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# IMPROVING QUALITY OF SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC) PROCESS USING CMMI FOR DEVELOPMENT VERSION 1.3 (A CASE STUDY APPROACH)

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**ABSTRACT**

The purpose of this research is to know how to improve the quality of Software Development Life Cycle (SDLC) process through some stages: identify existing SDLC process weaknesses, provide an evaluation of the current SDLC process, and provide solutions to overcome its weaknesses. Analysis methods used in this research based on CMMI Development version 1.3 by referring to the continuous representation and project roadmap which focus on 5 (five) processes area: Project Planning, Project Monitoring and Control, Requirement Management, Configuration Management, Process and Product Quality Assurance. Assessment method used in this research is SCAMPI (Standard CMMI Appraisal Method for Process Improvement) Class C. Based on the results of the assessment, SDLC process has not been yet successfully reach capability level 1 due to the organization has not yet implement fully specific practices on five processes area, so it means there is still a score less than 4 (four) for the specific practice. Based on these results, author gives the proposed solution for specific area which still has a weakness, in order to increase the specific practice score into 4 (four).

**Keywords:** *Software Development Life Cycle, CMMI for development, Continuous Improvement, Information system, Software Development.*

## 1. INTRODUCTION

In the current era of globalization, the development of Information Technology (IT) has been increasingly advanced. Many software that has been created successfully and in accordance with the needs of users, but many of the software developed failed because without going through the process of developing system life cycle in accordance with its stages. This is often characterized by the addition of a bloated cost and poor quality of deliverables.

Today, software service companies are required to produce high-quality software that can be useful to support the company's business operations and also support management in decision-making. Therefore, it is necessary to apply system development life cycle to solve the problem of software project failure. SDLC covers all activities consisting of system analysis, system design, programming, testing, and system maintenance and other project management processes required for the success of the new software development process.

The Information Technology Division of Bina Nusantara Foundation is a division that serves as a supporter of Information Technology services for all stakeholders who work under Yayasan Bina Nusantara and one of the IT services provided is software development. However, in the process of software development at the Information Technology Division of Bina Nusantara Foundation is still often the case over deadline is in project work is not in accordance with a predetermined schedule or not completed in time and also the cost incurred for the project exceeds the budget limit set previously.

Based on the description above, this research aims to find out how far the success of software development process being done that is by using Capability Maturity Model Integration (CMMI) framework.

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In this research writing consists of 5 chapters, chapter 1 discusses the background of the importance of software development quality, chapter 2 discusses literature review which describes the meaning of the results of previous research. In chapter 3 discusses the research methodology consists of two ways: collection and assessment data using the CMMI framework version 1.3, in chapter 4 discusses the results of the analysis of the data collection and assessment process described in chapter 3, and finally chapter 5 discusses the conclusions from the results of this study and recommendations that must be done by the organization in order to achieve the highest target score according to that determined by the CMMI framework.

## 2. LITERATURE REVIEW

Software, also called a program, consists of a series of related instructions, organized for a common purpose that tells the computer what tasks to perform and how to perform them [1]. According to O'Brien & Marakas [2], software is the general term for various kinds of programs used to operate and manipulate computers and their peripheral devices.

The Systems Development Life Cycle (SDLC) is the traditional systems development method that organizations use for large-scale IT projects. The SDLC is a structured framework that consists of sequential processes by which information systems are developed. For our purpose we identify six processes: systems investigation, systems analysis, systems design, programming and testing, implementation, operation and maintenance [3]. The systems development life cycle offers a structured, well-controlled, and well-documented approach to systems development. This control and this structure can be important for managing large systems development projects and can also be a way of ensuring that available resources for systems development effort are maximized [4]. System Development Life Cycle (SDLC) identifies all the activities required to build, launch, and maintain an information system. Normally, the SDLC includes all the activities that are part of systems analysis, systems design, programming, testing, and maintaining the system as well as other project management processes that are required to successfully launch and deploy the new information system. There are 6 (six) processes in SDLC namely: project initiation, project planning, analysis, design, implementation, deployment, and support [5].

According to Chemuturi [6], in creating software, we should pay attention to software quality. The software quality is fitness for use, with fitness and use being crucial to proper understanding of quality. Quality is a major concern in the development of software projects because we get satisfied customers as a result of improved quality of the software. One can satisfy customers by delivering them compliant product with good quality and delivering within budget and schedule [7]. There is no device in existence to measure the quality of software project. But there are standard set by ISO 9001/9000-3, CMMI and many others to acquire good quality software [8]. CMMI (Capability Maturity Model Integration) framework provides technical guidelines to achieve a particular level of process development quality. The main objective of CMMI is to enhance the quality of produced software according to final user's requirements. Using models such as CMMI model to assess quality of software is not only a minimum need for organization's existence but also a business strategy [9].

