) = 5 / 9 = 0.56 X(2) = 0 / 9 = 0 X(3) = 4 / 9 = 0.44
Coupling	X = 4 / 9 = 0.44
Failure Avoidance	X = 5 / 9 = 0.56
Restorability	X = 7 / 9 = 0.78
Restoration Effectiveness	X = 7 / 9 = 0.78
Functional Adequacy	X = 7 / 9 = 0.78
Functional Completeness	X = 1 – 1 / 9 = 0.89
IT Usage	X = 4 / 9 = 0.44
IT Density	X = 6 / 7 = 0.86
Computational Accuracy	X = 5 / 5 = 1
Data Exchangeability	X = 1 / 3 = 0.33
Access Auditability	X = 5 / 9 = 0.56
Functional Understandability	X = 7 / 9 = 0.78
Completeness Documentation	X = 8 / 9 = 0.89
Input Validity Checking	X = 3 / 9 = 0.33
Undoability	X = 7 / 9 = 0.78
Attractive Interaction	X = 6 / 9 = 0.67

Metric-Based Improvement Suggestions:

Complexity (X(1) = 0,56, X(2) = 0, X(3) = 0,44)

Complexity metric value is low, so there is no need for further improvements.

Coupling (X = 0,44)

The value of Coupling metric is low and acceptable. When we try to decrease the dependencies, it is noticed that we cannot change or remove the reports, forms, and other documents used in this sub-process. So, further improvements are not practical.

Functional Adequacy and Functional Completeness (X = 0,78, X = 0,89)

The values obtained for these metrics are not low, but according to definitions of these metrics, there are some discrepancies between the regulatory documents and the implementations of the sub-process. So, they should be updated considering these discrepancies.

Restorability and Restoration Effectiveness metrics (X = 0,78, X = 0,78)

In AS-IS sub-process, all reports, forms, and related documents are prepared in computer environment and kept in PR Folder. So, the values of these metrics are high, but not equal to 1. The main reason is that there are some activities which do not include recorded results. So, further improvements are not practical.

Failure Avoidance (X = 0,56)

Failure Avoidance metric value is not high due to the fact that some of activities are documented as "No review, inspection, checkpoint or similar techniques" for AS-IS sub-process. However when the sub-process model is inspected, we noticed that possible reviews are performed. So, further improvements are not practical.

IT Usage and IT Density metrics (X = 0,44, X = 0,86)

IT Usage metric value is low due to the fact that most of activities include decision mechanism and are not related with the IT applications. Also, the result of these activities are not recorded anywhere. On the other hand, the value of IT Density metric is high since most of reports, forms or other documents are prepared, updated or deleted in computer environment except reviewers' comments. The suggestion is same as mentioned in previous sub-processes for reviewers' comments.

Data Exchangeability metric (X = 0,33)

The value of the Data Exchangeability metric value is low. During this sub-process, reports and forms are updated according to attitude of the PR. So, the further improvements are not practical.

Access Auditability metric (X = 0,56)

The value obtained for Access Auditability metric is low, because the most of the activities are performed without any record so, the result is normal. We should prevent the missing records of the activities. It can be provided updating regulatory documents according to implementation of the sub-process or changing the implementation of the sub-process.

Functional Understandability metric (X = 0,78)

The value of Functional Understandability metric is not low, but when we inspect the activities of this sub-process it is noticed that there is difficulties during discussion of the reviewers' comment and taking action items. It causes that PR Meeting takes too much time and some of defects can be missed during PR Meeting. These activities should be explained more clear in regulatory documents.

Completeness Documentation metric (X = 0,89)

The value obtained for this metric is not low, but according to description of this metric it shows us that there is some activities are not described in the regulatory documents results with forgotten activity. So, regulatory documents should be updated considering missing activities in regulatory documents according to implementation of the sub-process.

Input Validity Checking (X = 0,33)

Although necessary inputs are checked, Input Validity Checking metric value is low. So the further improvements are not seemed practical since there is no any mistake due to the input parameter invalidity.

Undoability metric (X = 0,78)

The metric value is high, but when we analyze the activities of this sub-process it is observed that some activities are not recorded. There is an improvement suggestion for PR Meeting from previous metric including reviewers' comments and recording action items. In this way the value of this metric is increased.

Attractive Interaction metric (X = 0,67)

Attractive Interaction metric is not low, but it is noticed that there are some activities which have some difficulties. The implementation of the sub-process and the regulatory documents should be analyzed and these difficulties should be resolved.

These activities are about PR Meeting and inputs are coming from Individual Check sub-process. If we perform the improvement suggestions in Individual Check sub-process, the metric value is increased.

3.4.5 Measurements and Improvement Suggestions for AS-IS Peer Review Closure Sub-Process

In this section, improvement suggestions based on SG metrics will be presented considering measurement results which are given in Table 11.

Table 11 Measurements for the AS-IS Peer Review Closure Sub-Process

Metrics	**AS-IS Peer Review Closure Sub-Process (Number of activity = 6)**
Complexity	X(1) = 4 / 6 = 0.67 X(2) = 0 / 6 = 0 X(3) = 2 / 6 = 0.33
Coupling	X = 2 / 6 = 0.33
Failure Avoidance	X = 4 / 6 = 0.67
Restorability	X = 4 / 6 = 0.66
Restoration Effectiveness	X = 4 / 6 = 0.66
Functional Adequacy	X = 3 / 6 = 0.50
Functional Completeness	X = 1 – 2 / 6 = 0.67
IT Usage	X = 3 / 6 = 0.50
IT Density	X = 4 / 4 = 1
Computational Accuracy	X = 4 / 4 = 1
Data Exchangeability	X = 2 / 2 = 1
Access Auditability	X = 4 / 6 = 0.66
Functional Understandability	X = 4 / 6 = 0.66
Completeness Documentation	X = 5 / 6 = 0.83
Input Validity Checking	X = 3 / 6 = 0.50
Undoability	X = 4 / 6 = 0.66
Attractive Interaction	X = 3 / 6 = 0.50

Metric-Based Improvement Suggestions:

Complexity metric (X(1) = 0,67, X(2) = 0, X(3) = 0,33)

When we inspect this sub-process, we observe that X(1) value is high but it only means that most of the activities have structured decisions which have well defined and standard solutions. So, there is no need for further improvements.

Coupling metric (X = 0,33)

Coupling metric value is low for AS-IS, further improvements are not practical since interactions cannot be changed or removed.

Failure Avoidance metric (X = 0,67)

Failure Avoidance metric value is high. When we analyze the activities of the sub-process it is noticed that all necessary checks are performed. So, further improvements are not practical.

Restorability, Restoration Effectiveness, and Undoability metrics (X = 0,66, X = 0,66, X = 0,66)

Restorability, Restoration Effectiveness, and Undoability metric values are not low, but as mentioned in previous metrics, the resolution of the action items and additional action items are not recorded. The improvements suggestions are also applicable for these metrics. It is also related with Undoability metric.

Functional Completeness, Functional Understandability, and Attractive Interaction metrics (X = 0,67, X = 0,66, X = 0,50)

These metric values are not low, but the action items are tracked using hard copies of the AI Form and the resolution description of the AIs are missing. Also additional action items found when the author updates the Draft document(s) according to AIs are not recorded. Also, there is no relative information in regulatory documents about how to perform these activities. We should provide recording the additional AIs and the resolution description of the AIs. Also, the regulatory documents should be updated considering this missing information.

IT Usage metric (X = 0,50)

Draft Product(s) and Updated Product(s) are compared using some tools, but activities for action items and additional ones are not tracked with IT applications. So, the value of this metric is low. We can improve this metric performing improvement suggestion given in previous metric.

Functional Adequacy metric (X = 0,50)

The value obtained for this metric is not low. However, according to definition of this metric, there are some activities which are not adequate with their definitions in regulatory documents. So, both regulatory documents and the implementation of the sub-process should be considered and regulatory documents should be updated.

IT Usage metric (X = 0,50)

The value of IT Usage metric is low. In this metric, we are again faced with the same problem in Functional Completeness, Functional Understandability, and Attractive Interaction metrics. The resolution descriptions of action items and additional action items should be prepared in computer environment and kept.

Access Auditability metric (X = 0,66)

Access Auditability metric value is not low but we observe that some activities are not managed correctly as mentioned in previous metric. The improvement suggestions are same as previous metrics.

Completeness Documentation metric (X = 0,83)

The value calculated for Completeness Documentation metric is not low, but when we analyze the sub-process it is observed that there is a missing activity in AS-IS sub-process about measurement of peer review process. This activity is also missing in the regulatory documents. So, we should update the regulatory documents including how to perform this missing activity.

Input Validity Checking metric(X = 0,50)

This metric value is low since some of activities do not have any checkpoints for inputs validity. But when we inspect the sub-process, it is noticed that in these activities inputs which includes all data for this sub-process are obtained from Internal Review Meeting sub-process. Also, all reports and forms are used to update Draft Product(s) by author before this sub-process. So, further improvements are not practical.

3.5 DISCUSSION

In XCOM, there are defined processes, but there are some mismatches between the processes and their implementations. Also, there are some activities which need to be improved because there should be different implementation for these activities.

When we compare the improvements suggestions based on the assessment of the AS-IS process and the metric-based improvements suggestions calculated according to Güceğlioğlu's study [1] , we notice that there are matching areas such as Functional Adequacy metric, Functional Completeness metric, Functional Understandability metric, Restorability metric, and Restoration Effectiveness metric.

There are also some improvements suggestions which are introduced in the assessment of the AS-IS process, but are not discovered by metrics such as senior staff participant as a reviewer, the size limitation of the product, PR data collection, internal review meeting time and PR training.

During the assessment of the process, both implementation of the process and the related regulatory documents have been investigated. There are some improvements studies such as Complexity and Coupling which are not noticed in the assessment of the AS-IS process.

There is an important reason describing why suggestions based on metrics and some of the suggestions from the staff are different directions. That is, these SG metrics are not calculated considering the effect of the activity.

As an example consider complexity metric. The measurements results for X1, X2, and X3 should be lower for better analyzability. According to Güceğlioğlu's study [1] , when the number of the decision points are increased, analyzability of the process is decreased. At this point, decision type should be considered. It means that we can not evaluate X(1)=1 and X(3)=1 as a same results. One of them is structured decision which is routine and repetitive and the other one is un-structured decision which requires human intuition. Consider "AS-IS and TO-BE Prepare Peer Review Sub-Processes". For AS-IS Sub-Process, X(1) = 0.50, X(2) = 0, and X(3) = 0.33. For TO-BE Sub-Process, X(1) = 0.83, X(2) = 0, and X(3) = 0.12. The value of X(3) is higher but when we inspect both AS-IS and TO-BE sub-processes, the complex activities are in AS-IS sub-process. So, during evaluation of this metric value, decision types should also be considered.

Güceğlioğlu's [1] static process evaluation methodology which provides the users with the ability to measure the quality of the activities and thereby predict the quality of the process can be used as a starting point for SPI activities. Therefore, the predictability of the rate of the SPI studies can be increased.

CHAPTER 4

IMPROVED PROCESS MODEL

4.1 IMPROVED PEER REVIEW PROCESS AT XCOM

In this section some of improvement suggestions are implemented and the resulting improved process is presented. The rationale for every suggested modification is presented briefly.

TO-BE Peer Review Process includes the following sub-processes:

1. SQE Check,
2. Prepare Peer Review,
3. Individual Check,
4. Internal Review Meeting, and
5. Peer Review Closure.

The details of the activities for each sub-process are given in Appendix C and process models of the sub-process are given in Appendix D. Below, outlines of the improved sub-processes are presented in tabular form, together with a discussion of the improvement rationales.

4.1.1 TO-BE SQE Check Sub-Process

Table 12 TO-BE SQE Check Sub-Process

Step	Original	Suggested	Change Rationale
Input(s)	1. Draft Product(s)	No change	N/A
	2. Type of Work Products		
	3. Checklists		
	4. Standards		
	5. Organizational Policies and Templates		
	6. Proposals and Agreements		
	7. E-mail for PR Request		
	8. Project Plan		
Description	1. Request Peer Review	No change	N/A
	2. Check Draft Product(s) according to basic verification criteria		
	3. Send Draft Product(s) to its author to complete the product for review	No change	N/A

Table 12 (cont'd)

Step	Original	Suggested	Change Rationale
Description	*Does not exist*	*4. Check Project Team members and senior staffs to establish the Review Team.*	*To ensure that project team and senior staffs are checked according to their skills and experiences by considering PR needs. The rationale behind a decision is to find defects earlier and remove all possible defects from product(s) before release of the product(s). Also, SQE checks Review Team and ensures that Review Team is convenient enough to find all defects in the product(s).*
		5. Establish Review Team.	*It is necessary to establish Review Team at this point since project team and senior staffs are investigated. This will also help while determining PR time and location.*
Roles	1. Author.	No change	N/A
	2. SQE.	No change	N/A
	3. Project Team.	No change	N/A

Table 12 (cont'd)

Step	Original	Suggested	Change Rationale
Roles	*Does not exist*	*4. Senior Staffs.* *5. Review Team.*	*The main purpose is to find defects earlier by considering skills and experiences of senior staffs. This can help to avoid product(s) release with possible defects. In this way, Review Team is established.*
Output(s)	1. Draft Product(s) 2. Type of Work Products 3. Checklists 4. Standards 5. Organizational Policies and Templates 6. Proposals and Agreements 7.Email	No change	N/A

4.1.2 TO-BE Prepare Peer Review Sub-Process

Table 13 TO-BE Prepare Peer Review Sub-Process

Step	Original	Suggested	Change Rationale
Input(s)	1. Project Plan	No change	N/A
	2. Draft Product(s)		
	3. Standards		
	4. Checklists		
	5. Related Documents		
	6. PR Report	*Prepared by PR Tool.*	*This form will be generated automatically by using PR Tool.*
	Does not exist	*7. PR Tool.*	*PR Tool will be used to automate Peer Review Process.*
Description	*Moved*	*1. Scan Project Plan (to identify review team). (Moved to SQE Check Sub-Process).*	*Explained in SQE Check Sub-Process.*
	Moved	*2. Establish Review Team. (Moved to SQE Check Sub-Process).*	*Explained in SQE Check Sub-Process.*
	1. Identify Peer Review time and location.	No change	N/A
	2. Identify Peer Review Package and related documents and take them under control.	No change	N/A

Table 13 (cont'd)

Step	Original	Suggested	Change Rationale
Description	Does not exist	*3. Open PR Tool according to PR ID, time, date, Review Team, etc.*	*PR will be prepared by using PR Tool and process will be automated.*
	4. Fill out Peer Review report.	*Prepared by PR Tool.*	*This form will be generated automatically by using PR Tool.*
	Does not exist	*5. Enter SQE Time to PR Tool.*	*PR Metrics will be collected automatically and phase by phase.*
	6. Send Peer Review package to review team via e-mail	*Prepared by PR Tool.*	*E-mail is generated by PR Tool.*
Roles	*Removed*	1. Author.	*Two activities are moved to SQE Check Sub-Process.*
	2. SQE.	No change	N/A
	Removed	*3. Project Team.*	*Two activities are moved to SQE Check Sub-Process.*
	Removed	*4. Review Team.*	*Two activities are moved to SQE Check Sub-Process.*
Output(s)	1. E-mail for PR	No change	N/A
	2. PR folder (It includes PR Report, Draft Products, checklists, standards, and related documents)	No change	N/A

Table 13 (cont'd)

Step	Original	Suggested	Change Rationale
Output(s)	*Does not exist*	*3. PR Tool.*	*PR Tool will be used to automate Peer Review Process*
		4. SQE Time.	*SQE Time will be kept in PR Tool database. The main purpose is to collect PR Metrics automatically.*

4.1.3 TO-BE Individual Check Sub-Process

Table 14 TO-BE Individual Check Sub-Process

Step	Original	Suggested	Change Rationale
Input(s)	1. Draft Product(s)	No change	N/A
	2. Standards		
	3. Checklists		
	4. Related Documents		
	5. E-mail for PR		
	6. PR Report	*Prepared by PR Tool.*	*This form will be generated automatically by using PR Tool.*
	Does not exist	*7. PR Tool.*	*PR Tool will be used to automate Peer Review Process.*
Description	1. Read PR E-mail and take information about PR	No change	N/A
	2. Review the Draft Product(s)	No change	N/A
	Does not exist	*3. Enter comments to PR Tool.*	*The main purpose is to keep all reviewers' comments and to avoid data lost.*
		4. Respond the reviewers' comments.	*The main purpose is to decrease the PR meeting time. Author will respond the all reviewers' comments before PR (discussions can be performed before PR Meeting).*

Table 14 (cont'd)

Step	Original	Suggested	Change Rationale
Description	Does not exist	*5. Check author's responses to reviewers' comments.*	*The main purpose is to decrease the PR meeting time. Reviewers can agree with author response or not before PR Meeting.*
		6. Enter Reviewers' Review Time via PR Tool.	*PR Metrics will be collected automatically and phase by phase.*
		7. Enter Author's Response Time via PR Tool.	*PR Metrics will be collected automatically and phase by phase.*
Roles	1. Reviewers.	No change	N/A
	Does not exist	*2. Author.*	*Author responses are needed for reviewers' comments before PR Meeting.*
Output(s)	1. Reviewers' comments	*PR Tool is used.*	*All reviewers' comments will be kept in PR Tool database.*
	Does not exist	*2. Author Response Time.*	*Author Response Time will be kept in PR Tool database.*
		3. Reviewers' Review Time.	*Reviewers' Review Time will be kept in PR Tool database.*
		4. Author's response to reviewers' comments.	*Author's response is also kept in PR Tool database.*

