Investigative Report on Measure for System/Software Product
Quality Requirement Definition and Evaluation

March 2011

Ministry of Economy, Trade and Industry, Japan
Software Metrics Advanced Project
Product Quality Metrics Working Group

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Forward

The expectations placed on information systems and software products (hereinafter "system/software products") in citizens' lives and social economic activities in our country is ever increasing these days. On the other hand, the social impact caused by the suspension of business operations/services or decreased functionality due to system stoppage is strongly recognized. In the same way as for the services of other industries, the level of quality that system/software products should possess is called into question and at the same time there is a requirement for visualization and ensuring quality that complies with the users' needs.

In this situation, The Ministry of Economy, Trade and Industry has established the software metrics advanced project and set up the product quality metrics WG in order to improve the environment where users are able to use system/software products safely and securely. This WG is working on visualization of various qualities including reliability and security of system/software products and carrying out activities to form social shared awareness for them.

First of all the WG organized discussions related to measures in order to clarify the quality of various system/software products existing inside the country, and aggregated characteristics of discussion contents and mutual relationship in the form of a guide.[1] It is expected that discussions inside the country for measures and quality are understood and they will be used more profoundly with the pertinent guide. However, it is necessary to further form a shared awareness for different ideas and measurement methods for quality.

So, for the objective of establishing the quality of system/software products meeting the users' needs and to select measures that can be used commonly for establishment, the case research was performed and investigation was held for basic activities from quality requirement definition to quality evaluation and measures recommended for use for each quality characteristic. In this report, the pertinent contents are compiled.

It is expected that innovation in the IT industry of our country will accelerate and our safe and secure system/software products will acquire a place in the global market by establishing the social shared awareness of quality for system/software products.

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March 2011
Software Metrics Advanced Project
Product Quality Metrics WG

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[1] "Guide for visualization, ensuring and improvement of system/software quality"
http://www.meti.go.jp/policy/it_policy/softseibi/metrics/product_metrics.pdf

Software Metrics Advanced Project

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(As of March 2011)

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Composition of This Report

This report is composed as follows.

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1. Concept of the System/Software Quality Life Cycle Model and MeasuresMetrics

<< Description>>

Based on the concept of the system/software quality life cycle model in the ISO/IEC 25000 series, two basic activities for quality assurance of system/software products are described, they are quality requirement definition and quality evaluation.

<<Effects>>

It is possible to understand the basics of the quality assurance activities for system/software products.

2. Definition and Evaluation of System/Software Products Quality

<<Description>>

Activity content of quality requirement definition and quality evaluation in terms of quality assurance are explained. Further the concrete execution methods and the latest standard quality models that are required for execution methods are also explained, and definition contents are introduced using the preceding examples.

<<Effects>>

It is possible to learn about quality requirement definition and quality evaluation with examples using quality models and examples of ISO/IEC 25010.

3. Measures for Specifying Quality Requirements and Evaluating Quality

<<Description>>

Measures supporting the quality characteristics of ISO/IEC 25010, which can be used for quality requirement definition and quality evaluation are described.   Further, the domestic and international trends in quality measures when used for relatively difficult measurements are also described.

<<Effects>>

It is possible to learn about measures supporting the quality models of the ISO/IEC 25000 SQuaRE series, which can be used for quality requirement definition and quality evaluation.

4. Quality Requirement Definition Example for Three System Fields

<<Description>>

Quality requirement definition examples are shown for each phase and for each system field.

<<Effects>>

It is possible to learn about the characteristics of quality requirement definition for each system field.

Definition of terms

- System

  An aggregation that provides capabilities complying with the regulated needs or objectives by integrating more than one process, hardware, software, facility and personnel.

  Note)   Based on the definition of JIS X 0160-1996.

- Software

  A whole or part of a program, process, regulation and associated documentation regarding the information processing system.

  Note) Based on the definition of JIS X 0133-1 and JIS X 0129-1.

- System/software product

  Collective nominal name of both above mentioned system and software

- Software product

  An aggregation containing computer programs, procedures, associated documentation and data designated for distribution to users

  Note)   Interim products and products created for users including developers and maintenance persons are included.