In this research, we use CMMI for Development that is a reference model that covers activities for developing both products and services. CMMI for Development contains practices which cover project management process management, systems engineering, hardware engineering, software engineering, and other supporting processes used in development and maintenance [10]. According to Hakim [11], the choice of representation model offered by CMMI is stage representation and continuous representation. By using a continuous representation a company selects a process or a set of process areas and improves the process based on the process area selected. This representation uses capability level to describe the improvement process that has been achieved related to process area selected. To start CMMI implementation with continuous representation method should have a CMMI Roadmaps which consists of project roadmap, product roadmap, product integration roadmap, process roadmap and measurement roadmap.

The standard method used in appraisal, issued by Software Engineering Institute is the Standard CMMI Appraisal Method for Process Improvement (SCAMPI). Each implementation status is scored 1 – 5 in order to measure quantitatively. 1 (Not Yet), 2 (Not Implemented), 3 (Partially Implemented), 4 (Largely Implemented), 5 (Fully Implemented) [12].

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## 3. RESEARCH METHODOLOGY

This research is based on a case study approach which is conduct in IT Division of Bina Nusantara Foundation. The following is case study design represent how the author conduct this research.

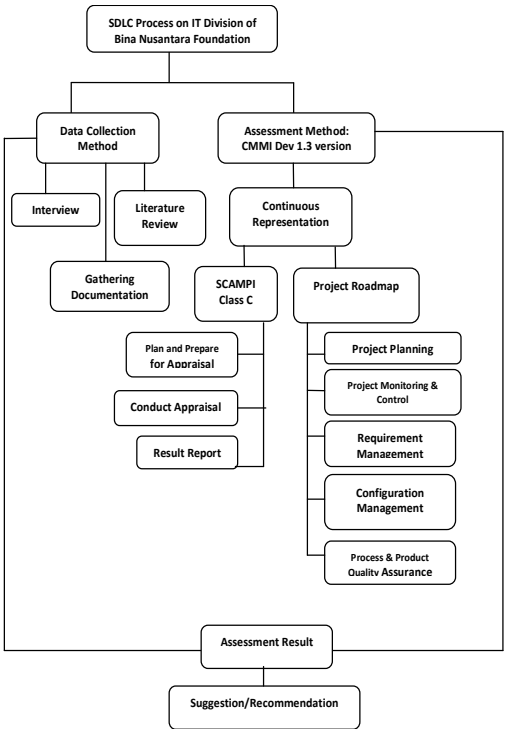


*Figure 1: Case study design*

This research consists of 2 (two) ways, namely: (1) Data collection through (a) interview with related party, (b) observation and (c) literature study. The Interview conducted by doing questions and answers sessions directly with the stakeholders: IT Director, IT Managers and IT Staffs. The Observation conducted by performs direct observation of SDLC process, (2) Assessment Method using CMMI Development version 1.3, which following are the detail processes:

a. Continuous representation with project roadmap adjusted with the identified problem found on SDLC process in IT Division. The project roadmap consists of 5 (five) processes area: Project Planning, Project Monitoring and Control, Requirement Management, Configuration Management, Process and Product Quality Assurance.

b. Assessment method used is SCAMPI (Standard CMMI Appraisal Method for Process Improvement) Class C, consists of 3 (three) phase: Plan and Prepare for Appraisal, Conduct Appraisal, and Report Result.

After knowing all the results of the assessment then the authors provide suggestions and recommendations for further research.

## 4. RESULTS AND DISCUSSION

Assessment method for this case using CMMI Development version 1.3. Here are the details of the assessment methods used in this paper.

1. The representation used is continuous representation with the roadmap project because it is adapted to the problems that occur in SDLC process of IT Division of Bina Nusantara Foundation. Through project roadmap assistance, the authors focus on 5 (five) process areas, namely: Project Planning (PP), Project Monitoring and Control (PMC), Requirement Management (REQM), Configuration Management (CM), and Process and Product Quality Assurance (PPQA).
2. The Assessment method used is SCAMPI (Standard CMMI Appraisal Method for Process Improvement) Class C, there are 3 (three) main phases for SCAMPI, namely: Plan and Prepare for Appraisal, Conduct Appraisal, and Report Result.

