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A STUDY ON THE QUALITY CHECK PROCESS MODEL FOR SOFTWARE DEVELOPMENT USING QUALITY GATE

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ABSTRACT

Abstract Many SW development companies have recently made a number of efforts to improve their organization's development capabilities and product quality. Although advanced process models such as CMMI and SPICE were introduced in Korea, they are too complex and diverse to apply to small domestic projects with limited efficiency. There have been many existing evaluation models, but the reality is that there is a lack of research on performance models that can be applied to projects. This thesis introduces the Software Development Quality Check Management Execution Model, a simple model that can be easily applied to small projects. Applying the proposed model to small projects is expected to improve the quality of the software.

Keywords: *Software engineering, CMMI, SPICE, Development methodology, SW Development Process, QG(Quality Gate)*

1. INTRODUCTION

Many SW companies are pushing for Software Process Improvement(SPI) to improve the development capabilities of SW developers and the quality of SW products[1][2][3][4]. However, quantitative evidence for the performance of the SPI is still lacking[5][6]. The SPI aims to establish an infrastructure and culture that supports practices and procedures through a methodology for effective SW development and can be integrated into ongoing corporate activities. However, these goals are presented as difficult to achieve[7].

SW development productivity requires three main elements of SW development projects: technology, manpower, and Balanced Perspective and Approach to Processes [13]. Until now, efforts to increase productivity of SW development have focused mainly on technical aspects related to SW construction and related alternatives have been suggested[14]. Due to the human-centric nature of SW development, the benefits of technological improvements must be supported by the necessary personnel and processes for the development process in order to be fully realized in the SW development process. The ultimate meaning of the success of the SW project is that it is a complete SW project success only when the expected business changes and corresponding values are communicated properly to the organization after the SW project is completed[15].

Many SW companies are pushing for improvements in SW processes such as CMMI or ISO/IEC 15504 (SPICE) to comply with period of delivery and cost, along with improved quality of SW products, and to bring the product to customer at the right time. However, given the high cost and manpower of improving the SW process, it is very important to present objective evidence of SW process capability level and SW project performance. Therefore, it is not enough to introduce a typical software process model without filtering, many small projects desperately need performance models that are adapted to the development environment or level of many small projects.

In this paper, we propose a lightweight software quality control system Software Quality Management System(SQMS) that reduces the complexity of existing software models and makes it easy to apply in smaller projects.

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2. RELATED RESEARCH

2.1 Software Process Assessment Relationship Model

Defining the correct processes and effective activities related to software development is very important because they facilitate the availability of the manpower and resources needed for successful software development, as well as the efficient use of the tools and equipment necessary for development. These activities also play a key role in improving the cost, schedule, and quality of software development projects[8]. The software process audit relationship model is the same as <Figure 1>. It is configured to diagnose an organization's current ability to perform processes through Process Assessment and to perform Process Capability Determination, which can be used for Process Improvement[9].

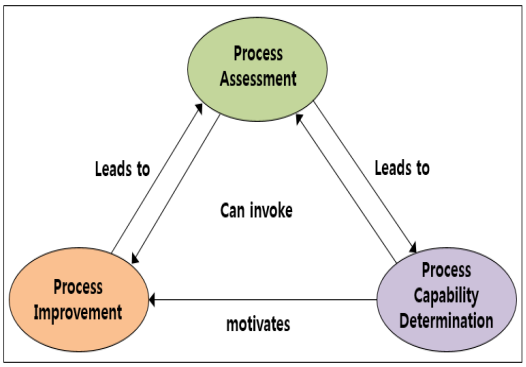

Figure 1: Process Assessment relationship

2.2 CMMi and ISO15504

The Capability Maturity Model Integration (CMMi)[11][12] was developed by the U.S. Software Engineering Institute (SEI) and consists of process, personnel, and technology levels. CMMi's individual processes consist of Specific Goal, Generid Goal to achieve, and activities that must be carried out to achieve these goals < Figure 2>.

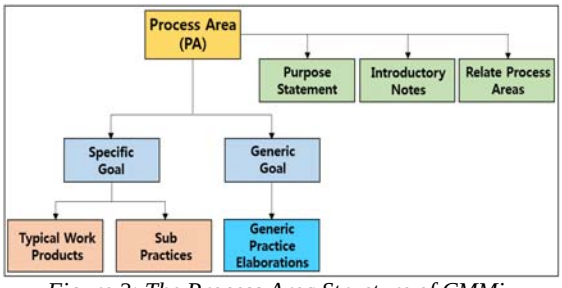

Figure 2: The Process Area Structure of CMMi

ISO15504 consists of five components, including Concept and Vocabulay, Performing and Assessment, Guidance on Performing An Assessment, Guidance on use for Process Improvement and Process Capability Determination, and An Exemplar Process Assessment based upon ISO/IEC, as shown in <Figure 3>[10].