  Note) Based on the definition of JIS X 0133-1 and JIS X 0129-1.

- Quality

  A whole characteristic related to capabilities complying with the clarified or implied needs of a certain "thing"

  Note) Based on the definition of JIS X 0133-1 and JIS X 0129-1.

- Software quality characteristics

  An aggregation of attributes of software products that describe and evaluate the quality of software products.   Quality characteristics of a given software can be deployed in the sub-characteristics of multiple hierarchies.

  Note)   Based on the definition of JIS X 0129-1

- Quality model

  An aggregation of characteristics and relationship between characteristics that can provide a basis for quality requirements and quality evaluation.

Note) Based on the definition of JIS X 0133-1 and JIS X 0129-1.

Remarks) The system/software product quality model including the system is regulated[2] as ISO/IEC 25010: Systems and software engineering – Systems and software product Quality Requirements and Evaluation （SQuaRE） – System and software quality models from JIS X 0129-1 （ISO/IEC9126-1） where the quality model for software products is regulated. Refer to the text for the contents of the pertinent quality model.
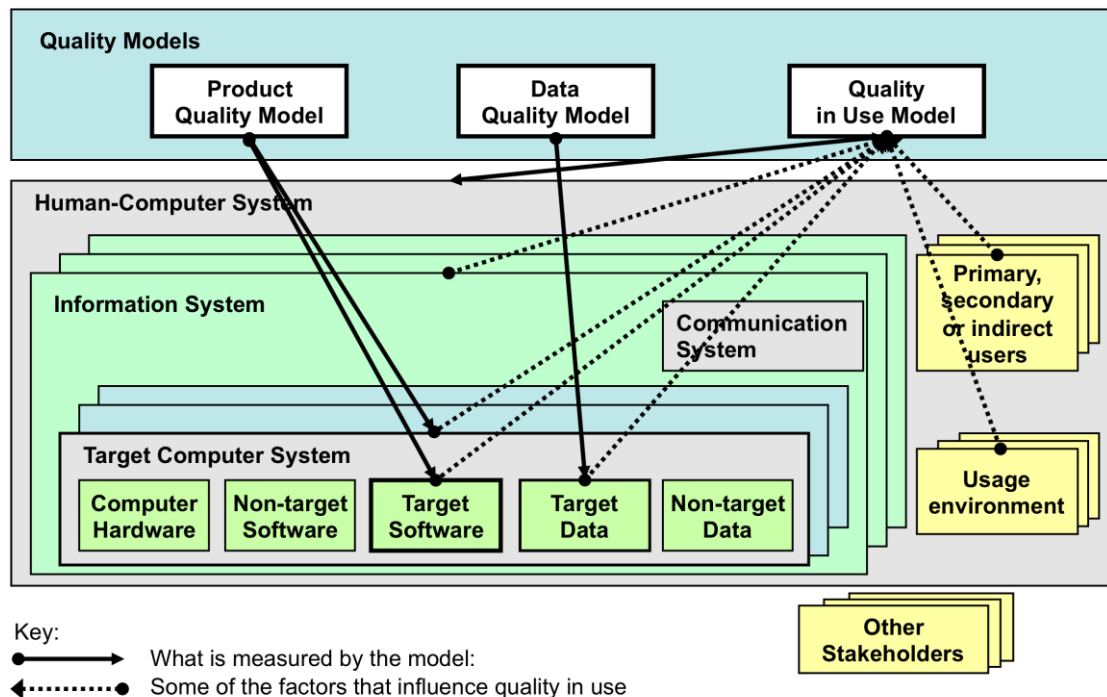
Fig. 0-1 Target of quality model in ISO/IEC 25010[3]

- Quality assurance

  All necessary planned and systematic activities for gaining the full faith that an item or product complies with defined technical requirements.

  Note) Based on ANSI/IEEE Std 730-1981

- Measure

  Variables to which the value is allocated as a result of measurement

  Note) The term "Measure" is used to refer to base measures, derived measures and indexes as a batch. In this report, measure is used to describe the measured volume.