Methods of data collection conducted for this research are:

1. Interview

   Data collection for this research is an interview session with Head of Software Development and IT Architecture and Quality Assurance Manager to obtain qualitative information on the current organization condition, it's related to the five process areas. The results of this interview will be used as basic information to perform the analysis process as a reference for recommendation. The project that was taken as the basis for the assessment for the writing of this research is project A. The problems faced in the IT Division of Bina Nusantara Foundation in SDLC process, namely:

   - Projects that often usually exceed from the deadlines of schedules and budgets.
   - There is no clear coverage and requirement for the project.

2. Literature Study

   The authors also perform data collection by documentation study which is one method

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of data collection by viewing or analyzing the documents that exist on the IT Division authorities.

*A. Plan and Prepare for Appraisal*

There are several processes at the stage of plan and prepare for appraisal, namely:

1. The requirement analysis, which is to analyze the needs of the assessment process. The purpose of the assessment is to conduct internal improvement. The target for the assessment activities for each process area is on Capability Level (CL) 1, so focus on the specific area. The project underlying this assessment is project A with the consideration that the project has many obstacles that are beyond schedule and budget.

*Table 1: Summary of Assesment Scope*

| ***Item*** | ***Value*** |
|---|---|
| *Goal* | *Internal Improvement* |
| *CMMI Model* | CMMI-Dev version 1.3, *Continuous Representation* |
| *Organization Unit* | Divisi TI Yayasan Bina Nusantara |
| *Appraisal Team* | 1. Elda<br>2. Yohannes K |
| *Method* | SCAMPI *Class* C |
| *Scope* | *CMMI Roadmap: Project Roadmap Process Area, Capability Level And Practice:*<br>1. PP, CL1: SP1.1, SP1.2, SP1.3, SP1.4, SP2.1, SP2.2, SP2.3, SP2.4, SP2.5, SP2.6, SP2.7, SP3.1, SP3.2, SP3.3<br>2. PMC, CL1: SP1.1, SP1.2, SP1.3, SP1.4, SP1.5, SP1.6, SP1.7, SP2.1, SP2.2, SP2.3<br>3. REQM, CL1: SP1.1, SP1.2, SP1.3, SP1.4, SP1.5<br>4. CM, CL1: SP1.1, SP1.2, SP1.3, SP2.1, SP2.2, SP3.1, SP3.2<br>5. PPQA, CL1: SP1.1, SP1.2, SP2.1, SP2.2 |
| *Sample/instance* | *Organization*, Project A |
| *Datasource* | Interview and Study Documentation |

Source: Hakim (2015:8)

2. Create planning for *appraisal*.
3. Select and prepare the team.
4. Prepare the participants and *initial objective evidence.*
5. Prepare to collect *objective evidence.*

*B. Conduct Appraisal*

There are several processes at the stage of conduct appraisal, namely:

1. Checking objective evidence.
2. Documenting objective evidence.
3. Verify objective evidence.
4. Initial output validation of appraisal using SCAMPI Class C allows to minimize validation attempts at this process.
5. Make appraisal results.

*C. Report Result*

The following is a recapitulation of the results of the assessment of the SDLC process of the IT Division of Yayasan Bina Nusantara for 5 (five) process areas with a total of 40 (forty) specific practices.