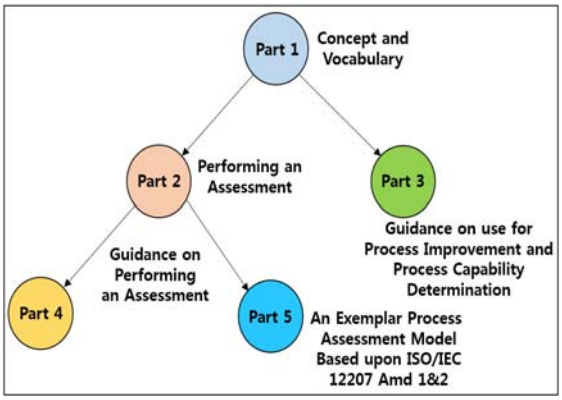

Figure 3: Components of ISO/IEC 15504

ISO/IEC 15504-2 makes it possible to create and use a Process Assessment Model (PAM) that defines a software assessment model that defines the process objectives and performance outcomes defined in the software process reference model. Process capability determination defines the target capability for a particular requirement and involves analyzing the differences between current capabilities and the capabilities required by the project to derive risks [9]. The process improvement flow is the process of defining organizational needs and business objectives, determining current capabilities, and then performing improvement activities repeatedly to achieve improvement objectives [10][11][12].

The benefits of SW process improvement are not limited to increasing the speed of development work, but rather to reducing the time required to rework a fault. Without a proper development process, the operation of the development team would be confusing, leading to low productivity and quality[16]. SW process refers to a working system that presents key activities within the SW life cycle required to develop high-quality SW. The basic idea of SW process is that more systematic and mature SW process capabilities are possible to produce higher quality SW products. Already, many SW development companies are showing that improving SW process capabilities leads to SW project performance and improved SW product

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quality, and pushing for improvement of SW process as a way to develop SW successfully and increase productivity[17][18].

3. QUALITY INSPECTION MANAGEMENT EXECUTION MODEL USING QG

3.1 Quality Gate Execution Model

The SW QG Quality Check Execution Model proposed in this thesis focused on the Project and Work Management, Service Establishment and Delivery parts of the CMMi category area, as shown in <Table 1>, and Based on the ISO15504 process audit relationship model, it consists of inspection, step-by-step capacity measurement and improvement as shown in <Figure 4>. Inspection is carried out through level diagnosis, and emphasis and risk are derived and managed through capability measurement in stages. Improvement consists of prevention, control, and education.

Table 1: PA(Process Area) by CMMi Category

Category	Process Area	Maturity Level
Process Management	· Organizational Performance Management (OPM)	5
	· Organizational Process Performance (OPP)	4
	· Organizational Process Definition (OPD)	3
	· Organizational Process Focus (OPF)	3
	· Organizational Training (OT)	3
Project and Work Management	· Quantitative Work Management (QWM)	4
	· Capacity and Availability Management (CAM)	3
	· Integrated Work Management (IWM)	3
	· Risk Management (RSKM)	3
	· Service Continuity (SCON)	3
	· Requirements Management (REQM)	2
	· Supplier Agreement Management (SAM)	2
	· Work Planning (WP)	2
	· Work Monitoring and Control (WMC)	2
Service Establishment and Delivery	· Strategic Service Management (STSM)	3
	· Service System Development (SSD)	3
	· Service System Transition (SST)	3
	· Incident Resolution and Prevention (IRP)	3
	· Service Delivery (SD)	2
Support	· Causal Analysis and Resolution (CAR)	5
	· Decision Analysis and Resolution (DAR)	3
	· Configuration Management (CM)	2
	· Measurement and Analysis (MA)	2
	· Process and Product Quality Assurance (PPQA)	2

Measure the difference before and after performing the step-by-step inspection activities