4.1.4 TO-BE Internal Review Meeting Sub-Process

Table 15 TO-BE Internal Review Meeting Sub-Process

Step	Original	Suggested	Change Rationale
Input(s)	1. Draft Product(s)	No change	N/A
	2. Standards		
	3. Checklists		
	4. Related Documents		
	5. PR Report	*Prepared by PR Tool.*	*This form will be generated automatically by using PR Tool.*
	6. Reviewers' Comments	*Entered to PR Tool.*	*Reviewers' comments will be kept in PR Tool database.*
	Does not exist	*7. Author Response.*	*These data will be generated automatically by using PR Tool.*
		8. PR Tool.	*PR Tool will be used to automate Peer Review Process*
Description	1. Check whether Peer Review is ready or not at PR time	No change	N/A
	2. Postpone/Cancel Peer Review Meeting	No change	N/A
	3. Start Peer Review Meeting	No change	N/A
	Removed	*4. Write total preparation effort to PR Report.*	*Since PR Tool is used for related metrics, there is no need to write efforts to PR Report. No hard copy information will be stored.*

Table 15 (cont'd)

Step	Original	Suggested	Change Rationale
Description	*Does not exist*	*4. Review all Reviewers' comments and author's responses and take action items.*	*PR Meeting will be performed by using PR Tool since PR Tool includes all reviewers' comments and Author response.* All AIs are taken automatically using *reviewers' comments and Author response.*
	Removed	*5. Review Reviewers' comments and investigate action items.*	*Since PR Tool is used, there is no need to perform this activity.*
	Removed	*6. Write action items to AI Form.*	*Since PR Tool is used, there is no need to perform this activity.*
	5. Conclude the PR Meeting	No change	N/A
	6. Update PR Report	*6. Update PR Report and AI Form.*	*PR Report and AI Form will be generated automatically.*
	7. Save and Exit	No change	N/A
Roles	1. Author.	No change	N/A
	2. SQE.	No change	N/A
	3. Reviewers.	No change	N/A
Output(s)	1. PR Report	No change	N/A
	2. AI form	No change	N/A
	3. Exit Decision	No change	N/A
	Does not exist	*4. PR Tool.*	*PR Tool will be used to automate Peer Review Process.*

4.1.5 TO-BE Peer Review Closure Sub-Process

Table 16 TO-BE Peer Review Closure Sub-Process

Step	Original	Suggested	Change Rationale
Input(s)	1. Updated Product(s)	No change	N/A
	2. Draft Product(s)		
	3. AI Form		
	4. PR Report	*Prepared by PR Tool.*	*This form will be generated automatically by using PR Tool.*
	Does not exist	*5. PR Tool*	*PR Tool will be used to automate Peer Review Process.*
Description	1. Take Updated Product(s) according to action items from author	No change	N/A
	2. Check Updated Product(s) by comparing Draft Product(s) and Updated Product(s)	No change	N/A
	Does not exist	*3. Close all AIs using PR Tool.*	*Status of the AIs and resolution description of the AIS are kept in PR Tool.*
	4. Update AI Form and PR Report	No change	N/A
	Does not exist	*5. Enter SQE Closure Time.*	*Author Update Time will be kept in PR Tool database.*
		6. Enter Author Update Time.	*SQE Closure Time will be kept in PR Tool database.*
	7. Close PR and Send Updated Product(s) to release	*PR Tool will be used.*	*PR will be closed in PR Tool.*
	8. Investigate issues or new AIs to identify action	No change	N/A
	9. Send Updated Product(s) to author to update	No change	N/A

Table 16 (cont'd)

Step	Original	Suggested	Change Rationale
Roles	1. Author.	No change	N/A
	2. SQE.	No change	N/A
Output(s)	1. Updated Product(s)	No change	N/A
	2. Signed AI Form and PR Report	No change	N/A
	Does not exist	*3. Author Update Time*	*Author Update Time will be kept in PR Tool database*
		4. SQE Closure Time	*SQE Closure Time will be kept in PR Tool database*
		5. PR Tool	*PR Tool will be used to automate Peer Review Process*

4.2 MEASUREMENTS FOR THE TO-BE PROCESS AND EVALUATION

4.2.1 Measurements for TO-BE SQE Check Sub-Process and Evaluation

In Table 17, SG metrics will be compared for the AS-IS and TO-BE SQE Check sub-processes and evaluation will be given.

Table 17 Measurements for the AS-IS and TO-BE SQE Check Sub-Processes

Metrics	**AS-IS SQE Check (Number of activity = 3)**	**TO-BE SQE Check (Number of activity = 5)**
Complexity	X(1) = 1 / 3 = 0.33 X(2) = 0 / 3 = 0 X(3) = 1 / 3 = 0.33	X(1) = 1 / 5 = 0.20 X(2) = 0 / 5 = 0 X(3) = 2 / 5 = 0.40
Coupling	X = 1 / 3 = 0.33	X = 2 / 5 = 0.40
Failure Avoidance	X = 1 / 3 = 0.33	X = 2 / 5 = 0.40
Restorability	X = 0 / 3 = 0	X = 1 / 5 = 0.20
Restoration Effectiveness	X = 0 / 3 = 0	X = 1 / 5 = 0.20
Functional Adequacy	X = 3 / 3 = 1	X = 5 / 5 = 1
Functional Completeness	X = 1 – 0/3 = 1	X = 1 – 0 / 5 = 1
IT Usage	X = 3 / 3 = 1	X = 5 / 5 = 1
IT Density	X = 9 / 9 = 1	X = 10 / 10 = 1
Computational Accuracy	X = 3 / 3 = 1	X = 5 / 5 = 1
Data Exchangeability	X = 1 / 1 = 1	X = 2 / 2 = 1
Access Auditability	X = 3 / 3 = 1	X = 5 / 5 = 1
Functional Understandability	X = 3 / 3 = 1	X = 5 / 5 = 1
Completeness Documentation	X = 3 / 3 = 1	X = 5 / 5 = 1
Input Validity Checking	X = 2 / 3 = 0.67	X = 4 / 5 = 0.80
Undoability	X = 0 / 3 = 0	X = 1 / 5 = 0.20
Attractive Interaction	X = 3 / 3 = 1	X = 5 / 5 = 1

Evaluation for the TO-BE SQE Check Sub-Process Considering AS-IS Sub-process:

Complexity metric (X(1) = 0,20, X(2) = 0, X(3) = 0,40)

When we analyze the values of X(1), X(2), and X(3) for TO-BE sub-process, it is observed that they are also low. Adding new activities to TO-BE sub-process causes the difference between the values for AS-IS and TO-BE sub-processes. There is no improvement suggestion related with this metric in the assessment of the AS-IS sub-process.

Coupling and Failure Avoidance metrics (X = 0.40, X = 0.40)

The value of these metrics for TO-BE sub-process are also low, but higher than AS-IS'. The reason for the differences between TO-BE and AS-IS sub-processes are same as mentioned in Coupling Metric. There is no improvement suggestion related with these metrics in the assessment of the AS-IS sub-process.

Restorability and Restoration Effectiveness metrics (X = 0,20, X = 0,20)

In the evaluation of this metric in AS-IS sub-process we observed that improvements related with this metric are not practical. However the value of this metric for TO-BE sub-process is higher. The reason for the difference is same as mentioned in Coupling Metric since the result of the added activity is recorded.

Input Validity Checking metric (X = 0,80)

Input Validity Checking metric value is high and acceptable for both AS-IS and TO-BE sub-processes. When we inspect TO-BE sub-process we find the same reason as mentioned in Coupling Metric which means that there is an improvement related with this metric.

Undoability metric (X = 0,20)

The value of this metric for TO-BE sub-process is also not high for TO-BE sub-process, however as we mention in AS-IS sub-process we do not need to keep any records. So, further improvements are also not practical for TO-BE sub-process too. The value of this metric is higher than AS-IS. The reason for the difference is same as mentioned in Coupling Metric.

4.2.2 Measurements for TO-BE Prepare Peer Review Sub-Process and Evaluation

Table 18 presents comparison of SG metrics for the AS-IS and TO-BE Prepare Peer Review sub-processes. Evaluation will also be given in this section.

Table 18 Measurements for the AS-IS and TO-BE Prepare Peer Review Sub-Processes and Evaluation

Metrics	**AS-IS Prepare Peer Review (Number of activity = 6)**	**TO-BE Prepare Peer Review (Number of activity = 6)**
Complexity	X(1) = 3 / 6 = 0.50 X(2) = 0 / 6 = 0 X(3) = 2 / 6 = 0.33	X(1) = 5 / 6 = 0.83 X(2) = 0 / 6 = 0 X(3) = 1 / 6 = 0.12
Coupling	X = 5 / 6 = 0.83	X = 5 / 6 = 0.83
Failure Avoidance	X = 3 / 6 = 0.50	X = 3 / 6 = 0.50
Restorability	X = 4 / 6 = 0.67	X = 6 / 6 = 1
Restoration Effectiveness	X = 4 / 6 = 0.67	X = 6 / 6 = 0.83
Functional Adequacy	X = 4 / 6 = 0.67	X = 6 / 6 = 1
Functional Completeness	X = 1 – 1 / 6 = 0.83	X = 1 – 0 / 6 = 1
IT Usage	X = 3 / 6 = 0.50	X = 6 / 6 = 1
IT Density	X = 7 / 7 = 1	X = 12 / 12 = 1
Computational Accuracy	X = 2 / 2 = 1	X = 4 / 4 = 1
Data Exchangeability	X = 5 / 5 = 1	X = 5 / 5 = 1
Access Auditability	X = 6 / 6 = 1	X = 6 / 6 = 1
Functional Understandability	X = 4 / 6 = 0.67	X = 6 / 6 = 1
Completeness Documentation	X = 6 / 6 = 1	X = 6 / 6 = 1
Input Validity Checking	X = 4 / 6 = 0.67	X = 4 / 6 = 0.67
Undoability	X = 3 / 6 = 0.50	X = 6 / 6 = 1
Attractive Interaction	X = 1 / 6 = 0.17	X = 6 / 6 = 1

Evaluation for the TO-BE Prepare Peer Review Sub-Process Considering AS-IS Sub-process

Complexity metric (X(1) = 0,83, X(2) = 0, X(3) = 0,12)

Although the value of the X(3) is low, the complexity metric value X(3) is high. In spite of higher value of X(3), there is no need for further improvements. It is easily noticed that all activities have characteristics of structured decisions which have well-defined and standard solution.

Coupling metric (0,83)

The coupling metric value for TO-BE sub-process is high like AS-IS sub-process. The reason is same as explained in AS-IS sub-process. So, there is no further improvements practical related with this metric.

Failure Avoidance metric (X = 0,50)

Failure avoidance metric value is not high, but it is acceptable. Because of the fact that the activities which are identified with "No review, inspection, checkpoint or similar techniques" include the checkpoints from previous activities as mentioned in AS-IS sub-process, there is no further improvement related with this metric.

Restorability and Restoration Effectiveness metrics (X = 1, X = 0,83)

When we inspect TO-BE sub-process it is observed that Restorability metric value is 1 and Restoration Effectiveness metric value is 0,83. These values are higher than AS-IS sub-process' metric values. The main reason is that all reports are prepared automatically using PR Tool and kept in PR Tool database. This prevents manual errors like copy-paste errors, missing information, unsaved/missing reports, etc.

Functional Adequacy and Functional Completeness metrics (X = 1, X = 1)

Although Functional Adequacy and Functional Completeness metric values are high for AS-IS sub-process, we noticed that these metric values equal to 1 in TO-BE sub-process. The main reason is that TO-BE sub-process is developed considering both implementations of the sub-process and related regulatory documents and regulatory documents are updated accordingly. So, improvement is deployed for this metric. This improvement is provided by PR Tool.

IT Usage metric (X = 1)

The value of IT Usage metric value is 1 in TO-BE sub-process. The main improvement is provided using PR Tool. All reports are prepared and recorded automatically and PR information is stored by this Tool.

Functional Understandability metric (X = 1)

The value of this metric is increased in TO-BE sub-process. The regulatory documents are updated adding enough explanations for how to perform these activities and Functional Understandability metric value becomes 1. Also, user manual of the PR Tool includes the useful information and details about PR.

Input Validity Checking metric (X = 0,67)

When we inspect both AS-IS and TO-BE sub-processes it is observed that possible input validity checking is performed. So, no further improvements are practical related with this metric.

Undoability metric (X = 0,50)

However Undoability metric value is increased to 1 in TO-BE sub-process since PR Tool is used and all activities and their results are stored in PR Tool database. Also, some of activities in AS-IS sub-process are removed from this sub-process according to improvement suggestions.

Attractive Interaction (X = 1)

Attractive Interaction metric value is low for AS-IS sub-process. As mentioned in AS-IS sub-process, it is very hard to manage updates/deletions/generations/etc of the documents. This metric value is 1 in TO-BE sub-process since PR Tool is used for performing this sub-process. All documents are prepared/updated/deleted/generated using PR Tool which prevents manual errors. Improvements are provided using PR Tool and removing some activities.

4.2.3 Measurements for TO-BE Individual Check Sub-Process and Evaluation

In this section, SG metrics for AS-IS and TO-BE Individual Check sub-processes will be given in Table 19 and evaluation will be presented.

Table 19 Measurements for the AS-IS and TO-BE Individual Check Sub-Processes and Evaluation

Metrics	**AS-IS Individual Check (Number of activity = 2)**	**TO-BE Individual Check (Number of activity = 7)**
Complexity	X(1) = 1 / 2 = 0.50 X(2) = 0 / 2 = 0 X(3) = 1 / 2 = 0.50	X(1) = 4 / 7 = 0.57 X(2) = 0 / 7 = 0 X(3) = 3 / 7 = 0.43
Coupling	X = 2 / 2 = 1	X = 5 / 7 = 0.71
Failure Avoidance	X = 2 / 2 = 1	X = 7 / 7 = 1
Restorability	X = 1 / 2 = 0.50	X = 6 / 7 = 0.86
Restoration Effectiveness	X = 0 / 2 = 0	X = 5 / 7 = 0.71
Functional Adequacy	X = 2 / 2 = 1	X = 7 / 7 = 1
Functional Completeness	X = 1 – 0 / 2 = 1	X = 1 – 0 / 7 = 1
IT Usage	X = 1 / 2 = 0.50	X = 7 / 7 = 1
IT Density	X = 6 / 7 = 0.86	X = 8 / 8 = 1
Computational Accuracy	X = 2 / 2 = 1	X = 7 / 7 = 1
Data Exchangeability	X = 2 / 2 = 1	X = 5 / 5 = 1
Access Auditability	X = 1 / 2 = 0.5	X = 7 / 7 = 1
Functional Understandability	X = 1 / 2 = 0.5	X = 7 / 7 = 1
Completeness Documentation	X = 2 / 2 = 1	X = 7 / 7 = 1
Input Validity Checking	X = 2 / 2 = 1	X = 7 / 7 = 1
Undoability	X = 0 / 2 = 0	X = 5 / 7 = 0.71
Attractive Interaction	X = 1 / 2 = 0.5	X = 7 / 7 = 1

Evaluation for the TO-BE Individual Check Sub-Process Considering AS-IS Sub-process

Complexity metric (X(1) = 0,57, X(2) = 0, X(3) = 0,43)

The complexity metric values (X1, X2, X3) are low for both AS-IS and TO-BE sub-processes, which is desirable. There is no need to further improve these metric values.

Also when we inspect the TO-BE sub-process it is noticed that Individual Check sub-process is updated too much. PR Tool provides the improvements for this sub-process.

Coupling metric (X = 0,71)

The value of Coupling metric in TO-BE sub-process is lower than AS-IS'. When we inspect the sub-process, it is observed that the difference between AS-IS and TO-BE sub-process is constituted by PR Tool.

This value is not low, but the further improvements are not practical.

Restorability and Restoration Effectiveness metrics (X = 0,86, X = 0,71)

In AS-IS sub-process we noticed that formal comment lists prepared by reviewers should be prepared in computer environment. Also storage of these records must be provided.

In TO-BE sub-process we see that are recorded and stored using PR Tool and PR Tool database. So, Restorability and Restoration Effectiveness metric values are high in TO-BE sub-process.

IT Usage and IT Density metrics (X = 1, X = 1)

Again we see that PR Tool usage increase the metric values. In this TO-BE sub-process, since the PR Tool provides the preparation and storage of the reviewers' comments and author's responses, IT Usage and IT Density metric values are 1.

Access Auditability metric (X = 1)

The increase of this metric in TO-BE sub-process is also related with PR Tool as mentioned in previous two metrics, because the access rights are defined in PR Tool.

Functional Understandability and Attractive Interaction metrics (X =1, X = 1)

Considering these improvement suggestions mentioned in AS-IS sub-process and PR Tool usage, TO-BE sub-process is developed and implemented. Then, we

noticed that the value of Functional Understandability and Attractive Interaction metrics become 1.

Undoability metric (0,71)

When we achieve the improvement suggestion as mentioned in Restorability and Restoration Effectiveness metrics using PR Tool, Undoability metric value becomes higher for TO-BE sub-process.

4.2.4 Measurements for TO-BE Internal Review Meeting Sub-Process and Evaluation

In Table 20, SG metrics for both the AS-IS and TO-BE Internal Review Meeting sub-processes will be presented and evaluation will be given.