*Table 2: Recapitulation Score for SDLC Assessment Process*

| ***Process Area*** | ***Goals*** | ***Practices*** | ***as-is*** | | ***to-be*** | |
|---|---|---|---|---|---|---|
| | | | ***Score*** | ***Total*** | ***Score*** | ***Total*** |
| *Project Planning* | SG1 | SP1.1 | 5 | 61 | 5 | 70 |
| | | SP1.2 | 5 | | 5 | |
| | | SP1.3 | 5 | | 5 | |
| | | SP1.4 | 2 | | 5 | |
| | SG2 | SP2.1 | 2 | | 5 | |
| | | SP2.2 | 5 | | 5 | |
| | | SP2.3 | 2 | | 5 | |
| | | SP2.4 | 5 | | 5 | |
| | | SP2.5 | 5 | | 5 | |
| | | SP2.6 | 5 | | 5 | |
| | | SP2.7 | 5 | | 5 | |
| | SG3 | SP3.1 | 5 | | 5 | |
| | | SP3.2 | 5 | | 5 | |
| | | SP3.3 | 5 | | 5 | |
| *Proj* | SG1 | SP1.1 | 3 | 29 | 5 | 50 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| *ect Monitoring and Control* | | SP1.2 | 3 | | 5 | |
| | | SP1.3 | 3 | | 5 | |
| | | SP1.4 | 3 | | 5 | |
| | | SP1.5 | 3 | | 5 | |
| | | SP1.6 | 2 | | 5 | |
| | | SP1.7 | 3 | | 5 | |
| | SG2 | SP2.1 | 3 | | 5 | |
| | | SP2.2 | 3 | | 5 | |
| | | SP2.3 | 3 | | 5 | |
| *Requirement Management* | SG1 | SP1.1 | 5 | 20 | 5 | 25 |
| | | SP1.2 | 5 | | 5 | |
| | | SP1.3 | 5 | | 5 | |
| | | SP1.4 | 2 | | 5 | |
| | | SP1.5 | 3 | | 5 | |
| *Configuration Management* | SG1 | SP1.1 | 5 | 24 | 5 | 35 |
| | | SP1.2 | 5 | | 5 | |
| | | SP1.3 | 2 | | 5 | |
| | SG2 | SP2.1 | 5 | | 5 | |
| | | SP2.2 | 3 | | 5 | |
| | SG3 | SP3.1 | 2 | | 5 | |
| | | SP3.2 | 2 | | 5 | |
| *Product And Process Quality Assurance* | SG1 | SP1.1 | 3 | 14 | 5 | 20 |
| | | SP1.2 | 3 | | 5 | |
| | SG2 | SP2.1 | 3 | | 5 | |
| | | SP2.2 | 5 | | 5 | |

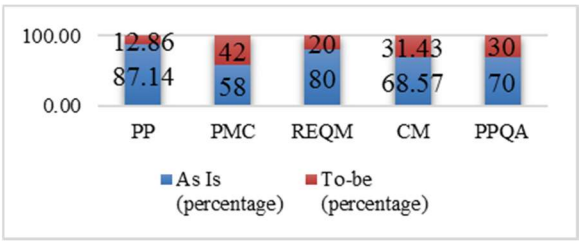


*Figure 2: Assessment Results per Process Area*

Based on the graph above, there is a gap in each process area, with details as follows:

1. *Process area for Project Planning* has a gap of 12,9%.
2. *Process area for Project Monitoring and Control* has a gap of 42%.
3. *Process area for Requirement Management* has a gap of 20%.
4. *Process area for Configuration Management* has a gap of 31,4%.
5. *Process area for Process and Product Quality Assurance* has a gap of 30%.

The conclusion is based on the assessment result above, SDLC process on IT Division of Bina Nusantara Foundation has not yet reached level 1 capability since it has not implemented some specific practice in five process areas (there are still score less than 4 for specific specific practice). According to the purpose of this research which is to know how to improve the quality of software development life cycle (SDLC) processes, we have done the process through some stages as stated on abstract section.

The following are suggestions or recommendations based on the assessment of the SDLC process on the IT Division of Bina Nusantara Foundation. The authors provide suggestions which organization can achieve score 4 on the whole processes and can achieve capability level 1.

## 5. CONCLUSIONS

### *A. Conclusion*

Based on the results of the assessment to the five process areas, there are Project Planning (PP), Project Monitoring and Control (PMC), Rquirement Management (REQM), Configuration Management (CM), and Process and Product Quality Assurance (PPQA) at Yayasan Bina Nusantara, can be summarized as the table below.

*Table 3: Assessment Result of SDLC*

| No | Description | Total |
|---|---|---|
| 1 | SP with *score* ≥ 4 | 18 |
| 2 | SP with *score* < 4 | 22 |
| | Total SP | 40 |

### *B. Suggestion & Recommendation*

1. Process Area for Project Planning
   In accordance with predetermined scope, the assessment of the process area Project Planning (PP) focuses on the practice on capability level 1 (SP 1.1, SP 1.2, SP 1.3, SP 1.4, SP 2.1- SP 2.7, SP 3.1, SP 3.2, SP 3.3). The table below is the weakness and recommendation for specific practice with score less than 4 (four).