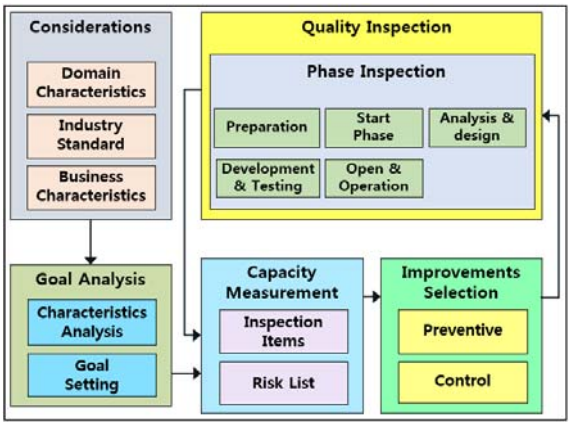

Figure 4: Framework of Quality Inspection management Execution Model

First, the Quality Inspection Process consists of 14 views, such as <Figure 5> throughout the software development lifecycle. Second, perform a capacity measurement. Based on the Phase Inspection results and product characteristics and goals, a checklist for quality inspection process is drawn. The detailed items of processes and outputs are applied to the project and industrial and organizational characteristics of the inspection target according to the process and quality inspection criteria. Third, improvement activities are carried out for prevention and control. As a preventive measure, the quality risks are identified early in the software development process and checked on a timely basis for improvement. Control activities are carried out through regular inspection to ensure that the quality activities management and performance outcome of the project meet the quality baseline of the quality activities control plan.

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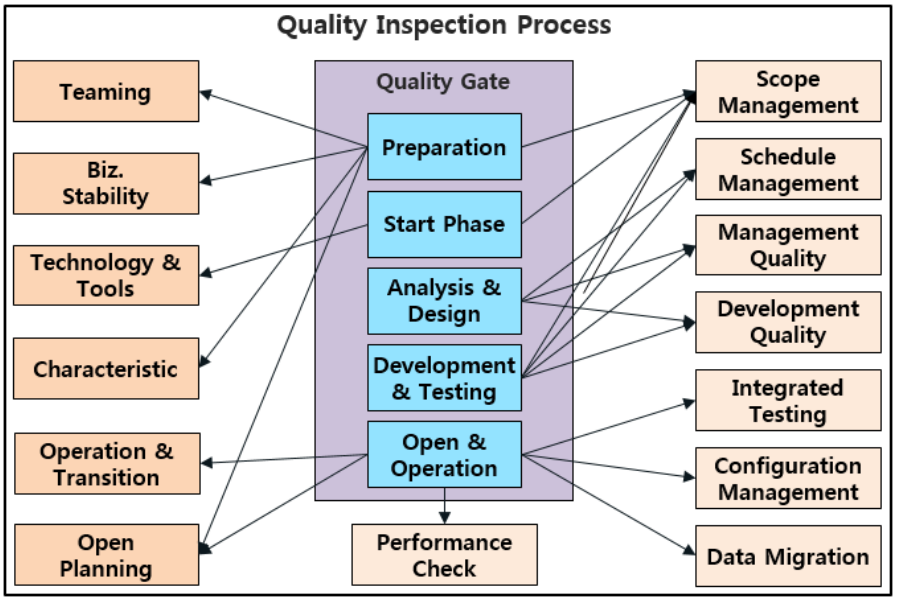

Figure 5: Components of Quality Inspection Process

3.2 QG(Quality Gate) Inspection Check List

The item composition of the software process quality check consists of 5 areas and each stage consists of detailed inspection items. 41 items for the Preparation Phase, 24 items for the Start Phase, 37 items for the Analysis & Design Phase, 40 items for the Development & Testing Phase, and 95 detailed items for the Open & Operation Phase.

3.2.1 Preparation Phase Inspection Check List

During the Preparation Phase, Scope Estimate, Project Risk, Operations Organization Collaboration, Development Schedule and Productivity, Scope management, Inspect Infra/Security Results, Review Technical Standards are Perform, as shown in <Table 2>.

Table 2: Preparation Phase Inspection Table

Inspection contents	Details of inspection
Teaming	· Check the adequacy of the company's manpower ratio [Key] · Appropriateness of input personnel
Scope Estimate	· Apply Quality Effort (QA, Common, Architect) [Key] · Specific customer requirements · Calculate the functions by dividing them into detail up to the screen menu criteria · Applying non-functional/functional requirements · Securing objectivity in calculating scale
Project Risk	· Possible issues related to Project Milestone and technology (performance, stability) [Key] · Possible compliance issues · Having experience in performing similar projects · History of project past performance
Operations Organization Collaboration	· Inspection of consultation with the operation organization (Application, Infra), scope of work, development schedule, etc. · Consider the customer's unit test and third-party test
Development Schedule and Productivity	· Check project open schedule · Check the appropriateness of input by development process · Check the productivity of the development program
Scope management	· Identify and prevent possible changes to requirements
Inspect Infra/Security Results	· Check impact assessment results for each area of Infra (AA, TA, DA, NW) · Check the review results of security experts
Review Technical Standards	· Check the review of technical standards, specific items, and non-standard cases · Share project success or failure experiences

3.2.2 Start Phase Inspection Check List

During the Start Phase, Scope management, MileStone Customer Participation, Project Progress Organization, Purchase status, Change Management, Constraints are Perform, as shown in <Table 3>.