Table 20 Measurements for the AS-IS and TO-BE Internal Review Meeting Sub-Processes and Evaluation

Metrics	**AS-IS Internal Review Meeting (Number of activity = 9)**	**TO-BE Internal Review Meeting (Number of activity = 7)**
Complexity	X(1) = 5 / 9 = 0.56 X(2) = 0 / 9 = 0 X(3) = 4 / 9 = 0.44	X(1) = 4 / 7 = 0.57 X(2) = 0 / 7 = 0 X(3) = 3 / 7 = 0.43
Coupling	X = 4 / 9 = 0.44	X = 3 / 7 = 0.43
Failure Avoidance	X = 5 / 9 = 0.56	X = 5 / 7 = 0.71
Restorability	X = 7 / 9 = 0.78	X = 6 / 7 = 0.86
Restoration Effectiveness	X = 7 / 9 = 0.78	X = 6 / 7 = 0.86
Functional Adequacy	X = 7 / 9 = 0.78	X = 7 / 7 = 1
Functional Completeness	X = 1 – 1 / 9 = 0.89	X = 1 – 0 / 7 = 1
IT Usage	X = 4 / 9 = 0.44	X = 7 / 7 = 1
IT Density	X = 6 / 7 = 0.86	X = 8 / 8 = 1
Computational Accuracy	X = 5 / 5 = 1	X = 6 / 6 = 1
Data Exchangeability	X = 1 / 3 = 0.33	X = 1 / 3 = 0.33
Access Auditability	X = 5 / 9 = 0.56	X = 7 / 7 = 1
Functional Understandability	X = 7 / 9 = 0.78	X = 7 / 7 = 1
Completeness Documentation	X = 8 / 9 = 0.89	X = 7 / 7 = 1
Input Validity Checking	X = 3 / 9 = 0.33	X = 3 / 7 = 0.43
Undoability	X = 7 / 9 = 0.78	X = 6 / 7 = 0.86
Attractive Interaction	X = 6 / 9 = 0.67	X = 7 / 7 = 1

Evaluation for the TO-BE Internal Review Meeting Sub-Process Considering AS-IS Sub-process

Complexity and Coupling metrics (X(1) = 0,57, X(2) = 0, X(3) = 0,43, X = 0,43)

Complexity and Coupling metric values of the AS-IS and TO-BE sub-processes are low and close to each other. As mentioned in AS-IS sub-process, we cannot change or remove the reports, forms, and other documents used in this sub-process, so we have no further improvement suggestions applied to sub-process as a result of these metrics.

Failure Avoidance (X = 0,71)

The value of the Failure Avoidance metric is high in TO-BE sub-process. The main reason is again usage of PR Tool which combines the activities and reduces the number of activities documented as "No review, inspection, checkpoint or similar techniques".

Restorability and Restoration Effectiveness metrics (X = 0,86, X = 0,86)

The values calculated for AS-IS sub-process are high, but when we inspect the TO-BE sub-process it is noticed that these metric values are increased. The main reason is the usage of PR Tool because peer review meeting is performed using PR Tool and results, forms, reports, and related docuents for all activities are recorded.

Functional Adequacy and Functional Completeness metrics (X = 1, X = 1)

The value of these metrics are not low in AS-IS sub-process, but we increse them updating implementation of the sub-process considering PR Tool usage and accordingly updating regulatory documents. In AS-IS sub-process we observed that regulatory documents should be updated considering both the process implementations and regulatory documents. So, the improvement suggestions become to be deployed.

IT Usage and IT Density metrics (X = 1, X = 1)

IT Usage and IT Density metric values are 1 for TO-BE sub-process due to the PR Tool. Improvements are again performed using PR Tool which includes all outputs, reports, forms, and related documents of the activities.

Data Exchangeability metric (X = 0)

As we mentioned in AS-IS sub-process, reports and forms are updated according to attitude of the PR. So, the value of the Data Exchangeability metric

value in AS-IS and TO-BE sub-processes are low and the further improvements are not practical.

Access Audaitability metric (X = 0,56)

When we analyze TO-BE sub-process, it is observed that improvements are performed by PR Tool since PR Tool database includes all activities' results and access rights are also controlled.

Functional Understandability metric (X = 1)

The value of this metric is increased in TO-BE sub-process. Because the activities which staff has difficulties are explained more clear in regulatory documents considering PR Tool. Because PR Tool provides facilities for PR Meeting and Individual Check.

Completeness Documentation metric (X = 1)

Since the regulatory documents are updated according to implementation of the sub-process considering PR Tool effect, the value of this metric is increased to 1.

Input Validity Checking

Input Validity Checking metric value is low for AS-IS and TO- BE sub-processes. Necessary inputs are checked in both AS-IS and TO-BE sub-processes, so the further improvements are not seemed practical since there is no any mistake due to the input parameter invalidity.

Undoability metric (X = 0,86)

Undoability metric value is increased both considering improvement suggestion from metrics and PR Tool.

Attractive Interaction metric (X = 1)

The Individual Check sub-process is improved considering reviewers' comments, author responses, and discussions between the reviewers and author using PR Tool. Also, regulatory documents are updated accordingly. In this way, the inputs for PR Meeting provided by Individual Check sub-process are managed. Also, PR Tool is used for all sub-process and regulatory documents are updated accordingly. So, the value obtained for Attractive Interaction metric is 1.

4.2.5 Measurements for TO-BE Peer Review Closure Sub-Process and Evaluation

SG metrics for the AS-IS and TO-BE Peer Review Closure sub-processes will be given in Table 21 and the evaluation will also be presented in this section.

Table 21 Measurements for the AS-IS and TO-BE Peer Review Closure Sub-Processes and Evaluation

Metrics	**AS-IS** **Peer Review Closure** **(Number of activity = 6)**	**TO-BE** **Peer Review Closure** **(Number of activity = 9)**
Complexity	X(1) = 4 / 6 = 0.67 X(2) = 0 / 6 = 0 X(3) = 2 / 6 = 0.33	X(1) = 7 / 9 = 0.78 X(2) = 0 / 9 = 0 X(3) = 2 / 9 = 0.22
Coupling	X = 2 / 6 = 0.33	X = 2 / 9 = 0.22
Failure Avoidance	X = 4 / 6 = 0.67	X = 8 / 9 = 0.89
Restorability	X = 4 / 6 = 0.66	X = 9 / 9 = 1
Restoration Effectiveness	X = 4 / 6 = 0.66	X = 9 / 9 = 1
Functional Adequacy	X = 3 / 6 = 0.50	X = 9 / 9 = 1
Functional Completeness	X = 1 – 2 / 6 = 0.67	X = 1 – 0 / 9 = 1
IT Usage	X = 3 / 6 = 0.50	X = 9 / 9 = 1
IT Density	X = 4 / 4 = 1	X = 4 / 4 = 1
Computational Accuracy	X = 4 / 4 = 1	X = 7 / 7 = 1
Data Exchangeability	X = 2 / 2 = 1	X = 2 / 2 = 1
Access Auditability	X = 4 / 6 = 0.66	X = 9 / 9 = 1
Functional Understandability	X = 4 / 6 = 0.66	X = 9 / 9 = 1
Completeness Documentation	X = 5 / 6 = 0.83	X = 9 / 9 = 1
Input Validity Checking	X = 3 / 6 = 0.50	X = 8 / 9 = 0,89
Undoability	X = 4 / 6 = 0.66	X = 9 / 9 = 1
Attractive Interaction	X = 3 / 6 = 0.50	X = 9 / 9 = 1

Evaluation for the TO-BE Peer Review Closure Sub-Process Considering AS-IS Sub-process

Complexity metric (X(1) = 0,78, X(2) = 0, X(3) = 0,22)

The values of the Complexity metric for AS-IS and TO-BE sub-processes are close to each other. When we inspect ths sub-process, X(1) value is high but it only means that most of the activities have structured decisions which have weell defined and standard solutions.

Coupling metric (X = 0,22)

Coupling metric value is low. Also, when we inspect this sub-process model it is easily observed that interactions cannot be changed or removed. The value is less than AS-IS' since TO-BE sub-process has much activities as a result of PR Tool usage.

Failure Avoidance metric (X = 0,89)

The value of this metric is higher than AS-IS sub-process'. The main reason is usage of PR Tool and also adding new activities as a result of PR Tool.

Functional Completeness, Functional Understandability, and Attractive Interaction metrics (X = 1, X = 1, X = 1)

In AS-IS sub-process we suggest that resolution description of the action items and additional AIs should be recorded and how to perform these activities should be given in regulatory document. In TO-BE sub-process, we see that PR Tool provides the way for improvements. Also, regulatory documents are updated including PR Tool details and activity details. So the values of these metrics are increased to 1.

Restorability, Restoration Effectiveness, and Undoability metrics (X = 1, X = 1, X = 1)

In these metrics again we see tha impacts of the PR Tool. As mentioned in previous metric, PR Tool includes all inputsi outputs, and results of the activities. So, the value of these metrics are increased to 1.

Functional Adequacy metric (X = 1)

The value of this metric is increased to 1 using PR Tool and updating regulatory document accordingly.

Access Auditability metric (X = 1)

This metric value is increased to 1 using PR Tool which provides the improvement suggestions as mentioned in AS-IS sub-process.

Completeness Documentation (X = 1)

The missing activity about measurement is added to sub-process using PR Tool and this data is automatically saved and regulatory documents are updated accordingly. So, the value of this metric is increased.

Input Validity Checking (X = 0,89)

The impact of the PR Tool is increased this metric since the implementation of the activities are detailed and regulatory documents are updated accordingly.

IT Usage metric (X = 1)

IT Usage metric value is again increased using PR Tool which provides improvements.

4.3 COMPARISON WITH CMMI FRAMEWORK

Within the CMMI framework, peer review is handled in the Verification process area and specific goals and practices are as follows [2] :

- *"Specific Goal 2 Perform Peer Reviews*
    - *Specific Practice 2.1 Prepare for Peer Reviews: Preparation activities for peer reviews typically include identifying the staff who will be invited to participate in the peer review of each work product; identifying the key reviewers who must participate in the peer review; preparing and updating any materials that will be used during the peer reviews, such as checklists and review criteria, and scheduling peer reviews.*
    - *Specific Practice 2.2 Conduct Peer Reviews: One of the purposes of conducting a peer review is to find and remove defects early. Peer reviews should address the following guidelines: there must be sufficient preparation, the conduct must be managed and controlled, consistent and sufficient data must be recorded (an example is conducting a formal inspection), and action items must be recorded.*
    - *Specific Practice 2.3 Analyze Peer Review Data: Analyze data about preparation, conduct, and results of the peer reviews."*

Since XCOM has CMMI level 3 certificate, peer reviews were performed considering specific practices. Hovewer, there were several problems in collecting and analyzing peer review data as follows:

- Data related to the preparation, conduct, and results of the peer reviews were tried to be recorded but, there were no consistent and meaningful data for peer reviews. (Typical data are product name, product size, composition of the peer review team, type of peer review, preparation time per reviewer, length of the review meeting, number of defects found, type and origin of defect, etc. [2])
- For this reason, the peer review data could not be collected. The actual results for peer reviews such as review time, number of defects for per product, etc. to expected results could not be compared since the actual results were not collected in PR.
- The verification data on defects could not be analyzed since all information was kept manually using different methods, forms and reports.
- Process improvement suggetions for the verification methods, criteria, and environment could not be considered and applied on time.

When we inspect these problems and assess the peer review process with regard to CMMI [2] , we observe that XCOM should improve its peer review process to collect all PR data consistently and meaningfully. The present author's suggestion on this point is consistent with CMMI indications.

Other improvements are related with the experiences of the staff in the projects and lessons learned from previous projects. Hovewer, if XCOM had PR data and analyzed it, other improvement suggestions related with the "size of the products", "internal review meeting time" and "maturity of the product" could be obtained.

In general, it is seen that when an automated PR data collection and analysis infrastructure is established, performance tracking of the process will be much more effective and any problems can be immediately detected.

CHAPTER 5

RESULTS AND CONCLUSION

This study has aimed to propose improvements for the peer review process applied in XCOM. For this reason, the improvements based on the assessment of the process and the improvements based on the SG metrics have been discussed.

The improvement suggestions given in Chapter 3 and improved process given in Chapter 4 have been presented to senior staff (with a mean experience of at least 5 years), project managers, and the SEPG members. The responses have been encouraging the improvements and they have been applied to the process.

In this chapter, the questions in Chapter 1 are answered and conclusion is presented.

5.1 RESULTS

The fundamental research questions of this study were posed as:

- Can the problems observed in an actual software development firm regarding the peer review process be improved using an ad-hoc approach?
- How does an ad-hoc improvement approach compare with the results of Selçuk Güceğlioğlu's [1] re-enactment software process modeling and assessment technique?

5.1.1 Answer 1

There was a chance to apply new process partially and assess the outcomes. The new model has overcome the major problems encountered in XCOM. Improvements have been applied without any problem. Peer review process is performing automatically now. As a result, peer review related metrics (size, effort, number of AIs, etc.) are collecting in PR database; therefore analyses of the measured data can be performed effectively.

PR reports and forms are prepared and stored automatically. There is no need for extra database for these forms and reports. Also, login mechanism in PR Tool provides the signature for each participants of the peer review. As a result of this improvement, hard copies are not needed anymore.

Since the discussions are performed before the internal review meeting, time of the meeting is decreased.

In parallel, regulatory documents have been updated considering all improvement suggestions and how to perform the process is explained.

Senior staff participant and size limitation for the work products to be reviewed have been added. Therefore, peer reviews can now be performed efficiently.

Also, trainings have been planned and added to XCOM's training plan.

The first impressions gathered from the staff about the informal reviews are very positive. These reviews have improved the development process and provide mature work products to the peer reviews, increasing overall development effectiveness.

5.1.1 Answer 2

Güceğlioğlu's approach [1] for adopting ISO 9126-3 to an organization provides predictability to some extent. But, both Güceğlioğlu's study and the ISO 9126 standard can not be used as the only SPI model since they do not reflect the effectiveness achieved in the actual application of the process.

B. Sezer [14], I..Yamaç [15], and H. Seçkin [16] have also proposed process improvement studies in large software development organizations. They have introduced improvement suggestions based on the assessment of the process and they have also used SG metrics during their studies. Then they have compared the results. At the end of the studies, they have observed that Güceğlioğlu's approach [1] is helpful as a starting point of SPI, but it is not enough to achieve successful improvements. Improvement suggestions should be also collected from staff members who apply the processes and maintain process assets. They can easily notice the weak and indistinct parts of the processes and process assets. So, staff should be the very starting point for every SPI study to provide realizations. So, trainings are needed to increase the knowledge of domain and knowledge of work.

5.1 CONCLUSION

Management commitment is one of the musts for process improvement discussed before. It is the starting point of successful achievement of any improvement.

Based on this study, the following observations have been made about SPI:

The main conclusion reached from these observations is that choosing a process model is complex and one should proceed with concrete data in making the necessary choices and arrangements. The applied process should be assessed and measured according to business objectives and organization's needs to define the weak and indistinct parts of the processes and the process assets. SPI models and methodologies should be chosen considering objectivities, needs, and culture of the organization.

In addition, the software process improvements which result in major changes should be applied to pilot project to see the impacts. Within the scope of this study, PR tool was first applied in a limited scope, and based on an evaluation, its usage was extended.

Continuous improvement should be provided. Improvement suggestion should be collected. After they are analyzed and the action plan and deployment plan should be prepared. Therefore, improvements would be applied under systematic coordination.

XCOM collects lessons learned from the projects and process improvement suggestions, but there is a missing point. Staff submits Lessons Learned and Process Improvement Suggestions to a common database, but these are not evaluated efficiently. The needed resource should be provided and continuous improvements based on these suggestions should be planned and realized to produce high quality work products.

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APPENDIX A

"AS-IS Process Activities"

Table A - 1 AS-IS SQE Check Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents/ Archival Records/ Tools/ Applications/ Other Medias
1	Request Peer Review	According to project plan, peer review is requested by project team via e-mail. The author prepares the review package and submits to SQE to organize a peer review.	Project Team Author	Project Plan E-mail for PR request Draft Product(s) Checklists Standards Organizational Policies and Templates Proposals and Agreements Type of work products
2	Check Draft Product(s) according to basic verification criteria	SQE checks the Draft Product(s) with respect to the following verification criteria: • Peer Review package has been prepared according to applicable Organizational policies and templates. • Peer Review package is complete with required checklists, standards and type of work products. • Peer Review package is consistent with proposals and agreements. After checking, SQE decides whether product is ready for review or not.	SQE	Draft Product(s) Checklists Standards Organizational Policies and Templates Proposals and Agreements Type of work products
3	Send Draft Product(s) to its author to complete the product for review	If the product is found inadequate, the SQE can inform the Project Team and author via e-mail and sends the Draft Product(s) to its author to complete. Author checks the product(s) and after updating the product(s), again sends the product to SQE for SQE check.	Author SQE Project Team	E-mail Draft Product(s)

Table A - 2 AS-IS Prepare Peer Review Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents/ Archival Records/ Tools/ Applications/ Other Medias
1	Scan Project Plan (to identify review team)	Project Plan includes the Peer Review schedule and staff names and their roles and responsibilities. So, review team is selected according to Project Plan	SQE Project Team	Project Plan
2	Establish Review Team	If Project Plan does not include the Peer Review schedule, staff names and their roles and responsibilities, Project Team and SQE establish the review team.	SQE Project Team Review Team	Project Plan
3	Identify Peer Review time and location	Review Team, SQE and Author establish the review time and location according to project schedule and the staff work status.	SQE Author Review Team	Project Plan (by Telephone Conversation or e-mail)
4	Identify Peer Review Package and related documents and take them under control	Review package (Draft Product(s), Checklists, and Standards) and related documents are take under control for Peer Review	SQE	Draft Product(s) Checklists Standards Related Documents
5	Fill out Peer Review report.	Peer Review report is prepared by writing all information for the Peer Review (i.e. PR ID, Time, Location, Author Name, Reviewer Name, etc.)	SQE	PR Report
6	Send Peer Review package to review team via e-mail	An e-mail is prepared to inform the Review Team, Author and also project managers. This e-mail includes the Peer Review report, Review Package (Draft Product(s), Checklists, Standards, and Related Documents), and short description of the Peer Review. SQE send the Meeting Request for Peer Review	SQE Review Team Project Managers	PR Report E-mail for PR Draft Product(s) Checklists Standards Related Documents