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*Table 4: Recommendation: Proses Area for Project Planning*

| No | *Specific Practice* | *Weakness* | *Recommendation* |
|---|---|---|---|
| 1 | SP 1.4 | There are no guidelines for determining cost estimates, so there is often an irrational estimate | It should determine the estimated work effort and cost for the work product and task based on rational estimation by:<br>• Collect the model or historical data from the project as a basis for estimating hours and costs.<br>• Informing additional infrastructure when estimating efforts and costs (eg memory disk, network capacity, and tools for prototyping).<br>• Estimated efforts and costs with models, historical data and a combination of both. |
| 2 | SP 2.1 | Project schedules, schedule dependencies, and project budgets have not been executed properly, such as over budget and over deadlines | They should create and implement project schedules and budgets from the project by:<br>• Identify the main milestone.<br>• Identify schedule assumptions.<br>• Identify limits.<br>• Identify interdependent processes.<br>• Create and implement schedules and budgets. |
| 3 | SP 2.3 | The lack of guidance in determining the requirements for project needs such as data management plans, master lists of managed data, content data and format descriptions and more. So the data used is not in accordance with the standardization. | We recommend planning for "project data" management by:<br>• Create requirements and procedures to ensure the confidentiality and security of the data.<br>• Create mechanisms to archive data and to access those data.<br>• Determine the project data to be identified, collected, and distributed.<br>• Determine requirements to provide access and distribution of data to relevant stakeholders. |

Based on the results of the table above, the authors suggest recommendations to overcome some weaknesses in project planning. There are 3 (three) recommendations for process area project planning. The author hopes that by applying the recommendations to the specific areas that have weaknesses, it is able to increase the score to 4 (four).

**2. Process Area for Project Monitoring Control**

In accordance with predetermined scope, the assessment of the Project Monitoring and Control (PMC) process focuses on practice on capability level 1 (SP1.1, SP 1.7, SP 2.1, SP 2.2, SP 2.3). The table below is the weakness and recommendation for specific practice with score less than 4 (four).

*Table 5: Recommendation: Proses Area for Project Monitoring and Control*

| No | *Specific Practice* | *Weakness* | *Recommendation* |
|---|---|---|---|
| 1 | SP 1.1 | No project performance records, cost performance, or deviations from the project manager or system analyst as a comparison in the monitoring process of upcoming project planning | There should be a record of project performance, cost performance, and deviation. |
| 2 | SP 1.2 | There is no record of commitment review from the project manager or system analyst as a comparison in the supervision | There should be a record of commitment review. |

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| | | | |
|---|---|---|---|
| | | of commitment in the future | |
| 3 | SP 1.3 | There is no project risk monitoring record from the project manager or system analyst as a comparison in future project risk monitoring | There should be a record of project risk monitoring.<br>The practices that can be done, namely:<br>• Review the risk documentation periodically.<br>• Revised risk documentation as additional information.<br>• Communicate the risk status to relevant stakeholders. |
| 4 | SP 1.4 | There is no record of data management from the project manager or system analyst as a comparison in the monitoring of data management in the future | There should be data management recording.<br>The practices that can be done, namely:<br>• Review the activities of data management in project planning periodically.<br>• Identify and documenting significant problems and impacts.<br>• Documenting the results of a review of data management activities |
| | | | . |
| 5 | SP 1.5 | There are no records of monitoring of stakeholder involvement from the project manager so there is no written reference in comparison to future project planning | There should be monitoring reports of stakeholder engagement.<br>The practices that can be done, namely:<br>• Review status of stakeholder involvement periodically.<br>• Identify and document significant problems and impacts.<br>• Document the results of a status review of stakeholder involvement. |
| 6 | SP 1.6 | There is no project manager's review of project and project management in determining whether there are significant problems or lack of performance | The project manager should review project and project management.<br>Create a documentation of the project's results. |
| 7 | SP 1.7 | • Registration of milestone review is not standardized because there is no standardization of milestone review documentation<br>• There is an error that is not corrected because the previous milestone | There should be recording and standardization of recording of milestone review results.<br>The practices that can be done, namely:<br>• Review conduct milestone with stakeholders.<br>• Review project commitments, plans, status, and risks.<br>• Identify and document significant problems and impacts. |

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| | | | |
|---|---|---|---|
| | | review results are not recorded | • Documenting the review results. |
| 8 | SP 2.1 | Recording becomes un-standardized Because there is no standardization in listing the problem | There should be standardization of the standard record of the problem. The practices that can be done, namely: 1. Collecting problems for analysis. 2. Analyze the problem to determine corrective action. |
| 9 | SP 2.2 | Recording becomes un-standardized because there is no standardization in the recording of a corrective action plan | There should be a standardized recording of a corrective action plan. |
| 10 | SP 2.3 | | |

Based on the results of the table above, the authors suggest recommendations to overcome some weaknesses in project planning. There are 10 (ten) recommendations for process area monitoring and control project. The author hopes that by applying the recommendations to the specific areas that have weaknesses, it is able to increase the score to 4 (four).