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Table 3: Start phase Inspection Table

Inspection contents	Details of inspection
Scope management	· Check that the contract with the customer has been completed · Inspect items discussed about project scope
Mile Stone Customer Participation	· Check the weekday schedule step by step [Key] · Check the engagement organization and engagement plan of the customer [Key]
Project Progress Organization	· Checks the completion status and size of personnel for collaboration
Purchase status	· Inspect the establishment of outsourcing and product purchase plans
Change Management	· Check if the contract size and scope change control procedures have been agreed with the customer [Key]
Constraints	· Check support request as a result of project execution · Check if the project performance environment is in place · Identify the environmental status of projects

3.2.3 Analysis & design Phase Inspection Check List

During the Analysis & design Phase, Project Progress, Requirements Management, Scope management, Development and Data Migration, Purchase status, Constraints are Perform, as shown in <Table 4>.

Table 4: Analysis & design Phase Inspection Table

Inspection contents	Details of inspection
Project Progress	· Check that the project is progressing without delay · Change of Milestone
Requirements Management	· Conducts review activities with customers to check if requirements have been reached · Review that non-functional requirements have been derived without omission
Scope management	· Setting design baselines [Key] · Agree with the customer about the established baseline [Key]
Development and Data Migration	· Identifying the environment configuration for development or the readiness for input by development team members · Establish detailed development schedule plan [Key] · Preparing for data migration [Key]
Purchase status	· Check if outsourcing and product purchase plans have been established · Check risks related to partner input
Constraints	· Identify the challenges of carrying out a project · Check work environment

3.2.4 Development & Testing Phase Inspection Check List

During the Development & Testing Phase, Project Progress, Scope management, Unit Testing Progress, integration Testing Plan, Open and Inspection Indicators, Purchase status, Constraints are Perform, as shown in <Table 5>.

Table 5: Development & Testing Phase Inspection Table

Inspection contents	Details of inspection
Project Progress	· Check if progress of project is being made in accordance with plan · Check the progress of the test phase · Check if the data transfer is aligned with the target and implementation time objectives. · Change of Milestone
Scope management	· Change request details · Check the progress of CCB settlement
Unit Testing Progress	· Perform third-party testing of developed programs · If a test has been performed, check the defect level (defect rate is lower than 10%).[Key]
integration Testing Plan	· Establish integrated test plan and agree with customer [Key]
Open and Inspection Indicators	· Check the agreed open schedule and check sheet with the customer attainable [Key]
Purchase status	· Check if outsourcing and product purchase plans have been established
Constraints	· Identify the challenges of carrying out a project · Check work environment

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3.2.5 Open & Operation Phase Inspection Check List

During the Open & Operation Phase, Operation Transfer, Data Migration, Stakeholder Opinions, Inspect Infra/Security Results, Security Inspect, Testing and Training are Perform, as shown in <Table 6>.

Table 6: Open & Operation Phase Inspection Table

Inspection contents	Details of inspection
Operation Transfer	· Review operation transfer plans [Key] · Check operation plan, scope of failure, and resolution by type of failure [Key] · Check for possible change in requirements after system open · Secure a minimum stabilization period of 2 weeks
Data Migration	· Ensuring that data migration results are free from errors [Key] · Confirms agreement with the customer regarding the data migration result [Key]
Stakeholder Opinions	· Listening to the opinions of the operators
Inspect Infra Results	· Check the results of impact assessment by infra(AA, TA, DA, NW)
Security Inspect	· Check security expert review results · Checking the encryption of personal information · Check professional encryption
Testing and Training	· Check the results of processing for integrated test conditions, defect handling rate, and major error types [Key] · Check the results of user and operator training · Verifying and checking the Voice Of Customer (VOC) during the project.

3.3 Design and Implement SQMS Tool

3.3.1 SQMS Basic Model and Schematic

For objective QG activities, the project team and the QG implementation team are divided into the procedures of the project team and the QG team as shown in <Figure 6> to review the quality of the performance of the project or stage to determine whether the project should be continued or not, and the major activities are defined in Entry Critia and Exit Critia at each stage, and judgment based on detailed measurement plans and objective measurement results are established. Phase-by-Phase QGs are essential activities that proactively reduce risk factors to increase project success and ensure product quality.