Table A - 3 AS-IS Individual Check Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents Archival Records/ Tools/ Applications/ Other Medias
1	Read PR E-mail and take information about PR	Review Team read the Peer Review report and take information about PR. PR e-mail includes information for Draft Product(s), standards, checklists, related documents, PR ID, PR Date, roles and responsibilities, etc.	Review Team	Peer Review Report E-mail for PR Draft Product(s) Checklists Standards Related Documents
2	Review the Draft Product(s)	Each member individually examines the Draft Product(s) against appropriate review checklists, applicable standards prior to the review meeting according to their peer review roles and responsibilities assigned and take their comments in the Draft Product(s) to discuss in Peer Review Meeting	Review Team	Hard/Soft Copy of the Reviewers' Comments Checklists Standards Related Documents Draft Product(s)

Table A - 4 AS-IS Internal Review Meeting Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents Archival Records/ Tools/ Applications/ Other Medias
1	Check whether Peer Review is ready or not at PR time	SQE checks that Draft Product(s) are reviewed by Review Team. Then, SQE is sure that Review Team is available in PR time.	SQE Author Review Team	-
2	Postpone/Cancel Peer Review Meeting	If author/SQE/Review Team is not ready for Peer Review, peer review is re-scheduled if the remaining time is known or cancelled to be re-scheduled later if there is no information when PR Meeting can be performed.	SQE Author Review Team	-
3	Start Peer Review Meeting	Peer Review Meeting is started by SQE.	SQE	Draft Product(s) Checklists Standards Related Documents Hard/Soft Copies of Reviewers' Comments
4	Write total preparation effort to PR Report	SQE, Review Team and the Author give the total preparation effort and SQE notes their effort to PR Report.	SQE Author Review Team	PR Report
5	Review Reviewers' comments and investigate action items	Review Team read their comments during PR Meeting. All comments are investigated to take action items with Review Team, SQE and the author.	SQE Author Review Team	Hard/Soft Copies of Reviewers' Comments
6	Write action items to AI Form	Accepted comments are taken as action items and all of them entered to AI form.	SQE Author Review Team	AI Form
7	Conclude the PR Meeting	Review Team take an exit decision to determine if the product(s) meet the review completeness criteria defined in the Quality Assurance Plan. SQE, having the review team's agreement, identify the product disposition as one of the following: • Accept as is • Revise with no further review • Revise and schedule another review	SQE Author Review Team	PR Report Network

Table A – 4 (cont'd)

No	Activity Name	Activity Definition	Staff	Forms/ Documents Archival Records/ Tools/ Applications/ Other Medias
8	Update PR Report	Peer Review finish time is entered to PR Report by SQE, them signed with Peer Review participant.	SQE Author Review Team	AI Form AI Report Network
9	Save and Exit	Hard Copy and Soft Copy of the PR Report and AI Form are saved.	SQE Network	AI Form AI Report Network

Table A - 5 AS-IS Peer Review Closure Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents Archival Records/ Tools/ Applications/ Other Medias
1	Take Updated Product(s) according to action items from author	Author sends the Updated Product(s) according to action items to SQE. SQE takes Updated Product(s)	SQE Author	Updated Product(s)
2	Check Updated Product(s) by comparing Draft Product(s) and Updated Product(s)	SQE checks the all action items on Updated Product(s) by comparing Updated Product(s) and Draft Product(s). The differences between two products must be explained by action items.	SQE	Draft Product(s) Updated Product(s) AI Form
3	Update AI Form and PR Report	SQE shall sign the Action Item Form and PR Report and take note the closure date to both documents.	SQE	PR Report AI Form
4	Close PR and Send Updated Product to release	SQE sends the Updated Product(s) to release and closes PR.	SQE	Updated Product(s)
5	Investigate issues or new AIs to identify action	If there are issues or new AIs, SQE and author investigate issues or new AIs and identify the action. At this point, if new issues or new AIs cause any update, SQE sends Updated Product(s) to author. Also, SQE updates AI Form.	SQE Author	Updated Product(s) AI Form
6	Send Updated Product(s) to author to update	If there are missing AIs, SQE sends Updated Product(s) to author to perform missing AI(s).	SQE Author	Updated Product(s) AI Form

APPENDIX B

"AS-IS Process Model"

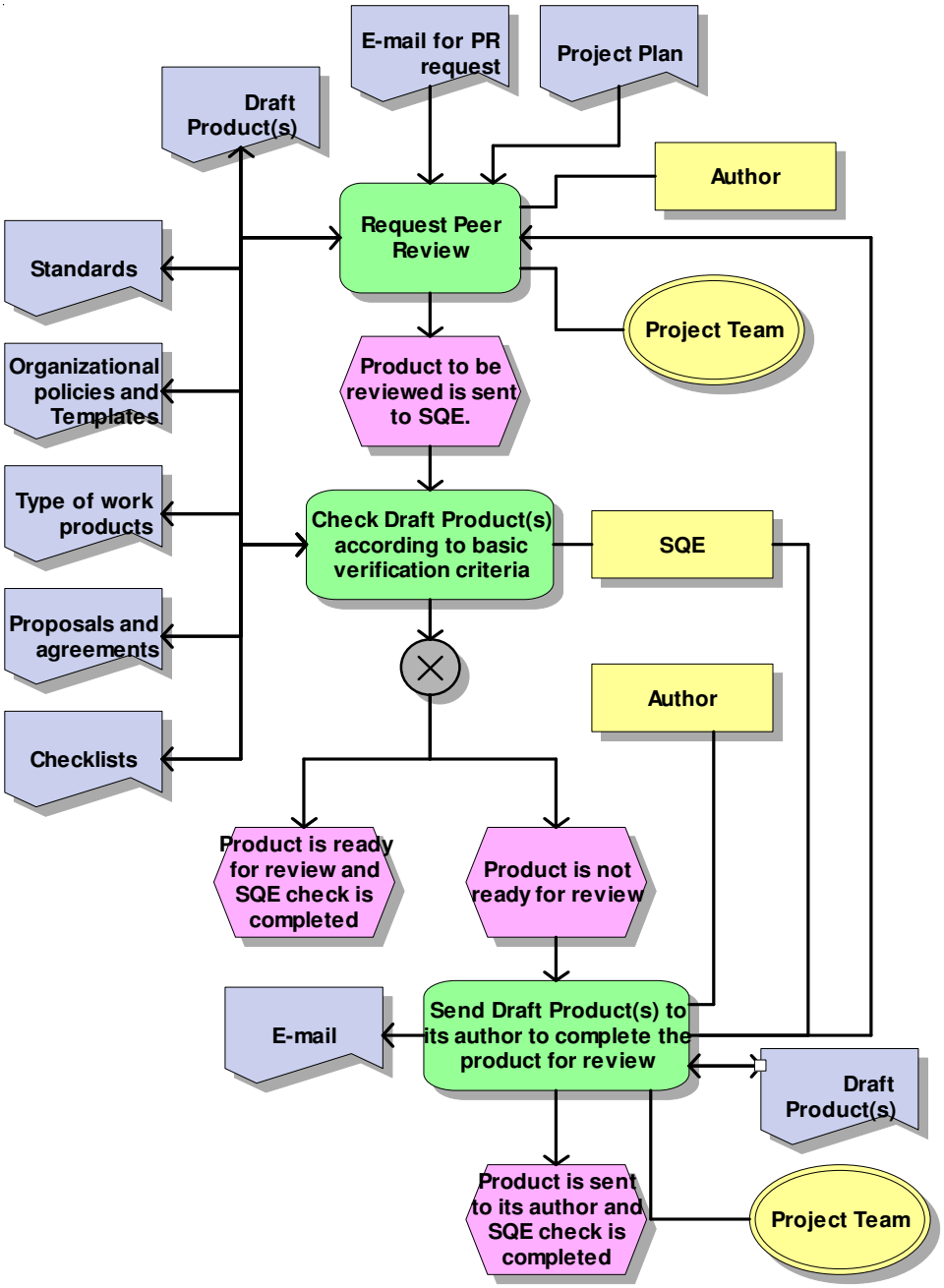

Figure B- 1 AS-IS SQE Check Sub-Process Model

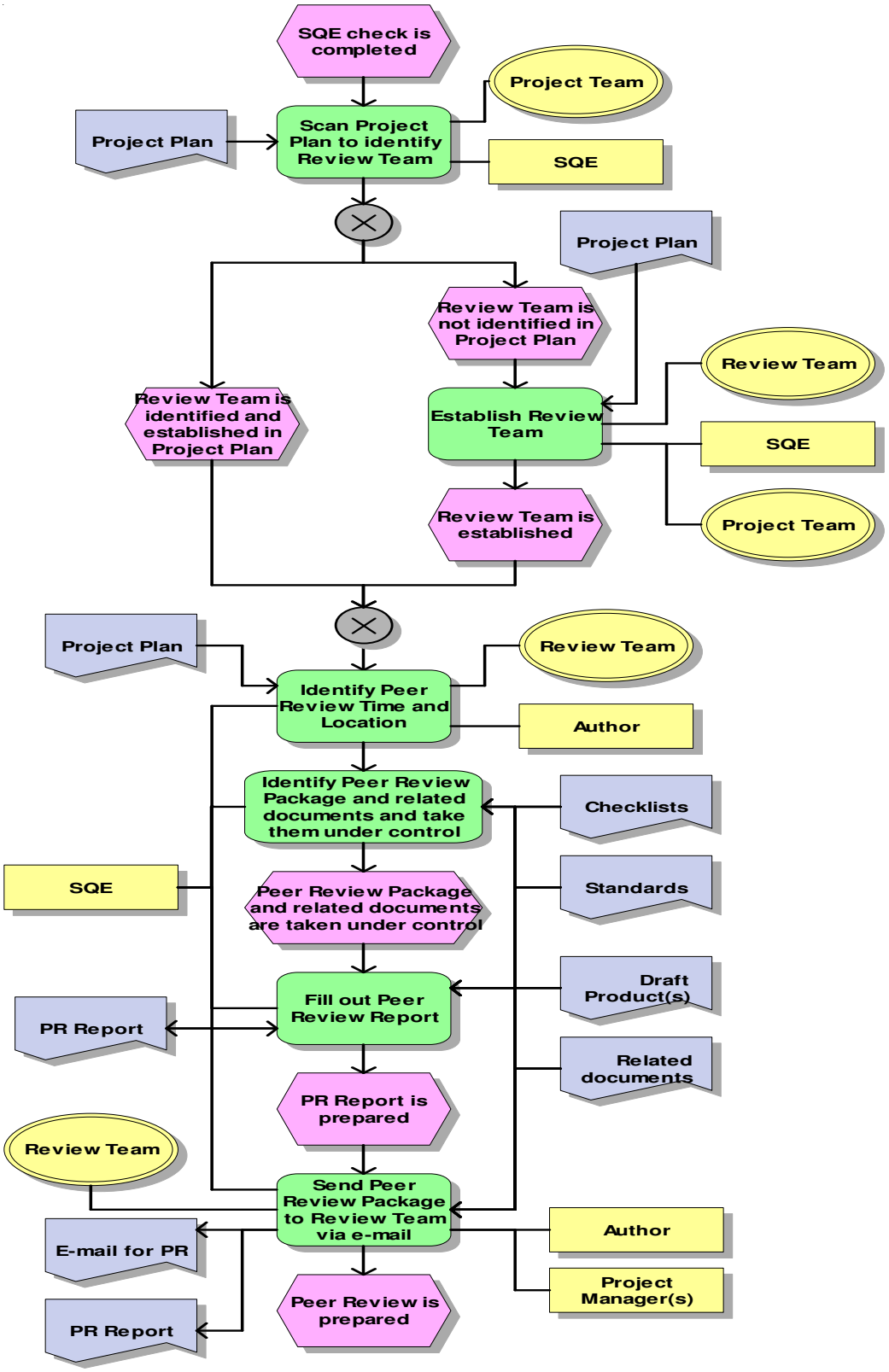

Figure B- 2 AS-IS Prepare Peer Review Sub-Process Model

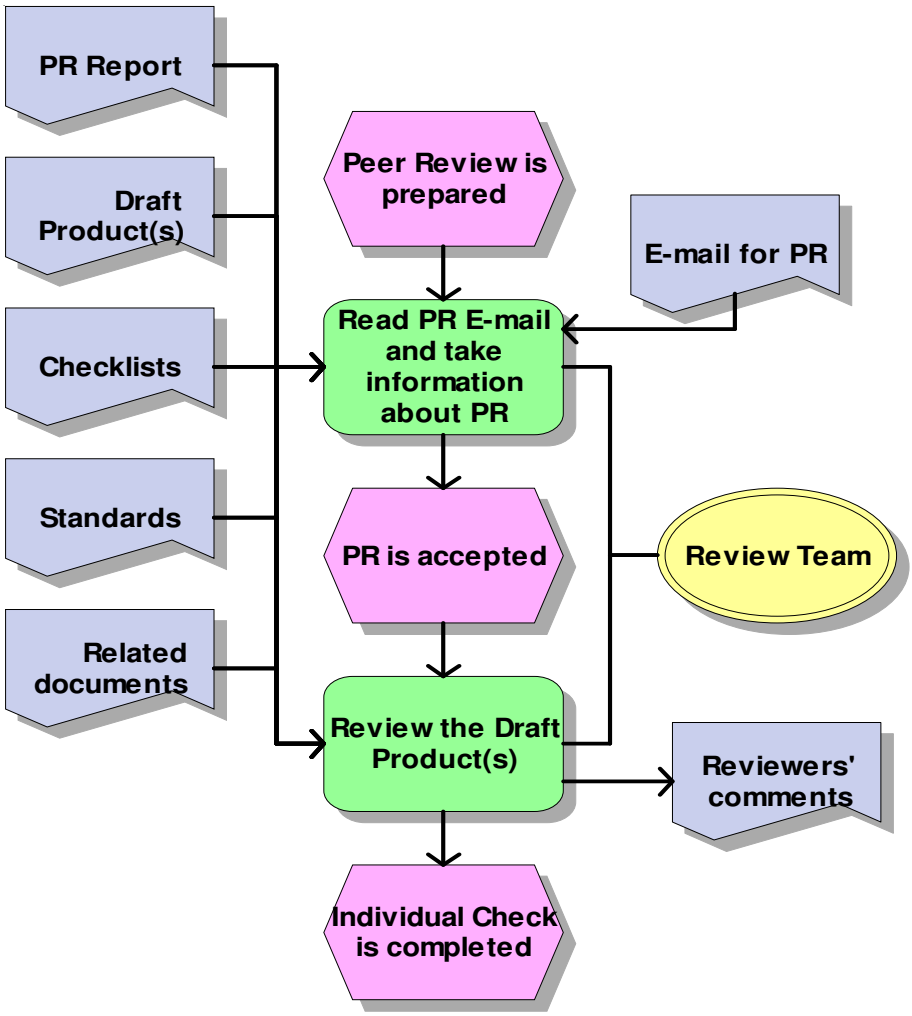

Figure B- 3 AS-IS Individual Check Sub-Process Model

Figure B- 4 AS-IS Internal Review Meeting Sub-Process

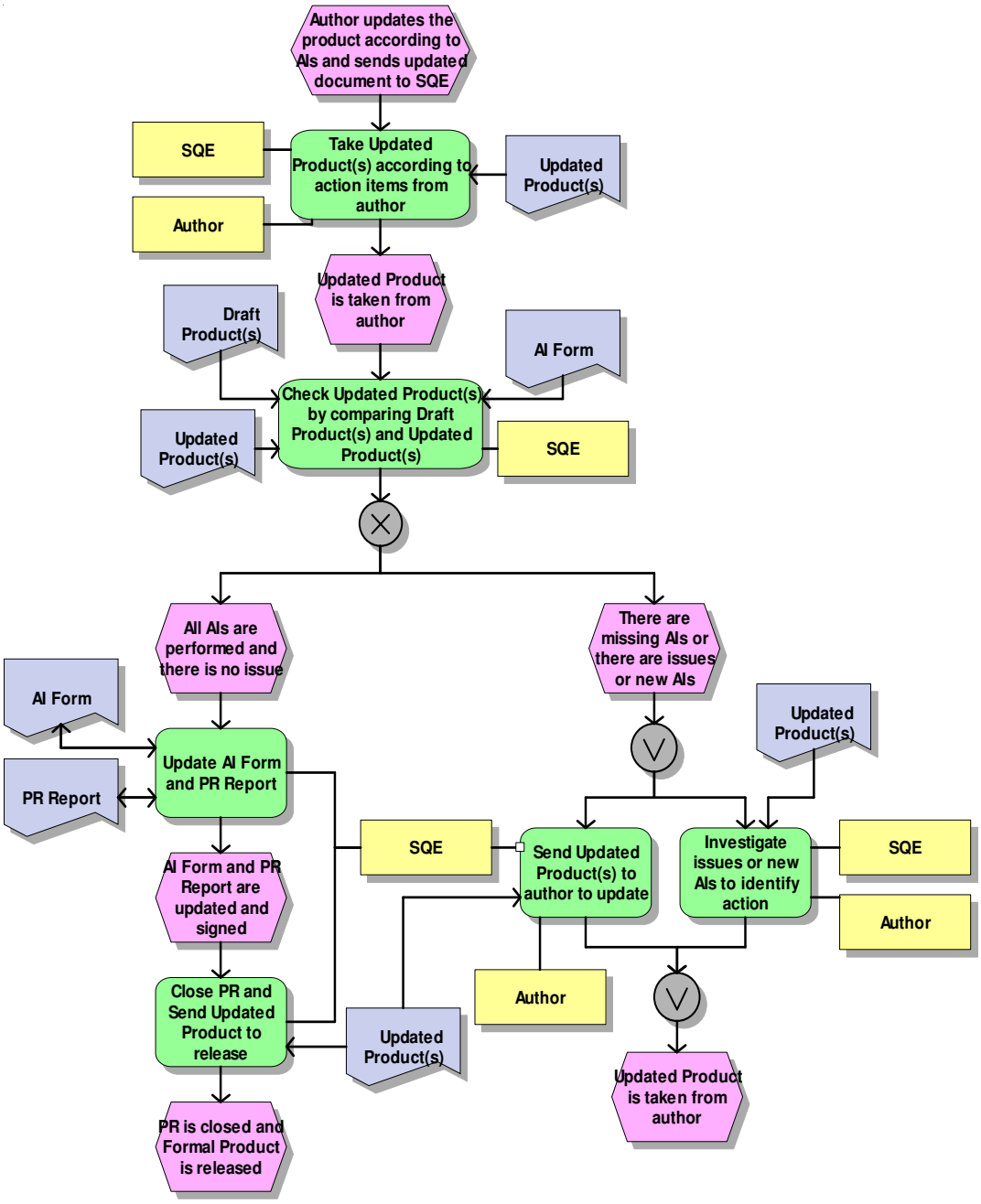

Figure B- 5 AS-IS Peer Review Closure Sub-Process Model

APPENDIX C

"TO-BE Process Activities"