  Note) Based on the definition of JIS X 0141-2009.

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[2] FDIS vote was passed as of Feb. 2011 and it is awaiting issuance as IS.

[3] ISO/IEC 25010: Systems and software engineering –Systems and software product Quality Requirements and Evaluation （SQuaRE） – System and software quality models

- Base measure

  Measured volume defined by a single attribute and method for quantifying the single attribute

  Note) Based on the definition of JIS X 0141-2009.

- Derived measure

  Measured volume defined as a function of the value of multiple base measures

  Note) Based on the definition of JIS X 0141-2009.

- Index

  Measured volume indicating the estimate or evaluation of specified attributes derived from the model regarding the defined information needs

  Note) Based on the definition of JIS X 0141-2009.
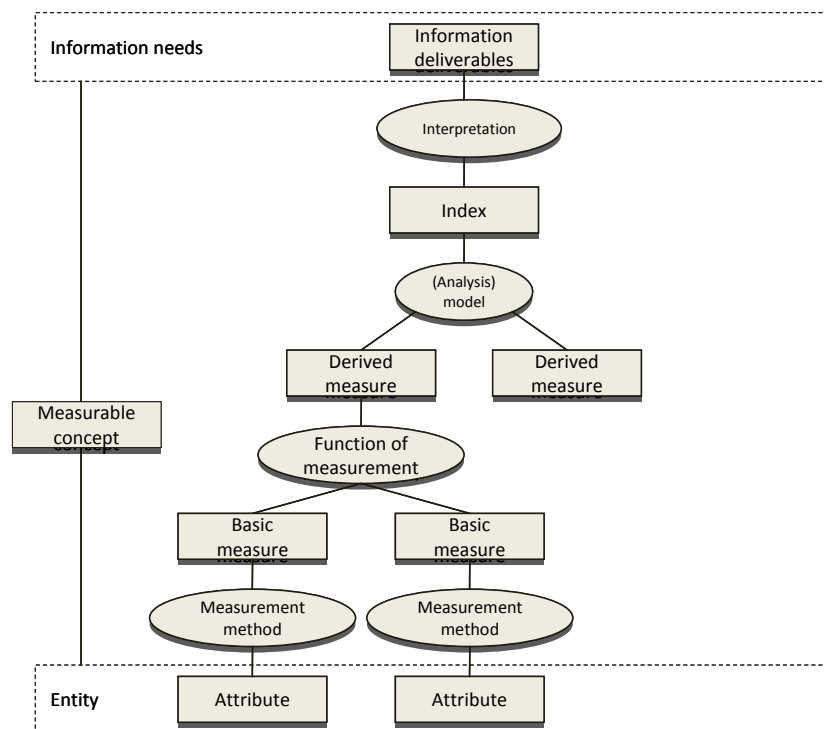
Fig. 0-2 Major relationship diagram for the measurement information model （JIS X0141:2009）

Table 0-1 Concrete example of measurement information model （JIS X 0141:2009）

Information needs	Evaluating the quality of deliverables at the coding work stage	
Measurable concept	Quality of deliverables	
Index	Defect density of design	
	Model	Calculating the average and control limit of the process using the value of defect density	
	Criteria	Necessary to perform follow-up research for the results outside the control limit range	
Derived measure	Defect density by review	
	Measurement function	Dividing the number of defects by scale for each spec.	
Base measure	Scale of spec.	No. of defects in spec.
	Measurement method	Counting No. of pages of spec.	Counting No. of defects listed up in the problem presentation tag
	Measurement method type	Objective	Objective
	Scale	Integer from zero to infinite	Integer from zero to infinite
	Scale type	Ratio scale	Ratio scale
	Unit of measurement	No. of pages	No. of defects
Attribute	Text of target spec. for review	List of defects extracted at review
Entity	Specification	Problem description tag

- Software life cycle process　(SLCP)

    Process of a series of tasks from development of software to operation and maintenance of the developed product.

    Note) Based on the definition of SLCP-JCF2007.