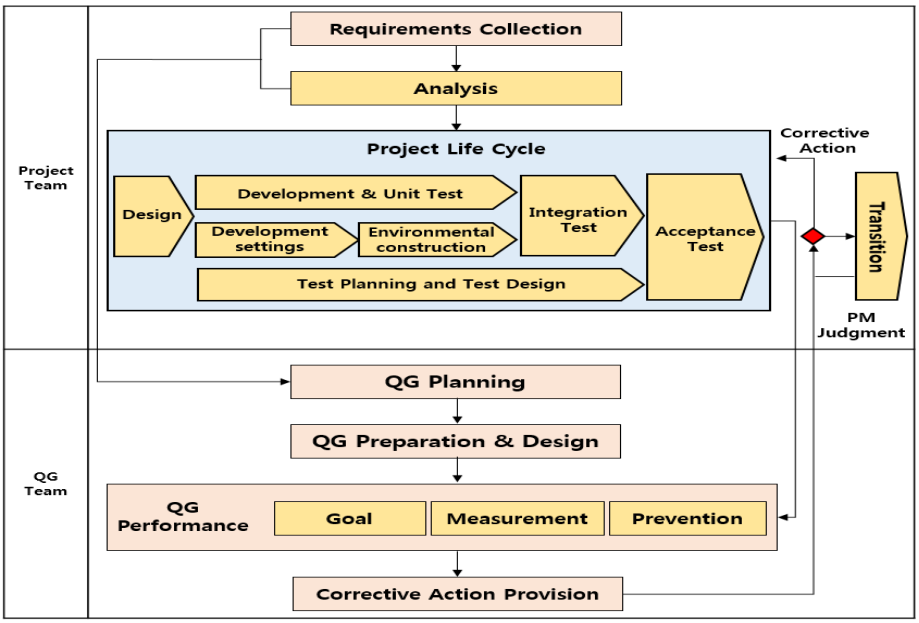

Figure 6: Relationship between project team and QG team

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3.3.2 SQMS Basic Model and Schematic

The QG Phase defines the list and timing to be inspected, and comprehensively examines the major activities of the Software Process to comprehensively integrate development progress to control or prevent development in advance< Figure 7>.

3.3.3 SQMS Basic Model and Schematic

As shown in <Figure 8>, the Common Area for QMS defines the standard checklists, objectives for step inspection, characteristics of Biz. And Domain, and the four areas of the SQMS are divided into Phase Inspection Area for detailed processing of the Step Inspection Items, Measurement Area for capacity measurement and step by step, Goal Control Area for identifying and processing strengths and weaknesses of the Step Inspection, and DashBoard Area for understanding and Monitoring the status of the step quality inspection.