Table C- 1 TO-BE SQE Check Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents/ Archival Records/ Tools/ Applications/ Other Medias
1	Request Peer Review	According to project plan, peer review is requested by project team via e-mail. The author prepares the Draft Product(s) and submits to SQE to organize a peer review.	Project Team Author	Project Plan E-mail for PR request Draft Product(s) Checklists Standards Organizational Policies and Templates Proposals and Agreements Type of work products
2	Check Draft Product(s) according to basic verification criteria	SQE checks the Draft Product(s) with respect to the following verification criteria: • Peer Review package has been prepared according to applicable Organizational policies and templates. • Peer Review package is complete with required checklists, standards and type of work products. • Peer Review package is consistent with proposals and agreements. After checking, SQE decides whether product is ready for review or not.	SQE	Draft Product(s) Checklists Standards Organizational Policies and Templates Proposals and Agreements Type of work products
3	Send product to its author to complete the product for review	If the product is found inadequate, the SQE informs the Project Team and author via e-mail and sends the Draft Product(s) to its author to complete. Author checks the product(s) and after updating the product(s), again sends the product to SQE for SQE check.	Author SQE Project Team	E-mail Draft Product(s)

Table C- 1 (cont'd)

No	Activity Name	Activity Definition	Staff	Forms/ Documents/ Archival Records/ Tools/ Applications/ Other Medias
4	Check Project Team members and senior staffs to establish the Review Team	Project Plan includes the Peer Review schedule and staff names and their roles and responsibilities. Skills and experiences of the project team members and the senior staffs are investigated with respect to needs of the Draft Product(s) to be reviewed. This activity is performed to define the Review Team of the Peer Review. During these activities, skills and experiences of the staffs are considered carefully. Also, project plan is investigated during establishing Review Team.	Author SQE Project Team Senior Staffs	Employee Database for staff information Project Plan
5	Establish Review Team	Review Team of Peer Review is established and their roles and responsibilities are set. These roles are set according to skills and experiences of the staffs. It is recommended that senior staffs should be chosen as a reviewer during peer reviews.	Project Team SQE Review Team	-

Table C- 2 TO-BE Prepare Peer Review Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents/ Archival Records/ Tools/ Applications/ Other Medias
1	Identify Peer Review time and location	Review Team establish the review time and location according to project schedule defined in Project Plan and the work status of the staffs. During setting peer review time, it is considered that enough time is given to review team for individual reviews.	Review Team SQE Author	Project Plan (by Telephone Conversation or e-mail)
2	Identify Peer Review Package and related documents and take them under control	Review package (Draft Product(s), Standards, and Checklists) and Related Documents are taken under control for Peer Review.	SQE	Draft Product(s) Checklists Standards Related Documents
3	Open PR Tool according to PR ID, time, date, Review Team, etc.	Peer Review tool is opened to prepare the PR. During this activity, SQE enters all information to PR tool. First of all, PR ID, time, date and location are entered. Then, Review Team is established and responsibilities of the team are entered. Related documents are referenced from PR tool to satisfy the access. Also, related metrics for Draft Product(s) are entered to PR tool by SQE. (i.e. If test cases are reviewed, total number of the test steps and total number of the test case are entered)	SQE	PR Tool
4	Fill out Peer Review report	Peer Review Report is prepared by writing all information for the Peer Review (i.e. PR ID, Time, Location, SQE Name, Author Name, Reviewer Name(s), etc.) using PR Tool	SQE	Peer Review Report PR Tool
5	Enter SQE time to PR tool	SQE enters time spent when preparing Peer Review.	SQE	PR Tool SQE Time
6	Send Peer Review package to review team via e-mail	An e-mail is prepared to inform the Review Team, Author and also project managers. This e-mail includes the Peer Review report, Review Package (Draft Product(s), Checklists, Standards, and Related Documents), and short description of the Peer Review. SQE send the Meeting Request for Peer Review	SQE Review Team Project Managers	PR Report E-mail for PR PR Tool Draft Product(s) Checklists Standards Related Documents

Table C- 3 TO-BE Individual Check Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents Archival Records/ Tools/ Applications/ Other Medias
1	Read PR E-mail and take information about PR	Review Team read the Peer Review report and take information about PR. PR E-mail includes information for Draft Product(s), standards, checklists, related documents, PR ID, PR Date, roles and responsibilities, etc. Then, Review Team accepts PR.	Review Team	PR Report E-mail for PR Draft Product(s) Standards Checklists Related Documents
2	Review the Draft Product(s)	Each member individually examines the Draft Product(s) against appropriate review checklists, applicable standards, prior to the review meeting according to their peer review roles assigned and they take notes for comments in Draft Product(s).	Review Team	Draft Product(s) Checklists Standards Reviewers' Comments
3	Enter comments to PR Tool	Reviewer Team enter their comments by using Peer Review tool. Each comment includes specific number /section /step /requirement /etc of the Draft Product(s) to be reviewed. All reviewers enter their comments before PR Meeting.	Review Team	PR Tool Reviewers' Comments
4	Respond the reviewers' comments	Author reads all Reviewers' comments to Draft Product(s) and gives response to each comment as "Agree", "Disagree", and "Discuss in Peer Review Meeting" and "Investigate" before PR Meeting. Author enters his/her response to all comments before PR Meeting.	Author	PR Tool Reviewers' Comments Author's Responses
5	Check author's responses to reviewers' comments	Review Team check the author's responses before Peer Review Meeting. Necessary investigations can be performed before Peer Review Meeting.	Review Team Author	PR Tool Reviewers' Comments Author's Responses
6	Enter Reviewers' Review Time via PR Tool	After finishing entering comments and reading the author response, each reviewer enters his/her review time to PR Tool.	Review Team	PR Tool Review Time
7	Enter Author's Response Time via PR Tool	Author enters his/her response time to PR Tool.	Author	PR Tool Response Time

Table C- 4 TO-BE Internal Review Meeting Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents Archival Records/ Tools/ Applications/ Other Medias
1	Check whether Peer Review is ready or not at PR time	SQE checks that Review Team review all Draft Product(s) and give their comments by using PR Tool and author gives the response to all reviewers' comments using PR Tool. Author must respond all comments of reviewers before PR is started. Then, SQE is sure that Review Team and Author are available in PR time.	SQE Author Review Team	PR Tool
2	Postpone/Cancel Peer Review Meeting	If author/SQE/Review Team is not ready for Peer Review, peer review is re-scheduled if the remaining time is known or cancelled to be re-scheduled later if there is no information when PR Meeting can be performed.	SQE Author Review Team	PR Tool
3	Start Peer Review Meeting	Peer Review Meeting is started using PR Tool by SQE.	SQE	PR Tool Draft Product(s) Checklists Standards Related Documents Author's Responses Reviewers' Comments PR Report
4	Review all Reviewers' comments and author's responses and take action items	During Peer Review Meeting, each comment are checked by Review Team and agreed with the responses. After checking all comments and responses, PR Action Items are taken using PR Tool. This activity is performed until all reviewers' comments are checked in PR Meeting.	SQE Author Review Team	PR Tool AI Form Author's Responses Reviewers' Comments

Table C- 4 (cont'd)

No	Activity Name	Activity Definition	Staff	Forms/ Documents Archival Records/ Tools/ Applications/ Other Medias
5	Conclude the PR Meeting	After all comments and responses are examined, Review Team take an exit decision to determine if Draft Product(s) meets the review completeness criteria defined in the Quality Assurance Plan. SQE, having the review team's agreement, identifies the product disposition as one of the following: • Accept as is • Revise with no further review • Revise and schedule another review	SQE Author Review Team	PR Tool AI Form
6	Update PR Report and AI Form	Peer Review finish time is entered to PR Report by SQE using PR Tool, then signed with Reviewer Team. Also, AIs are checked and AI Form is updated.	SQE	PR Tool AI Form PR Report
7	Save and Exit	PR is saved in PR Tool and PR Tool is closed (PR Report and AI Form are saved).	SQE	PR Tool AI Form PR Report

Table C- 5 TO-BE Peer Review Closure Sub-Process Activities

No	Activity Name	Activity Definition	Staff	Forms/ Documents Archival Records/ Tools/ Applications/ Other Medias
1	Take Updated Product(s) according to action items from author	Author sends the Updated Product(s) updated according to action items to SQE.	SQE Author	Updated Product(s)
2	Check Updated Product(s) by comparing Draft Product(s) and Updated Product(s)	SQE checks the all action items on Updated Product(s) by comparing Updated Product(s) and Draft Product(s). The differences between two products must be explained by action items.	SQE	Draft Product(s) Updated Product(s) AI Form
3	Close all AIs using PR Tool	If all AIs are performed and there is no issue, SQE closes all action items using PR Tool.	SQE	PR Tool
4	Update AI Form and PR Report	SQE updates AI Form and PR Report using PR Tool and take note the closure date to both documents.	SQE	AI Form PR Report PR Tool
5	Enter SQE Closure time	SQE enters his/her closure time to PR Tool.	SQE	PR Tool Closure Time
6	Enter Author Update time	SQE enters author update time to PR Tool.	SQE	PR Tool Update Time
7	Close PR and Send Updated Product(s) to release	After all AIS are closed and SQE Closure time and Author Update time are entered, SQE closes PR using PR Tool. Then, SQE sends Updated Product(s) for formal release.	SQE	PR Tool Updated Product(s)
8	Investigate issues or new AIs to identify action	If there are issues or new AIs, SQE and author investigate issues or new AIs and identify the action. At this point, if new issues or new AIs cause any update, SQE sends Updated Product(s) to author. Also, SQE updates AI Form.	SQE Author	Updated Product(s) AI Form
9	Send Updated Product(s) to author to update	If there are missing AIs, SQE sends Updated Product(s) to author to perform missing AI(s).	SQE Author	Updated Product(s) AI Form

APPENDIX D

"TO-BE Process Model"