1. Concept of System/Software Quality Life Cycle and Measures

This chapter shows the concept of quality assurance activity through the system/software quality life cycle model and describes the position of measures in the quality assurance activities based on the international standard.

1.1 Relationship of Quality Assurance Activity and Measures based on the Quality Life Cycle

The system is realized by a combination of life cycles of computer system and software products composing the system. For instance, in order to realize the management system, first of all the current problem is analyzed, the requirements are clarified and the management system complying with the requirements is designed. Next, the required specification of the information system is analyzed and defined based on the design of the management system. This includes the quality requirement definition of the information system. Further, based on the system function requirements and quality requirements of the information system, the information system is designed. After that, the function requirements and quality requirements of software products are analyzed and defined based on the result of the information system design. As just described, the life cycles of a system and software product are inseparably connected.

For these system/software products, quality assurance is required in order to assure that the regulated quality requirements are realized. In the case of the quality life cycle model (Fig. 1-1) of software products in ISO/IEC 25000 SQuaRE series, quality assurance is carried out by the following two activities.

Definition of System/Software Product Quality Requirements

Sorting user needs, making requirements into specifications, determining necessary **quality in use requirement** and determining measures used for evaluation.

Determining the **system quality requirements** at the system level in the form of specification and determining measures used for evaluation

Determining **quality requirements of product** at the software level in the form of specification and determining measures used for evaluation.

Quality in use requirements

System Quality requirements

Software Product Quality requirements

Evaluation of appropriateness using measures

Validation/evaluation of appropriateness using measures

Validation/evaluation of appropriateness using measures

User needs

Development /Realization

Measuring the goal achievement status in the actual system environment

Measuring the degree of realization of software product in the system environment intended for operation

Evaluating the design specification and source code

Quality in use

System Quality (external quality)

software product Quality (internal quality)

Information system

Computer system

Computer system

Software   Data

Hardware   ftware

Software

Realizing a service by linking multiple computer systems

Realizing function by linking multiple software

Realizing function required with individual software

Evaluation of System/Software Product Quality

Fig. 1-1 Quality assurance activity based on the quality life cycle model

(1) Definition of system/software products quality requirements

A quality model is created after defining the important quality characteristics for the future system/software products, and the contents and significance of each quality characteristic of the model is defined quantitatively as the quality requirement specification using "measure".

(2) Quality evaluation of system/software products by measures

"Measure" in the quality requirement specification are measured and evaluated for the developed deliverable.

As described above, for the quality assurance activity of system/software products, evaluation by the quality requirement definition and measurement using measures becomes the important factor.

1.2 Quality Requirement Definition Phase in the Quality Life Cycle Model

The quality requirement definition of the system/software quality life cycle model is equivalent to the part from the users' needs to the quality requirements for software products in Fig. 1-1.   The contents of each phase are shown below.

- User's needs

  Stakeholders of system/software products including users discover some kind of issue in the current procedure and existing information system and have a need for a new or next generation information system.   This becomes users' needs.   Development of the next generation of information system/software products starts from collecting, recording and selecting these users' needs.

- Quality in use requirements

  Quality in use shows how well system characteristics satisfy the users' needs in order to achieve the target when using the system in the specified environment and specified usage context. Issues in the current system are analyzed from the users' needs after selection and they are sorted out as the specification.   The quality and characteristics required for the specification are defined using measures and they are the quality in use requirements.

- System quality requirements

  System Quality shows the overall characteristics of software products defined to comply with clarified or implied needs when the system is used under the specified conditions.   Requirement spec. of individual system level is designed from the quality in use requirements for the current system and quality and characteristics required for each specification are defined using measures, and they are the system quality requirements.

- Software product quality requirements

  Software product Quality indicates the overall characteristics of attributes (software design, structure and components are included) defined to comply with clarified and implied needs when software products are used under the specified conditions.   Requirement specifications of software products (including interim deliverables such as document and source code) that compose the system are designed based on the requirement specifications and quality requirements of the system and the characteristics of the required quality and the contents related to the characteristics are defined using measures, and these are the software product quality requirements.   They can be

used as an evaluation and validation standard at the development stage.