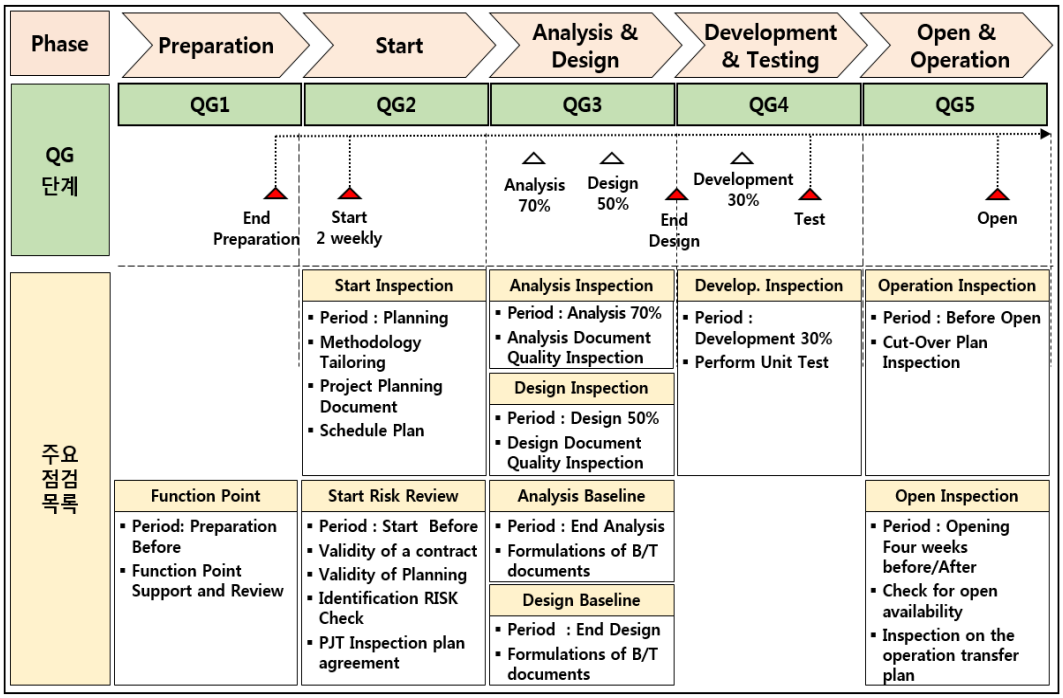

Figure 7: SQMS Based Model

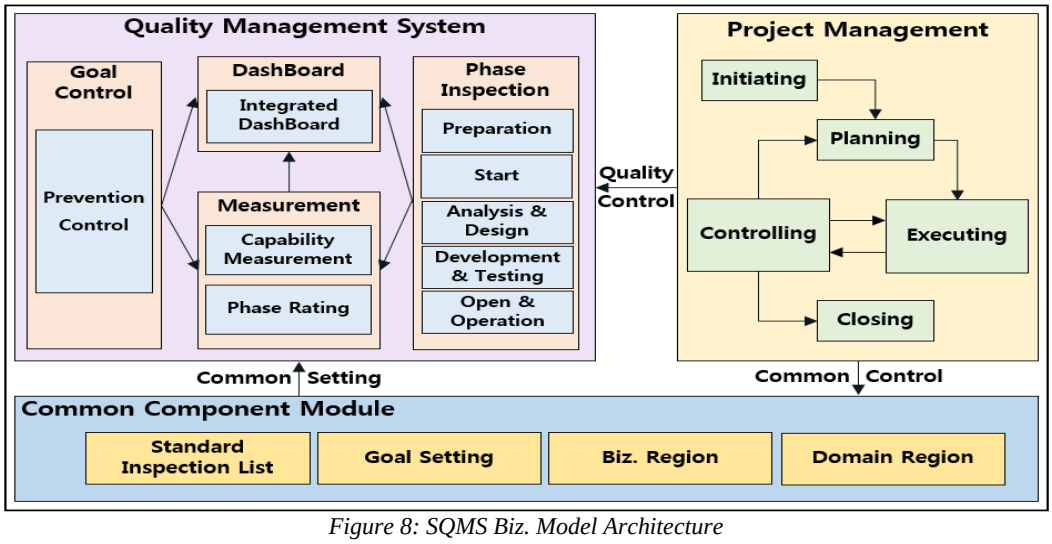

Figure 8: SQMS Biz. Model Architecture

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3.3.4 QG(Quality Gate) Inspection Result Level

The results of the inspection are documented in detail at each stage and the inspection result is defined as Step 5(Great, Good, Moderate, Insufficient, Bad) based on <Table 7> considering the execution status of the project step.

Table 7: QG(Quality Gate) Inspection Result Level Table

Inspection Result	Distribution	Document	Execution	Details of Inspection Result
Great	More Than 90% ~ 100%	O	O	· 100 % status of project execution in phase · Document(O), Current document(O) · Execution(O), Weakness(X)
Good	More Than 80% ~ Less Than 90%	O	80%↑	· Status of project execution by 80 % or more · Document(O), Current document(X) · Execution(O), Weakness(O)
Moderate	More Than 50% ~ Less Than 80%	O	30%↑~80%↓	· Partial project status (30 % or less, less than 80 %) · Document(O), Current document(X) · Execution(O), Weakness(X)
Insufficient	More Than 35% ~ Less Than 50%	X	1%↑~30%↓	· Partial project status (1 % or less, less than 80 %) · Document(X), Current document(X) · Execution(O), Weakness(X)
Bad	More Than 1% ~ Less Than 35%	X	X	· Not performing project in phase · Document(X), Current document(X) · Execution(X), Weakness(X)
N/A	-	-	-	· Not applied to the scope of execution · Not Target · Not Execute

3.4 Detailed key functions of SQMS

3.4.1 Project Quality Check Dashboard

The following <Figure 9> is an integrated dashboard for quality inspection by project stage.

This is a function that provides real-time information on quality status by step and manages them collectively by utilizing dashboards.

Project	Plan Start Date	Plan End Date	Cond.	Working Step	Emphasis Target	Final		Step Quality State						
						Cond.	Point	PRC	Start	Anal.	Design	Devel.	Test	TRC
National Basic Zone System	2018-03-25	2018-11-25	End	Taking Over	Emphasis	Nor.	82.70	92.00	83.00		96.00	95.00		81.00
Ukey Advanced Function	2018-03-25	2018-09-27	End	Taking Over	Emphasis	Nor.	78.20	90.00	88.00		95.00	98.00		78.20
Automation of Incentive Settlement	2018-04-05	2018-10-18	End	Development	General	Nor.	75.30	83.00	86.00	73.33	80.99	100.00		75.20
Terminal business (Ukey development)	2018-04-20	2018-08-15	End	Design	General	Good	86.80	76.00	71.00		89.16	81.33	92.00	86.80
T membership DIY service	2018-05-06	2018-09-08	End	Development	Emphasis	Good	89.00	87.40	74.00	88.66	93.00	89.00		83.30
PDF security mail	2018-02-02	2018-10-26	End	Taking Over	Emphasis	Best	88.60	88.20	78.00		93.33	78.33		88.60
Improving the voucher process	2018-03-18	2018-09-20	End	Taking Over	Emphasis	Best	98.20	92.20	89.00		100.00	90.00		98.20
Build a mobile customer center	2018-04-25	2018-10-31	End	Development	General	Best	95.30	74.00	89.00		93.33	88.33		85.40
Automating caller ID settings	2018-05-03	2018-11-30	End	Taking Over	General	Nor.	73.20	92.00	82.00		Delay	88.33		85.40

Figure 9: Quality Inspection Dashboard

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3.4.2 Quality inspection status by step

The following <Figure 10> is a function to monitor progress by expressing the quality check by project stage on a single screen.