Figure D- 1 TO-BE SQE Check Sub-Process Model

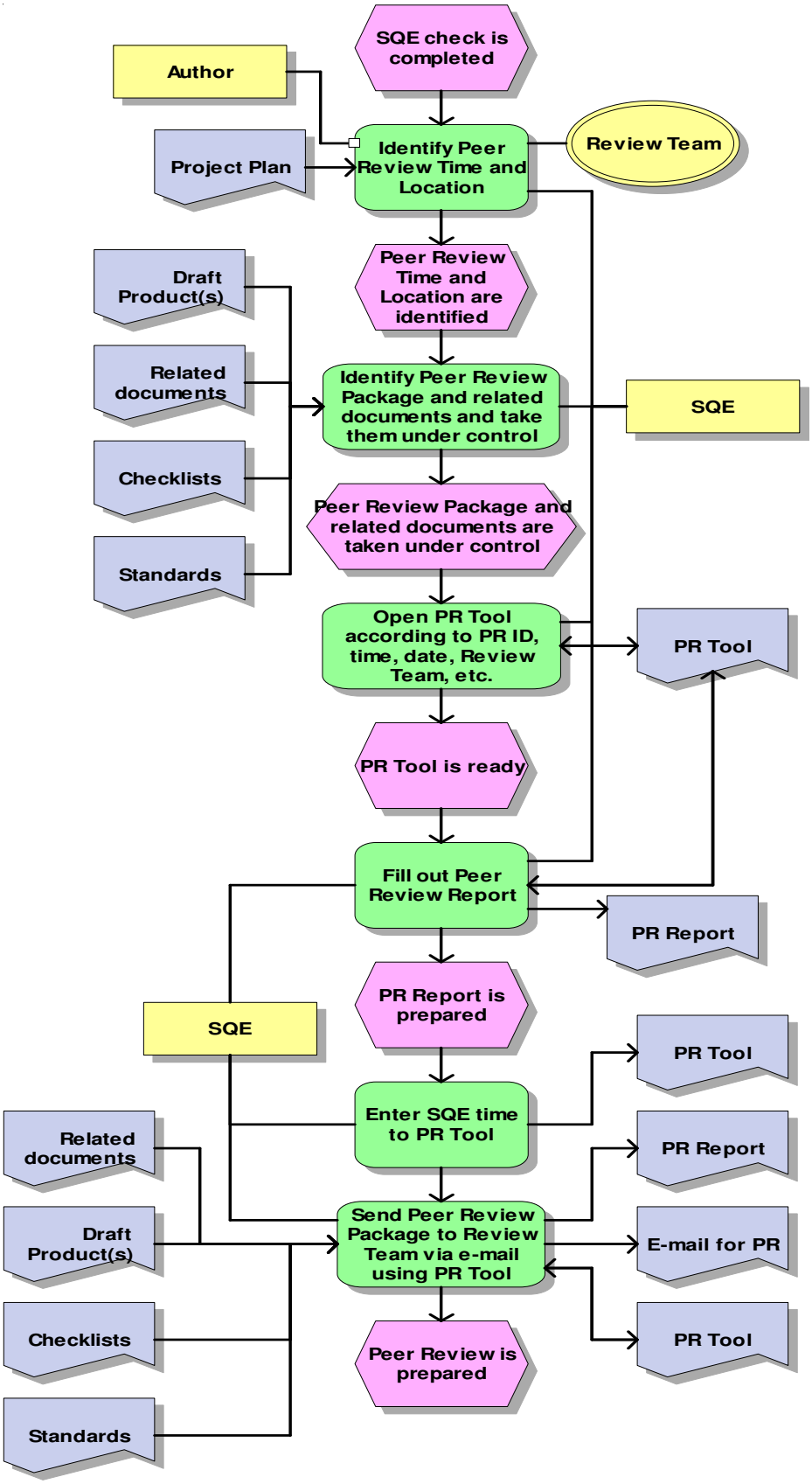

Figure D- 2 TO-BE Prepare Peer Review Sub-Process Model

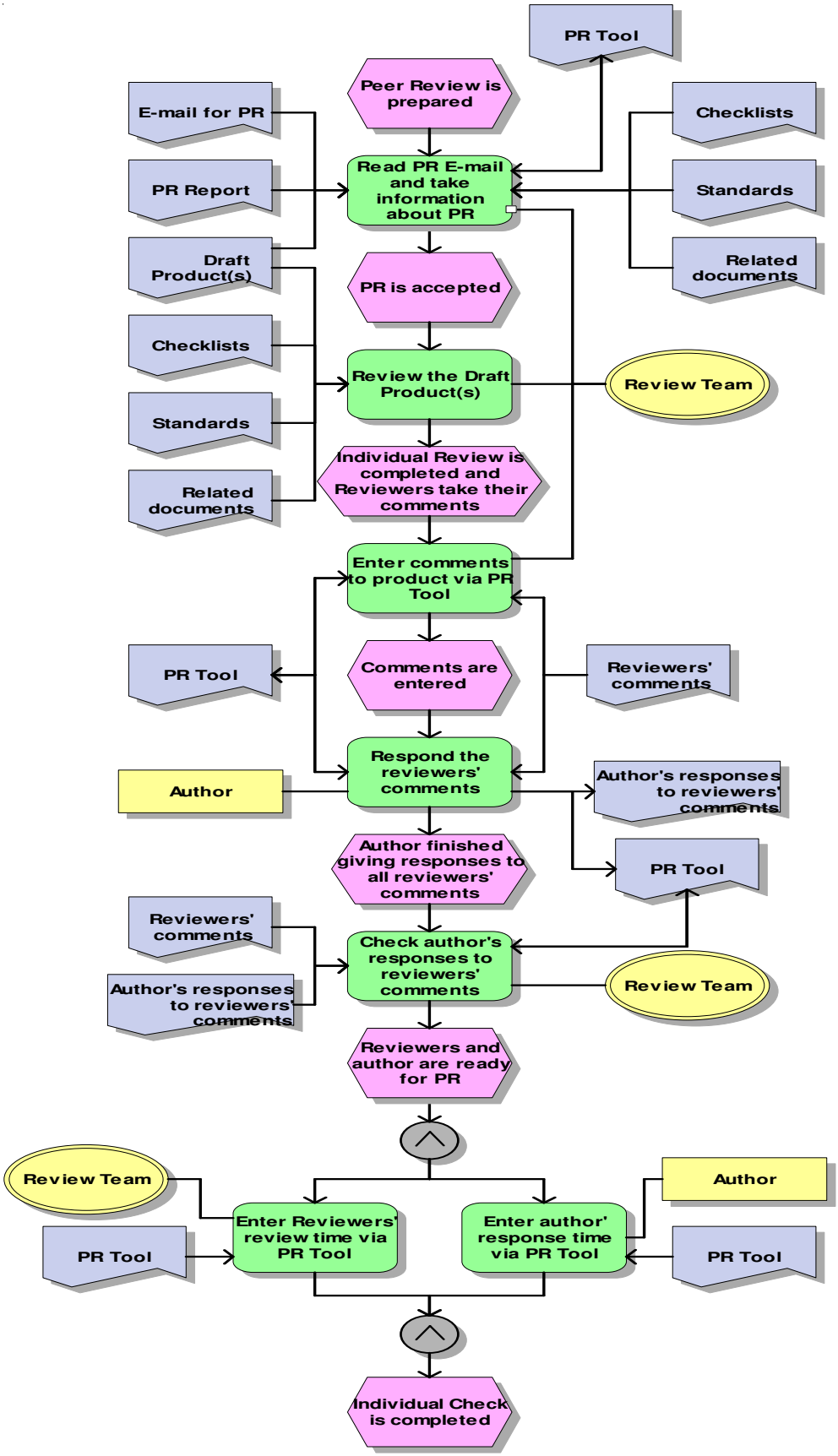

Figure D- 3 TO-BE Individual Check Sub-Process Model

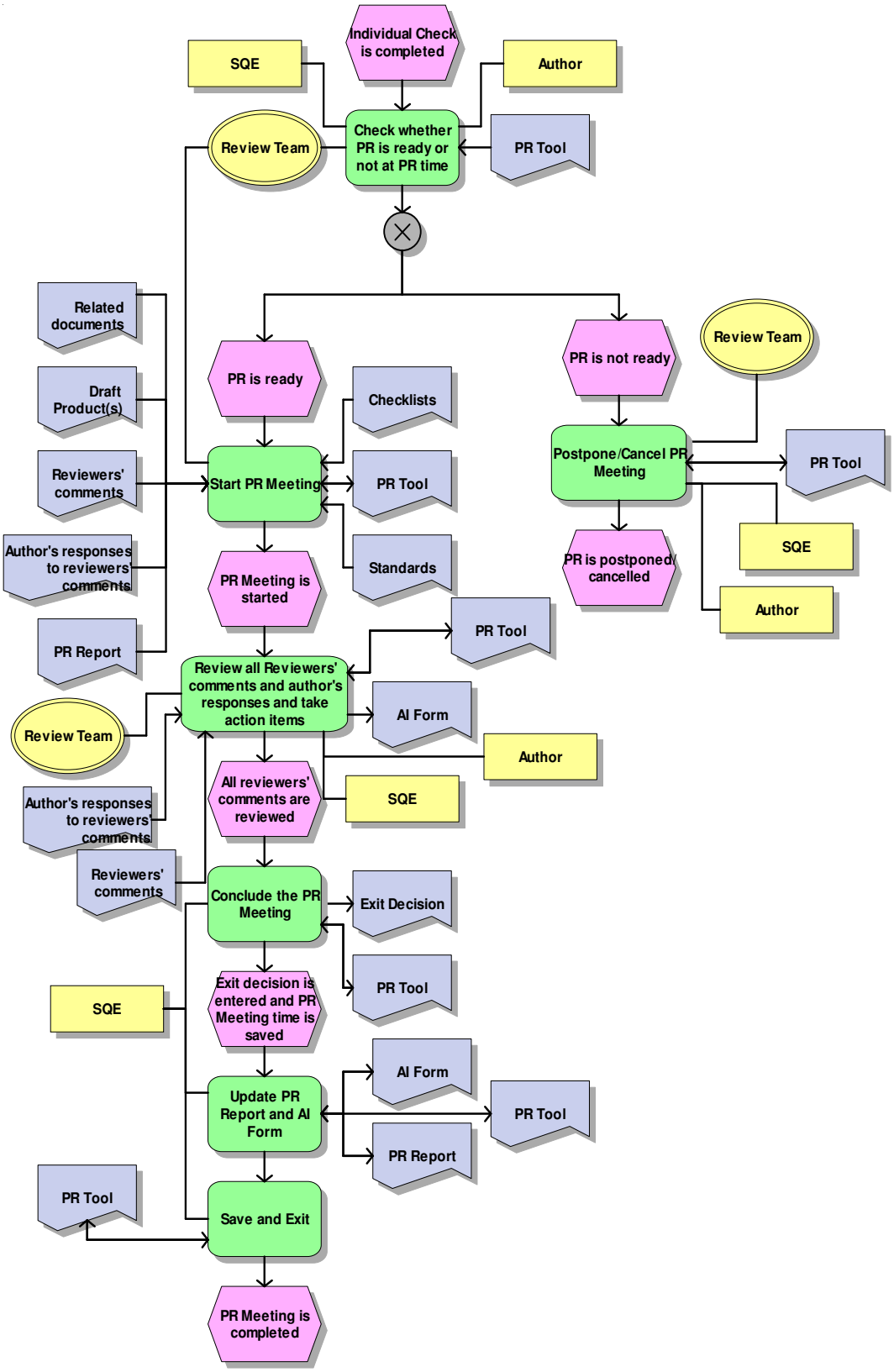

Figure D- 4 TO-BE Internal Review Meeting Sub-Process Model

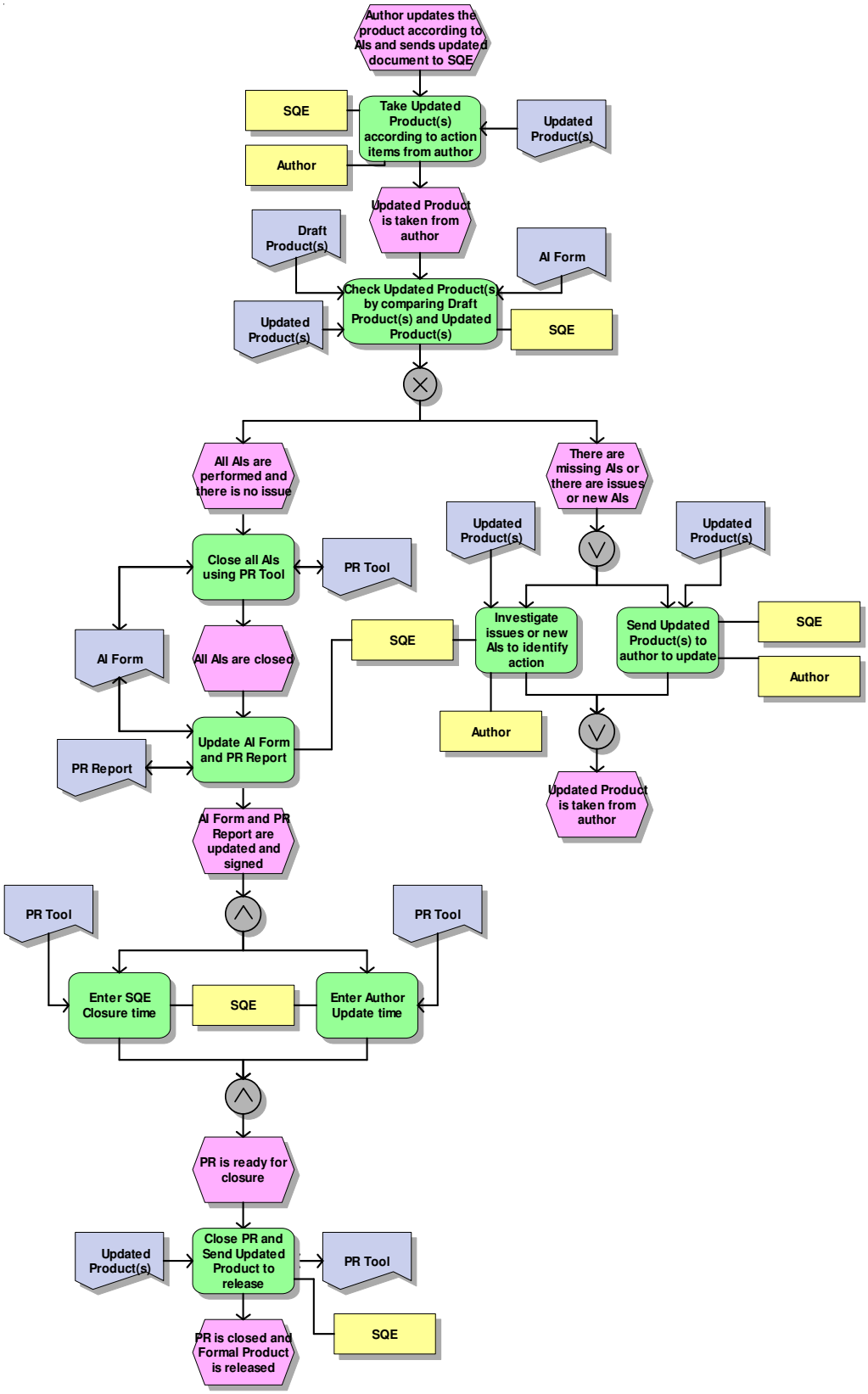

Figure D- 5 TO-BE Peer Review Closure Sub-Process Model

APPENDIX E

"Detail Measurement Results of the Sub-Processes"

Table E- 1 AS-IS SQE CHECK (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Semi-Structured	No interaction	No review, inspection, checkpoint or similar techniques
2	Structured	Interaction with Prepare Peer Review sub-process (sending Draft Product(s) to be reviewed, E-mail for PR Meeting)	SQE checks the Draft Product(s) with respect to basic verification criteria
3	No decision	No interaction	No review, inspection, checkpoint or similar techniques

Table E- 2 AS-IS SQE CHECK (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Not recorded	No restoration	Adequate	-
2	Not recorded	No restoration	Adequate	-
3	Not recorded	No restoration	Adequate	-

Table E- 3 AS-IS SQE CHECK (from 8 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	Computer environment is used.	Draft Product(s), Type of Work Products, Checklists, Standards, Organizational Policies and Templates, Proposals and Agreements, E-mail for PR Request and Project Plan are prepared in computer environment and tool applications.	Accuracy requirement: Author should be sure that his/her product(s) is/are ready for PR.
2	Computer environment is used.	Draft Product(s), Type of Work Products, Checklists, Standards, Organizational Policies and Templates, and Proposals and Agreements are prepared in computer environment and tool applications.	Accuracy requirement: SQE should check Draft Product(s) readiness.
3	Computer environment is used.	Draft Product(s) and E-mail are prepared in computer environment and tool applications.	Accuracy requirement: SQE should be sure that Draft Product(s) is not adequate according to basic verification criteria.

Table E- 4 AS-IS SQE CHECK (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	No interaction	Access auditability: All staffs can search PR package.	No difficulties or misunderstandings	Described.
2	Interaction with Prepare Peer Review sub-process (sending Draft Product(s) to be reviewed, E-mail for PR Meeting)	Access auditability All staffs can search PR package. Only SQE has write access to PR folder.	No difficulties or misunderstandings	Described.
3	No interaction	Access auditability All staffs can search PR package.	No difficulties or misunderstandings	Described.

Table E- 5 AS-IS SQE CHECK (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input validity checking for readiness of the peer review package by project team.	Not recorded	Attractive interaction
2	Input validity checking for readiness of the peer review package by SQE.	Not recorded	Attractive interaction
3	No input validity checking.	Not recorded	Attractive interaction

Table E- 6 TO-BE SQE CHECK (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Semi-structured	No interaction	No review, inspection, checkpoint or similar techniques
2	Structured	Interaction with Prepare Peer Review sub-process (sending Draft Product(s) to be reviewed, E-mail for PR Meeting)	SQE checks the Draft Product(s) with respect to basic verification criteria
3	No decision	No interaction	No review, inspection, checkpoint or similar techniques
4	Semi-structured	No interaction	SQE checks Project Team members and senior staffs to establish the Review Team
5	No decision	Interaction with Prepare Peer Review sub-process (Review Team is established).	No review, inspection, checkpoint or similar techniques

Table E- 7 TO-BE SQE CHECK (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Not Recorded	No restoration	Adequate	-
2	Not Recorded	No restoration	Adequate	-
3	Not Recorded	No restoration	Adequate	-
4	Not Recorded	No restoration	Adequate	-
5	Recorded in PR Report	Restoration from PR Tool database backup.	Adequate	-

Table E- 8 TO-BE SQE CHECK (from 8 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	Computer environment is used.	Draft Product(s), Type of Work Products, Checklists, Standards, Organizational Policies and Templates, Proposals and Agreements, E-mail for PR Request and Project Plan are prepared in computer environment and tool applications.	Accuracy requirement: Author should be sure that his/her product(s) is/are ready for PR.
2	Computer environment is used.	Draft Product(s), Type of Work Products, Checklists, Standards, Organizational Policies and Templates, and Proposals and Agreements are prepared in computer environment and tool applications.	Accuracy requirement: SQE should check Draft Product(s) readiness.
3	Computer environment is used.	Draft Product(s) and E-mail are prepared in computer environment and tool applications.	Accuracy requirement: SQE should be sure that Draft Product(s) is not adequate according to basic verification criteria.
4	Computer environment is used.	Project Plan is prepared in computer environment	Accuracy requirement: SQE and Project Team should be sure about reviewers. Reviewers should be chosen according to their skills and experiences.
5	Computer environment is used.	No forms, documents, archival records or other similar documents that are prepared, updated, deleted or searched	Accuracy requirement: SQE should check Review Team

Table E- 9 TO-BE SQE CHECK (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	No interaction	Access auditability: All staffs can search PR package.	No difficulties or misunderstandings	Described.
2	Interaction with Prepare Peer Review sub-process (sending Draft Product(s) to be reviewed, E-mail for PR Meeting)	Access auditability All staffs can search PR package. Only SQE has write access to PR folder.	No difficulties or misunderstandings	Described.
3	No interaction	Access auditability All staffs can search PR package.	No difficulties or misunderstandings	Described.
4	No interaction	Access Auditability Each staff can search his/her information. Also, team leader can search in Employee database.	No difficulties or misunderstandings	Described.
5	Interaction with Prepare Peer Review sub-process (Peer Review Team is established).	Access Auditability Only SQE has write access to SQA documents. All staffs have read access on SQA records.	No difficulties or misunderstandings	Described.

Table E- 10 TO-BE SQE CHECK (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input validity checking for readiness of the peer review package by project team.	Not Recorded	Attractive interaction
2	Input validity checking for readiness of the peer review package by SQE.	Not Recorded	Attractive interaction
3	No input validity checking.	Not Recorded	Attractive interaction
4	Input validity checking for skills and experiences of the project team and senior staffs.	Not Recorded	Attractive interaction
5	Input validity checking for review team members.	Recorded, undoability of PR Report	Attractive interaction

Table E- 11 AS-IS PREPARE PEER REVIEW (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Semi-Structured	No interaction	Project Plan is checked to establish the review team.
2	No decision	Interaction with Individual Check sub-process (Review Team is established)	No review, inspection, checkpoint or similar techniques
3	Semi-Structured	Interaction with PR Meeting sub-process (PR Time and Location is established).	Review Team decides review time and location
4	Structured	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Package is defined).	Peer Review Package and related documents are checked
5	Structured	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Report is sent).	No review, inspection, checkpoint or similar techniques
6	Structured	Interaction with PR Meeting sub-process and Individual Check sub-process (E-mail is sent).	No review, inspection, checkpoint or similar techniques

Table E- 12 AS-IS PREPARE PEER REVIEW (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Not Recorded	No restoration	Inadequate	-
2	Recorded in PR Report and PR Folder	Restoration from PR folder backup.	Inadequate	-
3	Recorded in PR Report and PR Folder	Restoration from PR folder backup.	Adequate	-
4	Recorded in PR Folder	Restoration from PR folder backup.	Adequate	-
5	Recorded in PR Report and PR Folder	Restoration from PR folder backup.	Adequate	-
6	Not Recorded	No restoration	Adequate	-

Table E- 13 AS-IS PREPARE PEER REVIEW (from 8 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	No IT usage	Project Plan is prepared in computer environment.	No specific accuracy requirement
2	No IT usage	Project Plan is prepared in computer environment.	No specific accuracy requirement
3	No IT usage	Project Plan is prepared in computer environment.	Accuracy requirement: Review Team should discuss PR time and location
4	PR Folder is used (in Network)	Checklists, standards, related documents and Draft Product(s) are prepared in computer environment.	Accuracy requirement: Review package should be identified.
5	PR Folder is used (in Network)	Checklists, standards, related documents, Draft Product(s) and PR Report	No specific accuracy requirement
6	E-mail is used	E-mail and PR Report are prepared in computer environment.	No specific accuracy requirement

Table E- 14 AS-IS PREPARE PEER REVIEW (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	No interaction	Access Auditability All staffs have read access and project manager has write access also.	Difficulties or misunderstandings in establishing review team.	Described.
2	Interaction with Individual Check sub-process (Review Team is established)	Access Auditability Only SQE has write access to SQA documents. All staffs have read access on SQA records.	Difficulties or misunderstandings in establishing review team.	Described.
3	Interaction with PR Meeting sub-process (PR Time and Location is established).	Access Auditability Only SQE has write access to SQA documents. All staffs have read access on SQA records.	No difficulties or misunderstandings	Described.
4	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Package is defined).	Access Auditability Only SQE has write access to SQA documents. All staffs have read access on SQA records.	No difficulties or misunderstandings	Described.
5	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Report is sent).	Access Auditability Only SQE has write access to SQA documents. All staffs have read access on SQA records.	No difficulties or misunderstandings	Described.
6	Interaction with PR Meeting sub-process and Individual Check sub-process (E-mail is sent).	Access Auditability Only SQE has write access to SQA documents. All staffs have read access on SQA records.	No difficulties or misunderstandings	Described.