As described above, for the quality requirement definition, quality in use requirements, system quality requirements and software product quality requirements for users' needs are defined using the quality model and measures.

1.3 Quality Evaluation Phase in the Quality Life Cycle Model

Quality evaluation in the system/software quality life cycle model is equivalent to the part from development/realization to quality in use in Fig. 1-1. The contents of each phase are shown below.

- Development/realization

  Development of software products is carried out based on the regulated quality requirements.

- Evaluation of software product quality   (internal quality)

  Achievement degree of quality of software products is validated according to the measurement method of the measures and rating standard defined in the quality requirement specification of software products.

- Evaluation of system quality   (external quality)

  Achievement degree of quality of system is validated and checked according to the measurement method of the measures and rating standard defined in the quality requirement specification of the system at the integrated test corresponding to the actual usage.

- Evaluation of Quality in use

  The degree to which a user can achieve the goal under the specific environment is checked and evaluated according to the measurement method of the measures and rating standard defined as the quality in use requirement specification.

As described above, for quality evaluation, how well system/software products meet regulated requirements is evaluated using the measurement data by measures.

2. Definition and Evaluation of System/Software Products Quality

In this chapter, the basic activities of quality requirement definition and quality evaluation for quality assurance are explained, and execution method and execution examples at each phase are introduced.

2.1 Definition of System/Software Products Quality Requirement

In this section, activity contents at each phase are explained in relation to the system/software product quality requirement definition, and execution method and execution examples are introduced.

2.1.1 Activity Contents of Quality Requirement Definition Phase

Phase of the quality requirement definition in the system/software product quality life cycle model is shown in Fig. 2-1.
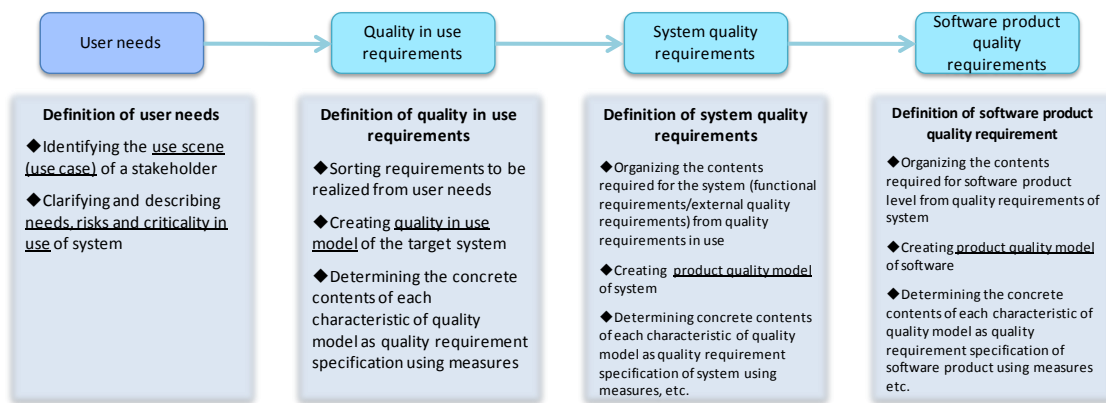
Fig. 2-1 Quality requirement definition in the quality life cycle model

Activity contents of each phase of the quality requirement definition are as shown below.

(1) Definition of users' needs

Multiple stakeholders actually related to the system are specified, and needs, risks and issues for the existing system are summarized based on the scene (use case) where each stakeholder uses the system.

(2) Definition of quality in use requirements

The requirements to be realized are selected from a list of needs, risks and issues taking into account the significance degree, the important quality characteristics are selected referring to the quality model at standard usage regulated in ISO/IEC 25010 and they are defined as the quality in use model

of the target system. Further, the concrete quality requirements are defined quantitatively using measures in order to clarify the significance degree of the defined quality characteristics and to measure the degree of realization.