3.4.3 Quality inspection results by step

The following functions <Figure 11> calculate the quality check result values for each checklist and provide information for improvement by expressing the status of the inspection. The results of the inspection criteria are linked to the results of the inspection criteria to express the scores and the status of the inspection zone in a straightforward manner. Therefore, it is possible to check the improvements easily and make up for the defects in the next step.

Figure 10: Status of quality inspection by Phase

Inspection Stage	Inspection Category	Point	Condition
PRC	Biz. Stability	40.00	Insufficiency
PRC	Team Configuration Appropriate	91.00	Best
PRC	Technical Structure	70.00	Normal
PRC	Scope	62.00	No
PRC	Take Over	80.00	Good
Design	Development Quality	100.00	Best
Design	Management Quality	100.00	Best
Design	Scope	100.00	Best
Design	Schedule	100.00	Best
Test	Development Quality	78.00	Normal
Test	Management Quality	100.00	Excellent

Figure11: Quality check result by Phase

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3.4.4 Quality inspection items by step

The following <Figure 12> lists the quality inspection by inspection stage. It is a function to check inspection classification and inspection items, register performance results in the system, and share quality results in real time.

Inspection Step	Inspection Item	Result
PRC		
TRC		
Development		
Development Quality		
Unit Test		
Development	Has the developer completed the unit test (UI, Batch etc.)?	1
Development	Did PM / PL confirm (Test, Output) of unit test results?	1
Development	Do you manage the developer and the PM / PL unit test for the development program list?	Y
Development	Are there traces of unit test execution? (Screen dump, server log, etc.)	Y
Development	Have you completed development and testing of data migration and validation programs?	Y
Development	Has the testing or verification activities done by customers or third parties been done?	Y
Development	Has the unit test result been agreed with the customer?	N
Test Planning & Preparation		
Development	Did you define the progress/fault management method and support tool in the test procedure?	Y
Development	Did you create an integration test scenario / case?	Y
Development	Integration Test Scenario / Case such as case, has the customer's agreement completed?	N
Development	Has the test environment been completed? (H/W, S/W, N/W, Data etc.)	Y
Development	Have you specifically defined the scope of testing by type / level of testing?	Y

Figure 12: Quality Check Item by Phase

4. EXPERIMENTAL CLASSIFICATION RESULTS AND ANALYSIS

Inspection items were selected in three stages for 60 small projects of S company and applied as project manager and quality manager.

Table 6: QG Inspection Result Level Table

Contents / Phase	Goal by Phase
1 Phase	· Phase : Initial (start) phase · Counts : 20 Projects · Standard checklist-based project status check
2 Phase	· Phase : Management (Analysis) Phase · Counts : 20 Projects · Complement project improvements after 1st Phase
3 Phase	· Phase : Improvement (Complete) Phase · Counts : 20 Projects · Analysis of Problems Derived from Phase 1 and Phase 2 · Strengthening the prevention and control activities in advance

4.1 Inspection results by QG through SQMS

The analysis results of quality inspection in 60 projects are as shown in <Table 8>.

Prevention is required for Teaming and Scope Estimate as part of starting a project. In the beginning phase of the project, preventive measures are required for Scope Management and Milestone Customer Partication, and in the analysis & design phase requires the prevention of Scope Management and Requirements Management related to the task, and the development & testing phase requires a lot of resources to be involved in the project progress and unit testing progress. The last step, Open & Operation Phase, requires intensive management of Stakeholder Opinion Extensions for project inspection.

Table 8: Inspection results by QG

Phase	Inspection Contents	Result				
		A	B	C	D	E
Prepara-tion	Teaming				●	
	Scope Estimate				●	

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Phase	Inspection Contents	Result				
		A	B	C	D	E
	Project Risk			○		
	Operation Organization Collaboration			○		
	Development Schedule and Productivity			○		
	Scope Management			○		
	Inspect Infra/Security Results		○			
	Review Technical Standards		○			
Start	Scope Management					●
	Milestone Customer Participation				●	
	Project Progress Organization			○		
	Purchase Status		○			
	Change Management			○		
	Constraints		○			
Analysis & Design	Project Progress			○		
	Scope Management				●	
	Requirement Management				●	
	Development and Data Migration			○		
	Purchase Status		○			
	Constraints	○				
Development & Testing	Project Progress				●	
	Scope Management			○		
	Unit Testing Progress					●
	Integration Testing Plan				●	
	Open and Inspection Indicators			○		
	Purchase Status	○				
	Constraints	○				
Open & Operation	Operation Transfer			○		
	Data Migration			○		
	Stakeholder Opinions				●	
	Inspect Infra/ Security Results			○		
	Security Inspect			○		
	Testing and Traing			○		