Table E- 15 AS-IS PREPARE PEER REVIEW (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input Validity Checking for project plan	Not Recorded	No attractive interaction. PMP cannot be used during this activity.
2	Input Validity Checking for establishing review team	Not Recorded	No attractive interaction. There is no enough information about how the Review Team is established.
3	Input Validity Checking for defining PR location and time.	Recorded, undoability of PR Report and PR Folder	Attractive interaction
4	Input Validity Checking for identifying PR package.	Recorded, undoability of PR Folder	No attractive interaction. It is hard to take PR Package under control.
5	No Input Validity Checking	Recorded, undoability of PR Report and PR Folder	No attractive interaction. Reports are prepared manually.
6	No Input Validity Checking	Not Recorded	No attractive interaction. E-mail is prepared manually.

Table E- 16 TO-BE PREPARE PEER REVIEW (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Semi-Structured	Interaction with PR Meeting sub-process (PR Time and Location is established).	Review Team decides review time and location
2	Structured	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Package is defined).	Identify Peer Review Package and related documents are checked
3	Structured	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Tool is used during PR).	PR Tool is checked
4	Structured	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Report is sent).	No review, inspection, checkpoint or similar techniques
5	Structured	No interaction	No review, inspection, checkpoint or similar techniques
6	Structured	Interaction with PR Meeting sub-process and Individual Check sub-process (E-mail is sent).	No review, inspection, checkpoint or similar techniques

Table E- 17 TO-BE PREPARE PEER REVIEW (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Recorded in PR Report and PR Tool	Restoration from PR Tool database and PR folder backups.	Adequate	-
2	Recorded in PR Report and PR Folder	Restoration from PR Tool database and PR folder backups.	Adequate	-
3	Recorded in PR Report and PR Tool	Restoration from PR Tool database and PR folder backups.	Adequate	-
4	Recorded in PR Report and PR Tool	Restoration from PR Tool database and PR folder backups.	Adequate	-
5	Recorded in PR Tool	Restoration from PR Tool database backup.	Adequate	-
6	Recorded in PR Tool	Restoration from PR Tool database backup.	Adequate	-

Table E- 18 TO-BE PREPARE PEER REVIEW (from 6 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	PR Tool and PR Folder are used	Project Plan is prepared in computer environment.	Accuracy requirement: Review Team should discuss PR time and location
2	PR Tool and PR Folder are used	Draft Product(s), Related Documents, Checklists and Standards are prepared in computer environment.	Accuracy requirement: Review package should be identified.
3	PR Tool and PR Folder are used	PR Tool is used.	Accuracy requirement PR Tool should be opened and then checked.
4	PR Tool and PR Folder are used	PR Tool is used and PR Report is prepared using PR Tool.	No specific accuracy requirement
5	PR Tool is used	PR Tool is used.	Accuracy requirement: SQE preparation time should be checked and entered to PR Tool
6	PR Tool is used	All of them are prepared in computer environment and PR Tool.	No specific accuracy requirement

Table E- 19 TO-BE PREPARE PEER REVIEW (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	Interaction with PR Meeting sub-process (PR Time and Location is established).	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
2	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Package is defined).	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
3	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Tool is used during PR).	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
4	Interaction with PR Meeting sub-process and Individual Check sub-process (PR Report is sent).	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
5	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
6	Interaction with PR Meeting sub-process and Individual Check sub-process (E-mail is sent).	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.

Table E- 20 TO-BE PREPARE PEER REVIEW (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input Validity Checking for PR time and location.	Recorded, undoability of PR Report and PR Tool	Attractive interaction
2	Input Validity Checking for identifying PR package.	Recorded, undoability of PR Report and PR Folder	Attractive interaction
3	No Input Validity Checking	Recorded, undoability of PR Report and PR Tool	Attractive interaction
4	Input Validity Checking for PR Tool	Recorded, undoability of PR Report and PR Tool	Attractive interaction
5	Input Validity Checking for SQE preparation time	Recorded, undoability of PR Tool	Attractive interaction
6	No Input Validity Checking	Recorded, undoability of PR Tool	Attractive interaction

Table E- 21 AS-IS INDIVIDUAL CHECK (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Structured	Interaction with Prepare Peer Review sub-process (PR e-mail is taken).	Review Team checks the PR information.
2	Semi-Structured	Interaction with SQE Check sub-process (PR package is used).	Reviewers check Draft Product(s)

Table E- 22 AS-IS INDIVIDUAL CHECK (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Not Recorded	No restoration	Adequate	-
2	Recorded as Soft/Hard copies by reviewers	No restoration	Adequate	-

Table E- 23 AS-IS INDIVIDUAL CHECK (from 8 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	For all, computer environment is used.	PR report, Draft Product(s), standards, checklists, e-mail and related documents are prepared in computer environment.	Accuracy requirement: Review Team should check PR information.
2	No IT usage (Computer environment may be used)	Candidate defects found list may not be prepared in computer environment.	Accuracy requirement: All reviewers should be sure that they review Draft Product(s) completely according to their assignments regarding to checklists, standards, etc.

Table E- 24 AS-IS INDIVIDUAL CHECK (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	Interaction with Prepare Peer Review sub-process (PR e-mail is taken).	Access Auditability. Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
2	Interaction with SQE Check sub-process (PR package is used).	No Access auditability	Difficulties or misunderstandings in writing comments and discussing issues.	Described.

Table E- 25 AS-IS INDIVIDUAL CHECK (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input Validity Checking for PR date and location.	Not Recorded	Attractive interaction
2	Input Validity Checking for Draft Product(s).	Recorded but can not be undoing.	No attractive interaction. There is a problem about recording reviewers' comments.

Table E- 26 TO-BE INDIVIDUAL CHECK (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Structured	Interaction with Prepare Peer Review sub-process (PR e-mail is taken).	Review Team checks the PR information.
2	Semi-Structured	Interaction with SQE Check sub-process (PR package is used).	Reviewers check Draft Product(s)
3	Structured	Interaction with Internal Review Meeting sub-process (Comments and responses are checked in PR Meeting).	Reviewers check their comments and enter them to PR Tool.
4	Semi-Structured	Interaction with Internal Review Meeting sub-process (Comments and responses are checked in PR Meeting).	Author checks reviewer's comments and gives his/her responses.
5	Semi-Structured	Interaction with Internal Review Meeting sub-process (Comments and responses are checked in PR Meeting).	Reviewers check author's responses to their own comments.
6	Structured	No interaction	Reviewers check their own review time and enter these time to PR tool
7	Structured	No interaction	Author checks his/her response time and enters this time to PR tool

Table E- 27 TO-BE INDIVIDUAL CHECK (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Not Recorded	No restoration	Adequate	-
2	Recorded as Soft/Hard copies by reviewers	No restoration	Adequate	-
3	Recorded in PR Tool	Restoration from PR Tool database backup.	Adequate	-
4	Recorded in PR Tool	Restoration from PR Tool database backup.	Adequate	-
5	Recorded in PR Tool	Restoration from PR Tool database backup.	Adequate	-
6	Recorded in PR Tool	Restoration from PR Tool database backup.	Adequate	-
7	Recorded in PR Tool	Restoration from PR Tool database backup.	Adequate	-

Table E- 28 TO-BE INDIVIDUAL CHECK (from 8 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	PR Meeting is set via e-mail by using PR Tool.	PR tool is used and all of them are prepared in computer environment and PR Tool.	Accuracy requirement: Review Team should check PR information.
2	All related data are stored in computer environment.	PR tool is used and all of them are prepared in computer environment and PR Tool.	Accuracy requirement: All reviewers should be sure that they review Draft Product(s) completely according to their assignments regarding to checklists, standards, etc.
3	Comments are entered to PR Tool.	PR tool is used and all of them are prepared in computer environment and PR Tool.	Accuracy requirement: All reviewers should be sure that they enter all comments to PR Tool.
4	Comments are entered to PR Tool.	PR tool is used and all of them are prepared in computer environment and PR Tool.	Accuracy requirement: Author should be sure that he/she gives his/her response to reviewers' comments.
5	Comments are entered to PR Tool.	PR tool is used and all of them are prepared in computer environment and PR Tool.	Accuracy requirement: Reviewers should be sure that author reads their comments and gives responses.
6	Metrics are entered to PR Tool.	PR tool is used and all of them are prepared in computer environment and PR Tool.	Accuracy requirement: Reviewers should be sure that they enter their review time to PR Tool.
7	Metrics are entered to PR Tool.	PR tool is used and all of them are prepared in computer environment and PR Tool.	Accuracy requirement: Author should be sure that he/she enters his/her response time to PR Tool.

Table E- 29 TO-BE INDIVIDUAL CHECK (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	Interaction with Prepare Peer Review sub-process (PR e-mail is taken).	No Access Auditability. Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
2	Interaction with SQE Check sub-process (PR package is used).	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
3	Interaction with Internal Review Meeting sub-process (Comments and responses are checked in PR Meeting).	Access Auditability Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
4	Interaction with Internal Review Meeting sub-process (Comments and responses are checked in PR Meeting).	Access Auditability Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
5	Interaction with Internal Review Meeting sub-process (Comments and responses are checked in PR Meeting).	Access Auditability Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
6	No interaction	Access Auditability Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
7	No interaction	Access Auditability Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.

Table E- 30 TO-BE INDIVIDUAL CHECK (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input Validity Checking for PR date and location.	Not Recorded	Attractive interaction
2	Input Validity Checking for Draft Product(s).	Not Recorded (may not be undo)	Attractive interaction
3	Input Validity Checking for comments that all comments are entered to PR Tool.	Recorded, undoability of PR Tool	Attractive interaction
4	Input Validity Checking for comments that all comments are responded by author.	Recorded, undoability of PR Tool	Attractive interaction
5	Input Validity Checking for responses of the reviewers' comments.	Recorded, undoability of PR Tool	Attractive interaction
6	Input Validity Checking for review time.	Recorded, undoability of PR Tool	Attractive interaction
7	Input Validity Checking for response time.	Recorded, undoability of PR Tool	Attractive interaction

Table E- 31 AS-IS INTERNAL REVIEW MEETING (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Structured	Interaction with Individual Check sub-process	SQE checks whether Peer Review is ready or not at PR time
2	Semi-Structured	Interaction with Individual Check sub-process	Review Team checks Peer Review Meeting time
3	Structured	No interaction	No review, inspection, checkpoint or similar techniques
4	Structured	Interaction with Individual Check sub-process	No review, inspection, checkpoint or similar techniques
5	Semi-Structured	Interaction with Individual Check sub-process	Review Reviewers' comments and action items are checked
6	Semi-Structured	No interaction	No review, inspection, checkpoint or similar techniques
7	Semi-Structured	No interaction	PR exit criteria is checked
8	Structured	No interaction	PR Report is checked
9	Structured	No interaction	No review, inspection, checkpoint or similar techniques

Table E- 32 AS-IS INTERNAL REVIEW MEETING (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Nor recorded	No restoration	Adequate	-
2	Recorded in PR Report	Restoration from PR Folder backup	Adequate	-
3	Recorded in PR Report	Restoration from PR Folder backup	Adequate	-
4	Recorded in PR Report	Restoration from PR Folder backup	Inadequate.	-
5	Not recorded	No restoration	Inadequate.	-
6	Recorded in AI Form	Restoration from PR Folder backup	Adequate	-
7	Recorded in PR Report	Restoration from PR Folder backup	Adequate	-
8	Recorded in PR Report	Restoration from PR Folder backup	Adequate	-
9	Recorded in PR Report	Restoration from PR Folder backup	Adequate	-

Table E- 33 AS-IS INTERNAL REVIEW MEETING (from 8 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	No IT usage	No forms, documents, archival records or other similar documents that are prepared, updated, deleted or searched	Accuracy Requirement: SQE should check whether Peer Review is ready or not at PR time (All reviewers should finish review).
2	No IT usage	No forms, documents, archival records or other similar documents that are prepared, updated, deleted or searched	Accuracy Requirement: If reviewers are not ready for peer review, new meeting should be discussed.
3	No IT usage	All of them are prepared in computer environment	No specific accuracy requirement.
4	No IT usage	PR Report is prepared in computer environment	No specific accuracy requirement.
5	No IT usage	Reviewers' comments may not be prepared in computer environment.	Accuracy Requirement: SQE should be sure that all reviewers' comments are investigated during peer review meeting.
6	IT usage in updating of AI Form. PR Folder is used (in Network)	AI Form is prepared in computer environment	Accuracy Requirement: SQE should be sure that all AIs are written to AI Form.
7	IT usage in updating of AI Form. PR Folder is used (in Network)	PR Report is prepared in computer environment	Accuracy Requirement: Review Team should check exit criteria of the PR
8	IT usage in updating of PR Report. PR Folder is used (in Network)	PR Report is prepared in computer environment	No specific accuracy requirement.
9	PR Folder is used (in Network)	No forms, documents, archival records or other similar documents that are prepared, updated, deleted or searched	No specific accuracy requirement.

Table E- 34 AS-IS INTERNAL REVIEW MEETING (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	Interaction with Individual Check sub-process	No Access Auditability.	No difficulties or misunderstandings	Described.
2	Interaction with Individual Check sub-process	No Access Auditability.	No difficulties or misunderstandings	Described.
3	No interaction	No Access Auditability.	No difficulties or misunderstandings	Described.
4	Interaction with Individual Check sub-process	No Access Auditability.	Difficulties or misunderstandings in how to write effort.	Not Described.
5	Interaction with Individual Check sub-process	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	Difficulties or misunderstandings in how to discuss and write reviewers' comments.	Described.
6	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
7	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
8	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
9	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.

Table E- 35 AS-IS INTERNAL REVIEW MEETING (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input validity checking for readiness of reviewers.	Nor recorded	Attractive interaction
2	No input validity checking	Recorded, undoability of PR Report	Attractive interaction
3	No input validity checking	Recorded, undoability of PR Report	Attractive interaction
4	Input validity checking for preparation time.	Recorded, undoability of PR Report	No attractive interaction. Preparation time is not recorded simultaneously.
5	Input validity checking for reviewers' comments.	Not recorded	No attractive interaction. There is a problem with reviewers' comments records and investigations.
6	No input validity checking.	Recorded, undoability of AI Form	No attractive interaction. AIs are identified in PR Meeting and it is very hard to manage it.
7	No input validity checking	Recorded, undoability of PR Report	Attractive interaction
8	No input validity checking	Recorded, undoability of PR Report	Attractive interaction
9	No input validity checking	Recorded, undoability of PR Report	Attractive interaction

Table E- 36 TO-BE INTERNAL REVIEW MEETING (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Structured	Interaction with Individual Check sub-process	SQE checks whether Peer Review is ready or not at PR time
2	Semi-Structured	Interaction with Individual Check sub-process	Review Team checks Peer Review Meeting time
3	Structured	No interaction	No review, inspection, checkpoint or similar techniques
4	Semi-Structured	Interaction with Individual Check sub-process	Reviewers' comments and author's responses are checked
5	Semi-Structured	No interaction	PR exit criteria is checked
6	Structured	No interaction	PR Report and AI Form are checked
7	Structured	No interaction	No review, inspection, checkpoint or similar techniques

Table E- 37 TO-BE INTERNAL REVIEW MEETING (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Not Recorded	No restoration	Adequate	-
2	Recorded in PR Tool and PR Report	Restoration from PR Tool database..	Adequate	-
3	Recorded in PR Tool and PR Report	Restoration from PR Tool database.	Adequate	-
4	Recorded in PR Tool and AI Form	Restoration from PR Tool database.	Adequate	-
5	Recorded in PR Tool and PR Report	Restoration from PR Tool database.	Adequate	-
6	Recorded in PR Tool and PR Report	Restoration from PR Tool database.	Adequate	-
7	Recorded in PR Tool and PR Report	Restoration from PR Tool database.	Adequate	-

Table E- 38 TO-BE INTERNAL REVIEW MEETING (from 8 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	PR Tool and PR Folder are used.	All documents are prepared/generated/updated/deleted/etc by using PR Tool.	Accuracy Requirement: SQE should check whether Peer Review is ready or not at PR time (All reviewers should finish review).
2	PR Tool and PR Folder are used.	All documents are prepared/generated/updated/deleted/etc by using PR Tool.	Accuracy Requirement: If reviewers are not ready for peer review, new meeting should be discussed.
3	PR Tool and PR Folder are used.	All documents are prepared/generated/updated/deleted/etc by using PR Tool.	Accuracy Requirement: SQE should check PR Tool
4	PR Tool and PR Folder are used.	All documents are prepared/generated/updated/deleted/etc by using PR Tool.	Accuracy requirement: SQE should be sure that all reviewers' comments and author response are checked during PR Meeting using PR Tool.
5	PR Tool and PR Folder are used.	All documents are prepared/generated/updated/deleted/etc by using PR Tool.	Accuracy Requirement: Review Team should check exit criteria of the PR
6	PR Tool and PR Folder are used.	All documents are prepared/generated/updated/deleted/etc by using PR Tool.	Accuracy Requirement: SQE should check and update PR Report and AI Form using PR Tool.
7	PR Tool and PR Folder are used.	All documents are prepared/generated/updated/deleted/etc by using PR Tool.	No specific accuracy requirement.

Table E- 39 TO-BE INTERNAL REVIEW MEETING (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	Interaction with Individual Check sub-process	Access Auditability PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
2	Interaction with Individual Check sub-process	Access Auditability PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
3	No interaction	Access Auditability PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
4	Interaction with Individual Check sub-process	Access Auditability PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
5	No interaction	Access Auditability PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
6	No interaction	Access Auditability PR Tool has different access rights for each staff. Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
7	No interaction	Access Auditability PR Tool has different access rights for each staff. Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.