### 3. *Recommendation* Process for Area Requirement Management

In accordance with predetermined scope, the assessment of the process area Requirement Management (REQM) focuses on practice on the capability level 1 (SP 1.1, SP 1.2, SP 1.3, SP 1.4, SP 1.5). The table below is the weakness and recommendation for specific practice with score less than 4 (four).

*Table 6: Recommendation: Proses Area for REQM*

| No | *Specific Practice* | *Weakness* | *Recommendation* |
|---|---|---|---|
| 1 | SP1.4 | There are constraints when it comes to tracking requirements for one of the projects because there is no mechanism that records the log requirement (two-way) | When translating the requirements of the Customer into Product Requirement, they should create a mechanism that records the requirements. There is a system or mechanism to record the log requirement. |
| 2 | SP1.5 | There is an unresolved requirement problem because there is no inconsistent documentation between the project plan and the requirement | Must make a standard operation procedure related to inconsistent issues between the project plan, the requirements, and the work product. |

Based on the results of the table above, the authors suggest recommendations to overcome some weaknesses in project planning. There are 2 (two) recommendations for process area requirement management. The author hopes that by applying the recommendations to the specific areas that have weaknesses, it is able to increase the score to 4 (four).

### 4. *Reccomendation:* Process Area *for* Configuration Management

In accordance with predetermined scope, the assessment of the Configuration Management (CM) process area focuses on practice on capability at level 1 (SP 1.1, SP 1.2, SP 1.3, SP 2.1, SP 2.2, SP 3.1, SP 3.2). The table below is the weakness and recommendation for specific practice with score less than 4 (four).

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

*Table 7: Recommendation: Proses Area for Configuration Management*

| No | *Specific Practice* | *Weakness* | *Recommendation* |
|---|---|---|---|
| 1 | SP1.3 | Configuration is inconsistent on projects with similar characteristics because there is no baseline | Baseline needs to be made for internal use and delivery to customers so there is a standard in the SDLC process. |
| 2 | SP2.2 | • Not all parties involved in the project are aware of any changes to the configuration, this is because there is no oversight of configuration changes.<br>• Requires repeated notifications of configuration changes | There should be a standard operating procedure regarding configuration changes. Examples of work product in this practice are: revised history of the configuration and archive of the baseline. Documenting changes to the configuration and the exact reason for the change. |
| 3 | SP3.1 | The existence of team members who do not know the configuration changes and still use the old configuration | There should be a mechanism or system that explains the configuration, such as:<br>• Revision history of configuration.<br>• Recording a configuration change request. |
| 4 | SP3.2 | The current configuration does not match the needs of the running project (since no update was made to the configuration) | It should have an audit of the current configuration to ensure the configuration complies with certain standards. |

Based on the results of the table above, the authors suggest recommendations to overcome some weaknesses in project planning. There are 4 (four) recommendations for process area configuration management. The author hopes that by applying the recommendations to the specific areas that have weaknesses, it is able to increase the score to 4 (four).

## 5. *Reccomendation:* Process Area for Process and Product Quality Assurance

In accordance with predetermined scope, the *process area on Process and Product Quality Assurance* (PPQA) focuses on practice on capability level 1 (SP 1.1, SP 1.2, SP 2.1, SP 2.2). The table below is the weakness and recommendation for specific practice with score less than 4 (four).

*Table 8: Recommendation: Proses Area for Process and Product Quality Assurance*

| No | *Specific Practice* | *Weakness* | *Recommendation* |
|---|---|---|---|
| 1 | SP1.1 | Errors can be repeated because the report evaluation is not well documented | There should be a standard operation procedure that governs the evaluation process for the project. |
| 2 | SP1.2 | | There should be a standard operation procedure that regulates the evaluation process for the selected work product. |
| 3 | SP2.1 | | There should be a standard operating procedure in handling non-compliance issues related to product and process quality. |

Based on the results of the table above, the authors suggest recommendations to overcome some weaknesses in project planning. There are 3 (three) recommendations for process area process and product quality assurance. The author hopes that by applying the recommendations to the specific areas that have weaknesses, it is able to increase the score to 4 (four).

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In this research, the authors focus on 1 CMMI roadmap and 5 process area. For future research, the authors hope to do research by using a more complete area process provided by the CMMI Framework that is as much as 22 process areas and 5 types of roadmap that is: product roadmap, product integration roadmap, roadmap process, and measurement roadmap.

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