A: Great, B: Good, C: Moderate, D: Insufficient, E: Bad

4.2 SQMS Model Inspection

In each phase of the project, items checked for nonconformity or defect in <Table 9> were selected for each phase of the project to derive key prevention and control activities such as <Table 9>. The derived Check List was supplemented to the Inspection Check List at each stage, and insufficient items were drawn for each phase to focus on the new project.

Table 9: Enhancements required for Phase-by-Phase focused prevention

Phase	Details of improvements
Preparation	· Clarify customer's role and number of inputs · Clarification of scope of work
Start	· 10% schedule buffer confirmation when establishing WBS · Team Building to a level that Project Leader can manage
Analysis & Design	· Agree program priorities with the customer · Re-agreement on the Development Scale through the Estimation of the Design Period
Development & Testing	· Strengthening the review of development programs on a two-week basis · Introducing automation tools to improve productivity
Open & Operation	· Agree pending status of remaining work

4.3 Qualitative and Quantitative expected effects

The expected effects of applying the quality techniques of this project can be summarized as in <Table 10>.

Table 10: Qualitative expectations

Division	Explain
Communication improvement	· Draws up shared and resolved issues for each team · Minimize the impact of progress, quality and cost of a project
Quantification of quality control	· Management by numericalizing them step by step · Performance management compared to target · Improving and clarifying the prevention list
Project Visibility	· Diagram the management and development status of a project · Overall project visibility based on tracking management

Building and operating a quality check process that meets the characteristics of an organization or project is an essential process to derive a successful project. The results of Initial phase quality results and management (Analysis) Phase and Implementation Phase Step after

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improvement can be summarized as in <Table 11> by over 20%.

Table 11: Quantitative expectations

Phase	Inspection Results		
	1	2	3
Preparation	55%	70%	83%
Start	60%	75%	85%
Analysis & Design	63%	72%	87%
Development & Testing	67%	79%	86%
Open & Operation	53%	67%	81%

5. CONCLUSION AND FUTURE DIRECTIONS

Establishing and operating a development process that conforms to the characteristics of an organization or project is an essential condition for achieving successful project results. And conducting quality control activities is an essential process for continuous value creation.

The differences between the quality techniques of this project and the previous quality techniques can be summarized as in <Table 12>.

Table 12: Differences from Prior SW Quality Management System (SQMS)

Division	Prior SQMS	After SQMS
Common	· Using Advanced Processes (CMMi,SPICE)	
SW Process	· Complexity	· Applied according to business characteristics · Simplify
Schedule	· Process-centric management (Start, Implement, Close)	· Project Milestone-centric management (Preparation, Start, Analysis & Design, Development & Testing, Open & Operation)
Resource	· SPG-centric progression	· Project Team Member-centric Progress · Project on its own
Quality control	· Document-centric management · Analysis by expert judgment	· System Automation Deployment · System-based analysis

The software development quality inspection management process model proposed in this thesis consists of quality diagnosis, step-by-step measurement and improvement, and to prevent project failure, check the process and check the outputs. Accordingly, the software's completeness was increased so that the budget, schedule, and quality of the project could be improved in a balanced manner. Analysis of 60 projects based on the software development quality inspection management process model over one year showed an improvement of more than 20% in performance capability for each project.

The expected effects of solving key issues in the development process using SQMS of this study are summarized in <Table 13> as Real Time Information, System Utilization, and Flexibility.

Table 13: Expected Effects of the Study

Division	After QMS
Real-Time Information	· Strengthen connection between departments · Increase efficiency of work by establishing information sharing system · Visualize the progress of the job in real time through business automation · Establishing a system of compliance with the delivery date · Facilitates rapid decision making with real-time analysis of work processes
System Utilization	· Improve the standard process compliance of development tasks · Reliable data for continuous process improvement · Increase system utilization through process-centric system auto linkage · Improve system utilization by effectively supporting on-site operations rather than administrative processes
Flexibility	· Increased flexibility of work through dynamic reflection of changes in development processes · Monitor task load, progress, delays, and performance indicators for each process step · Enhance integrated management of processes, organizations, and systems · Manage the history of the iterative process and derive improvement points

In the future, studies linked to data analysis tools in the cloud environment are needed for quality control so that improvements can be immediately identified by statistical analysis of project management and quality control in conjunction with PMS.

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