Table E- 40 TO-BE INTERNAL REVIEW MEETING (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input validity checking for readiness of reviewers.	Recorded, undoability of PR Tool	Attractive interaction
2	Input validity checking for reviewers' comments and author's responses.	Recorded, undoability of PR Tool and PR Report	Attractive interaction
3	No input validity checking	Recorded, undoability of PR Tool and PR Report	Attractive interaction
4	Input Validity Checking for all PR Tool.	Recorded, undoability of PR Tool and AI Form	Attractive interaction
5	No input validity checking	Recorded, undoability of PR Tool and PR Report	Attractive interaction
6	Input Validity Checking for all PR Tool.	Recorded, undoability of PR Tool and PR Report	Attractive interaction
7	No input validity checking	Recorded, undoability of PR Tool and PR Folder	Attractive interaction

Table E- 41 AS-IS PEER REVIEW CLOSURE (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Structured	No interaction	No review, inspection, checkpoint or similar techniques
2	Structured	Interaction with Internal Review Meeting and SQE Check sub-process	SQE checks Updated Product(s) by comparing Draft Product(s) and Updated Product(s)
3	Structured	Interaction with Internal Review Meeting sub-process	AI Form and AI Report are checked
4	Structured	No interaction	No review, inspection, checkpoint or similar techniques
5	Semi-Structured	No interaction	Issues or new AIs are checked
6	Semi-Structured	No interaction	Issues or new AIs are checked

Table E- 42 AS-IS PEER REVIEW CLOSURE (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Recorded in database	Restoration from database backups.	Adequate	-
2	Recorded in database	Restoration from database backups.	Adequate	-
3	Recorded in AI Form, PR Report and PR Folder	Restoration from PR folder backup.	Adequate	-
4	Recorded in PR Report as hard copy and database	Restoration from hard copies of PR records	Inadequate.	-
5	Not recorded	No restoration	Inadequate.	-
6	Not recorded	No restoration	Inadequate.	-

Table E- 43 AS-IS PEER REVIEW CLOSURE (from 8 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	Updated Product(s) is/are prepared in computer environment.	All of them are prepared in computer environment.	No specific accuracy requirement
2	Updated Product(s) and Draft Product(s) are compared by using computer environment and software tools.	All of them are prepared in computer environment.	Accuracy requirement: SQE should be sure about all action items are applied to Draft Product(s) and there is no missing AI.
3	PR folder is used.	All of them are prepared in computer environment.	Accuracy requirement: SQE should check AI Form and PR Report
4	No IT Usage	All of them are prepared in computer environment.	No specific accuracy requirement
5	No IT Usage. PR closure is recorded as hard copy.	All of them are prepared in computer environment.	Accuracy requirement: SQE should check missing AIs or new issues
6	No IT Usage	All of them are prepared in computer environment.	Accuracy requirement: SQE should check that there are missing AIs

Table E- 44 AS-IS PEER REVIEW CLOSURE (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	No interaction	Access auditability Project's development libraries have different access rights.	No difficulties or misunderstandings	Described.
2	Interaction with Internal Review Meeting and SQE Check sub-process	Access auditability Project's development libraries have different access rights. Draft Product(s) and Updated Product(s) also have versions.	No difficulties or misunderstandings	Described.
3	Interaction with Internal Review Meeting sub-process	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
4	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
5	No interaction	No Access auditability	Difficulties or misunderstandings how to manage new issues and missing AIs.	Not Described.
6	No interaction	No Access auditability	Difficulties or misunderstandings how to manage new issues and missing AIs.	Described.

Table E- 45 AS-IS PEER REVIEW CLOSURE (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input validity checking about Updated Product(s).	Recorded, undoability of database	Attractive interaction
2	Input validity checking about Updated Product(s) and Draft Product(s). All action items are checked by SQE.	Recorded, undoability of database	Attractive interaction
3	No input validity checking.	Recorded, undoability of AI Form, PR Report and PR Folder	Attractive interaction
4	No input validity checking.	Recorded, undoability of PR Report and database	No attractive interaction. Since AIs are tracked from hard copies, it is hard to manage it.
5	Input validity checking about new issues.	Not recorded	No attractive interaction. Since problems are not tracked by using any database, it is hard to manage it.
6	No input validity checking.	Not recorded	No attractive interaction. Since new AIs are not entered to any database by author, it is hard to manage it.

Table E- 46 TO-BE PEER REVIEW CLOSURE (from 1 to 3)

Activity Number	Complexity (1)	Coupling (2)	Failure Avoidance (3)
1	Structured	No interaction	No review, inspection, checkpoint or similar techniques
2	Structured	Interaction with Internal Review Meeting and SQE Check sub-processes	SQE checks Updated Product(s) by comparing Draft Product(s) and Updated Product(s)
3	Structured	No interaction	AIs are checked using PR Tool
4	Structured	Interaction with Internal Review Meeting sub-process	AI Form and PR Report are reviewed
5	Structured	No interaction	SQE Closure time is checked
6	Structured	No interaction	Author Update time is checked
7	Structured	No interaction	No review, inspection, checkpoint or similar techniques
8	Semi-Structured	No interaction	Issues or new AIs are checked
9	Semi-Structured	No interaction	Issues or new AIs are checked

Table E- 47 TO-BE PEER REVIEW CLOSURE (from 4 to 7)

Activity Number	Restorability (4)	Restoration Effectiveness (5)	Functional Adequacy (6)	Functional Completeness (7)
1	Recorded in database	Restoration from database backups.	Adequate	-
2	Recorded in database	Restoration from database backups.	Adequate	-
3	Recorded in PR Tool and AI Form	Restoration from PR Tool database and PR folder backups.	Adequate	-
4	Recorded in AI Form, PR Report and PR Tool	Restoration from PR Tool database and PR folder backups.	Adequate	-
5	Recorded in PR Tool	Restoration from PR Tool database and PR folder backups.	Adequate	-
6	Recorded in PR Tool	Restoration from PR Tool database and PR folder backups.	Adequate	-
7	Recorded in AI Form, PR Report, PR Folder and PR Tool	Restoration from PR Tool database and PR folder backups.	Adequate	-
8	Recorded in PR Folder and PR Tool	Restoration from PR Tool database and PR folder backups.	Adequate	-
9	Recorded in PR Folder, database and PR Tool	Restoration from PR Tool database and PR folder backups.	Adequate	-

Table E- 48 TO-BE PEER REVIEW CLOSURE (from 8 to 10)

Activity Number	IT Usage (8)	IT Density (9)	Computational Accuracy (10)
1	Updated Product(s) is/are prepared in computer environment.	All of them are prepared in computer environment and tools.	No specific accuracy requirement
2	Updated Product(s) and Draft Product(s) are compared by using computer environment and software tools.	All of them are prepared in computer environment and tools.	Accuracy requirement: SQE should be sure about all action items are applied to Draft Product(s) and there is no missing AI.
3	PR Tool and PR folder are used.	All of them are prepared in computer environment and tools.	Accuracy requirement: SQE should check all AIs are closed in PR Tool
4	PR Tool and PR folder are used.	All of them are prepared in computer environment and tools.	Accuracy requirement: SQE should check AI Form and PR Report
5	PR Tool and PR folder are used.	All of them are prepared in computer environment and tools.	Accuracy requirement: S QE should checked that time is entered
6	PR Tool and PR folder are used.	All of them are prepared in computer environment and tools.	Accuracy requirement: SQE should checked that time is entered
7	PR Tool and PR folder are used.	All of them are prepared in computer environment and tools.	No specific accuracy requirement
8	PR Tool and PR folder are used.	All of them are prepared in computer environment and tools.	Accuracy requirement: SQE should check missing AIs or new issues
9	PR Tool and PR folder are used.	All of them are prepared in computer environment and tools.	Accuracy requirement: SQE should check that there are missing AIs

Table E- 49 TO-BE PEER REVIEW CLOSURE (from 11 to 14)

Activity Number	Data Exchangeability (11)	Access Auditability (12)	Functional Understandability (13)	Completeness of Documentation (14)
1	No interaction	Access auditability Project's development libraries have different access rights.	No difficulties or misunderstandings	Described.
2	Interaction with Internal Review Meeting and SQE Check sub-processes	Access auditability Project's development libraries have different access rights.	No difficulties or misunderstandings	Described.
3	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
4	Interaction with Internal Review Meeting sub-process	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
5	No interaction	PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
6	No interaction	PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
7	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records Also, PR Tool has different access rights for each staff.	No difficulties or misunderstandings	Described.
8	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.
9	No interaction	Access auditability Only SQE has write access to SQA records. All staffs have read access to SQA records	No difficulties or misunderstandings	Described.

Table E- 50 TO-BE PEER REVIEW CLOSURE (from 15 to 17)

Activity Number	Input Validity Checking (15)	Undoability (16)	Attractive Interaction (17)
1	Input validity checking about Updated Product(s).	Recorded, undoability of database	Attractive interaction
2	Input validity checking about Updated Product(s) and Draft Product(s). All action items are checked by SQE.	Recorded, undoability of database	Attractive interaction
3	Input validity checking about PR Tool.	Recorded, undoability of PR Tool and AI Form	Attractive interaction
4	Input validity checking about PR Tool.	Recorded, undoability of AI Form, PR Report and PR Tool	Attractive interaction
5	Input validity checking for SQE closure time.	Recorded, undoability of PR Tool	Attractive interaction
6	Input validity checking for author update time.	Recorded, undoability of PR Tool	Attractive interaction
7	Input validity checking about PR Tool.	Recorded, undoability of AI Form, PR Report, PR Folder and PR Tool	Attractive interaction
8	Input validity checking about new issues.	Recorded, undoability of PR Folder and PR Tool	Attractive interaction
9	No input validity checking.	Recorded, undoability of PR Folder, PR Tool and database	Attractive interaction

APPENDIX F

S. Güceğlioğlu's Static Process Evaluation Metrics [1]

1. Maintainability Metrics

a. Analyzability Metrics

i. Complexity

Table F- 1 Complexity Metric

Method of application	Count number of decisions which necessitate different branches in the process flow and compare with number of activities
Measurement, formula and data element computations	Each decision type is counted separately. • X (1) = A / B, for structured decisions[(1)] A = Number of structured decisions B = Number of activities • X (2) = A / B, for unstructured decisions[(2)] A = Number of unstructured decisions B = Number of activities • X (3) = A / B, for semi-structured decisions[(3)] A = Number of the semi-structured decisions B = Number of activities
Interpretation of measured value	0 < = X < = 1 The lower value of X (1), X (2), X (3), the better analyzability

[(1)] **Structured Decision:** This type of decision is defined as programmable decision as its' situation is fully understood. Structured decisions are routine and repetitive decisions. Therefore, a well-defined and standard solution can be formed to perform necessary actions.

[(2)] **Unstructured Decision:** In unstructured decision, situation is not clear and requires creative decision. Sometimes, it is a complex problem and necessitates fuzzy logic.

[(3)] **Semi-structured Decision:** This type of decision has characteristics of both structured and unstructured decisions. It may be repetitive and routine, but requires human intuition.

ii. Coupling

Table F- 2 Coupling Metric

Method of application	Count number of interactions with other processes and comparing with number of activities
Measurement, formula and data element computations	X = A / B A = Number of interactions B = Number of activities
Interpretation of measured value	0 < = X < = 1 The lower value of X, the better analyzability

2. Reliability Metrics

a. Fault Tolerance Metrics

i. Failure Avoidance

Table F- 3 Failure Avoidance Metric

Method of application	Count the number of activities in which review, inspection, checkpoint or similar techniques are applied and compare with the number of activities
Measurement, formula and data element computations	X = A / B A = Number of activities in which review, inspection, checkpoint or similar techniques are applied B = Number of activities
Interpretation of measured value	0 < = X < = 1 The higher value of X, the better failure avoidance

b. Recoverability Metrics

i. Restorability

Table F- 4 Restorability Metric

Method of application	Count the number of activities which are recorded and compare with the number of activities
Measurement, formula and data element computations	X = A / B A = Number of activities which are recorded in paper or magnetic environment B = Number of activities
Interpretation of measured value	0 < = X < = 1 The higher value of X, the better restorability

ii. Restoration Effectiveness

Table F- 5 Restoration Effectiveness Metric

Method of application	Count the number of activities which can be restored by using the records in paper based or magnetic environment when an abnormal event occurs and compare with the number of activities
Measurement, formula and data element computations	X = A / B A = Number of activities which can be restored B = Number of activities Another formula for measuring the restoration effectiveness can be given as below: X = A / B A = Number of activities which can be restored B = Number of recorded activities
Interpretation of measured value	0 < = X < = 1 The higher value of X, the better restorability effectiveness

3. Functionality

a. Suitability Metrics

i. Functional Adequacy

Table F- 6 Functional Adequacy Metric

Method of application	Count the number of activities that are adequate for performing the tasks as prescribed in the regulatory documents and compare with the number of activities
Measurement, formula and data element computations	X = A / B A = Number of adequate activities with their definitions in regulatory documents B = Number of activities
Interpretation of measured value	0 < = X < = 1 **THE HİGHER VALUE OF X, THE BETTER FUNCTİONAL ADEQUACY**

ii. Functional Completeness

Table F- 7 Functional Completeness Metric

Method of application	Count the number of missing activities detected in practice and compare with the number of activities described in the regulatory documents (as “activities in theory”)
Measurement, formula and data element computations	X = 1- A / B A = Number of activities which are defined in the regulatory documents of the organization, but forgotten in practice, B = Number of activities
Interpretation of measured value	0 < = X < = 1 The higher value of X, the better functional completeness

b. IT Based Functionality Metrics

i. IT Usage

Table F- 8 IT Usage Metric

Method of application	Count the number of activities in which IT applications are used and compare with the number of activities
Measurement, formula and data element computations	X = A / B A = Number of activities in which IT applications are used for preparation, deletion, updating or searching purposes B = Number of activities
Interpretation of measured value	0 < = X < = 1 The higher value of X, the more IT usage

ii. IT Density

Table F- 9 IT Density Metric

Method of application	Count the number of forms, reports, archival records or other similar documents prepared, updated, deleted or searched by using IT applications and compare with the number of forms, reports, archival records or other similar documents in the process
Measurement, formula and data element computations	X = A / B A = Number of forms, reports, archival records or similar other documents that are prepared, updated, deleted or searched by using IT applications B = Number of forms, documents, archival records or similar other documents in the process
Interpretation of measured value	0 < = X < = 1 The higher value of X, the more IT density

c. Accuracy Metrics

i. Computational Accuracy

Table F- 10 Computational Accuracy Metric

Method of application	Count the number of activities in which accuracy requirements have been implemented as defined in the regulatory document and compare with the number of activities which have specific accuracy requirements
Measurement, formula and data element computations	X = A / B A = Number of activities in which specific accuracy requirements have been implemented, as defined in regulatory document B = Number of activities which have specific accuracy requirements
Interpretation of measured value	0 < = X < = 1. The closer to 1, the more accurate

d. Interoperability Metrics

i. Data Exchangeability

Table F- 11 Data Exchangeability Metric

Method of application	Count the number of activities in which no operation such as parsing or extracting is performed on the received data ("input parameters to the activity") before using it and compare with the number of activities which have interactions with other processes
Measurement, formula and data element computations	X = A / B A = Number of activities in which no change is performed on the received data before using it (using the data as it has been transferred) B = Number of activities which have interactions with other processes If B equals to 0, it means that there are no interactions in the process activities with other processes. The result is set as "No interaction" without dividing by zero.
Interpretation of measured value	0 <= X <= 1. The closer to 1, the more data exchangeability

e. Security Metrics

i. Access Auditability

Table F- 12 Access Auditability Metric

Method of application	Count the number of the activities in which there is access to data and the access can be audited and compare with the number of the activities which have accesses to data sources
Measurement, formula and data element computations	X = A / B A = Number of activities which have access to the data and this access can be audited with its actor B = Number of activities which have accesses to the data sources
Interpretation of measured value	0 < = X < = 1. The closer to 1, the more auditable

4. Usability

a. Understandability Metrics

i. Functional Understandability

Table F- 13 Functional Understandability Metric

Method of application	Count the number of activities of which purposes and tasks are understood by the staff and compare with number of process activities
Measurement, formula and data element computations	X = A / B A = Number of activities in which staff do not encounter difficulties in understanding the tasks to be performed, B = Number of process activities
Interpretation of measured value	0 <= X <= 1 The closer to 1, the better understandability

b. Learnability Metrics

i. Existence in Documents

Table F- 14 Existence in Document Metric

Method of application	Count the number of activities described in the available documents and compare with the number of activities
Measurement, formula and data element computations	X = A / B A = Number of activities which are described in the available documents, B = Number of activities
Interpretation of measured value	0 <= X <= 1 The closer to 1, the more complete documentation

c. Operability Metrics

i. Input Validity Checking

Table F- 15 Input Validity Checking Metric

Method of application	Count the number of activities in which checking for valid data is provided for input parameters and compare with the number of process activities
Measurement, formula and data element computations	X = A / B A = Number of activities in which validity checking can be performed for input parameters B = Number of activities
Interpretation of measured value	0 <= X <= 1 The closer to 1, the better input validity checking in the activities

ii. Undoability

Table F- 16 Undoability Metric

Method of application	Count the number of the recorded activities which can be undone after they are completed and compare with the number of process activities
Measurement, formula and data element computations	X = A / B A=Number of activities which can be undone, B= Number of activities
Interpretation of measured value	0 <= X <= 1 The closer to 1, the better undoability

d. Attractiveness Metrics

i. Attractive Interaction

Table F- 17 Attractive Interaction Metric

Method of application	Count the number of activities which have attractive appearance and provide staff with easiness in preparation, deletion or updating forms, reports, archival record or similar other documents and compare with the number of activities
Measurement, formula and data element computations	X = A / B A = Number of activities in which staff can prepare, delete or update forms, reports, archival records or similar other documents with no difficulties B = Number of activities Another formula for measuring the attractive interaction can be given as below: X = A / B A = Number of activities in which staff can prepare, delete or update forms, reports, archival records or similar other documents with no difficulties B = Number of recorded activities The former formula measures the attractive interaction by considering all activities whether recorded or not, while the latter formula measures the attractive interaction by considering only recorded activities.
Interpretation of measured value	0 <= X <= 1 The closer to 1, the more attractive interaction