(3) Definition of the system quality requirements and the software product quality requirements

The system quality requirements are analyzed and defined as a specification in order to realize the requirements in use as functions and services. At this time, in the same way as for quality in use requirements, the important quality characteristics are selected referring to the standard system/software product quality model regulated in ISO/IEC 25010 and the quality model of the target product is determined. Further, the system quality requirements are defined quantitatively using measures.

For the software product quality requirements, the same procedure is taken, namely design contents of system obtained from the system quality requirement are analyzed and the software product quality requirements are defined quantitatively.

2.1.2　Quality Requirement Definition Method and Case Studies

（1）**Specification method of users' needs an example**

（a）Specification method

For the consideration of new or next generation system/software products, first of all, various stakeholders including direct users, indirect users, operation controllers and owners are sorted out.

Next, needs and risks for the current system/software products are considered by anticipating the usage scenario (use case) for each stakeholder and the results are compiled into a list.

Stakeholder (user class)	Usage scenario	Needs/Risk/ Issue	Degree of importance
A（‥）	・・・	・・・	・・・
B（‥）	・・・	・・・	・・・
・・・	・・・	・・・	・・・

Fig. 2-2　Example of a list of needs, risks and issues for stakeholders

Table 2-1 shows a classification of user classes for identification of characteristics of

users.　It is possible to consider the functions that system/software products should be furnished with, operation method or handling method of defects including malfunction according to the characteristics of user classes.　For instance in the case of system/software products used mainly by the beginner user class, "easy to understand the operation at one view" or "system is designed in a manner that no serious impact is caused even if a malfunction occurs" can be included in the required needs.

Table 2-1　Classification of user classes

User class　(targets)	Meaning
Beginner　(person)	Unspecified users who are not always required to receive education on usage method before using the information system/software products E.g.) usage of ATM, ticketing system and internet service
Intermediate　(person)	Specified users who are required to receive education on usage method before using the information system/software products E.g.) usage of enterprise type systems
Advanced　(person)	Users who can maintain on their own or give concrete instruction when the information system/software products have an issue E.g.) monitoring system
Others　(system)	Other system/software products

（b）Case Studies

Table 2-2 shows the actually anticipated case studies of users (stakeholders), user classes and usage scenarios when realizing system/software products.　Moreover, the main functions that are regarded as necessary for these usage scenarios and furnished are also shown.

User class　(targets)	Table 2-2
Beginner　(person)	1
Intermediate　(person)	2
Advanced　(person)	3
Others　(system)	4

Table 2-2 Usage Scenario (Case Study) 1/3

Case #	(Field)System	Stakeholder	User class 1	User class 2	User class 3	User class 4	Usage scenario	Required main functions
1	(Finance/Insurance) Stock trading system	Securities company		X			Placing new orders, changing or canceling orders	Checking the order data and returning an acceptance notice
		Securities company		X			Receiving the result of checking up processing	Returning a contract result notice
		Information vendor			X		Receiving market information	Transmitting market information
		Stock div.			X		Monitoring the market	Receiving an inquiry from the trading control terminal, creating pertinent data and sending it back to the terminal
		Stock div.			X		Taking a regulatory measure including cessation of trading	Stopping trading of target shares, etc. upon indication from the trading control terminal
		Settlement system				X	Receiving contract data and carrying out the settlement processing	Sending contract data to settlement system on a regular basis
2	(Finance/Insurance) Insurance product capitalization system	Agent		X			Insurance premium amount can be calculated correctly with the contents input on the trial calculation screen of insurance product	Calculating insurance premiums with the contents input on the trial calculation screen for each product
		Agent		X			Creating an estimate based on calculated premium	Creating an estimate to be presented to a customer according to the result of premium calculation
		Agent		X			Creating an application form based on calculated premium	Creating an application to be presented to a customer according to the result of premium calculation
		Agent		X			Reporting the contents of insurance contract concluded with a customer to a company	Carrying out posting process to the system of an insurance company from creation data of application form
		Employee		X			Checking data reported by an agent	Indicating errors in data to be posted/processed
3	(Finance/Insurance) Financial institution counter terminal system	Bank clerk		X			Carrying out the counter business	Communicating with a host, inputting electronic statement and displaying the result

Table 2-2 Usage Scenario (Case Study) 2/3

Case #	(Field)System	Stakeholder	User class 1	2	3	4	Usage scenario	Required main functions
4	(Transport) Auto fare collection system using contactless IC card	Station staff		X			Issuing/selling IC cards	Issuing new IC cards (registration of information) and selling them to customers
		Passenger	X				Passing the ticket gate by presenting an IC card	Reading/writing IC card, controlling ticket gate door, processing usage information
		Customer	X				Shopping using IC card	Device or network capable of reading and writing IC card is required at the shop
		Passenger	X				Charging money to IC card	Ticketing machine writes the amount of money paid to the IC card
		Station staff		X			Registering for re-issuance of IC card in the event of loss	Re-issuance and registration for lost or damaged IC cards (new card registration, invalidation of old card)
5	(Electricity) Power supply, customer information control system	Meter reader		X			Reading the value indicated on the wattmeter and reporting the amount used to the customer	Extracting the indicated value from electricity meter to the business use terminal using communication function. Calculating the amount used and electricity rate based on the indicated value and issuing the slip.
		Receptionist		X			Researching the usage result and consulting to respond to inquiries about electricity usage method from customers	Indicating a record of figures indicated on a meter and electricity amount used for each time zone. Indicating parameters and analysis result for consulting.
		Operator		X			Starting or stopping electricity supply upon application from a customer to move in or out	Turning on or off the electric power meter from business use terminal using communication function. Calculating amount of electricity used at moving out on the business use terminal using communication function.
6	(Electricity) Information system providing customer information	Contractant	X				Referring to customer information	Specifying the customer
		Contractant	X				Referring to customer information	Providing latest information
		Contractant	X				Checking notices	Sending mail
		Employee		X			Handling inquiries	Accumulating history
7	(Agriculture) Agricultural information system	Japan Agriculture staff Agriculture worker		X			Monitoring the growth status of crops	Indication on maps of agricultural fields, indication of growth status of crops (coloring)
		Buyer including retailers		X			Checking the production site of crops	Outputting production history information of crops
8	(Disaster prevention) Earthquake early warning service	User (general)	X				When an occurrence of a strong quake is detected, receiving the alert automatically before it comes	Sounding alarm, flashing a lamp, stopping a machine automatically and calling associated people for emergency assembly (automatically) based on the received alert

Table 2-2 Usage Scenario (Case Study) 3/3

Case #	(Field)System	Stakeholder	User class				Usage scenario	Required main functions
			1	2	3	4		
9	(Content/information provision) EC SITE, Cyber mall	Consumer	X				Shopping	Searching products, authorizing individuals and making settlement
		Shop		X			Displaying products	Registering products, writing ad statements and controlling inventory
		Shop		X			Selling products	Making settlement, controlling inventory, controlling customers and carrying out distribution delivery
		Management		X			Placing an ad	Making recommendations, personalization
		Management		X			Recovering from errors	Notifying with mail when an error occurs
10	(Content/information provision) Multi player online game system used from mobile/PC	Player	X				Purchasing items used for games	Purchasing items using e-money (updating e-money balance granting items)
		Player	X				Playing games	Functions in general that configure each game
		Game operator			X		Determining cause and recovering errors if a problem occurs with a game	Displaying action history of a player Recording operation log of system
11	(Contents/information provision) Various information provision, Registration system	User	X				Searching or referring to desired information by specifying various conditions	Searching target information accurately and speedily, and returning a quick response (no stress for usage)
		User	X				Storing information of each individual in a system, including search results (bookmarks) and booking for participation in an event	A system should be created firmly so that no personal information leaks
		User	X				Possible to use for 24 hours 365 days except during regular maintenance time zone	Necessary to form HA composition[4] in order to minimize the risk of inability to provide service
12	(School/education) Educational learning system, Contents control system	User	X				Learning on web	Recording usage status, learning history and true/false result, and indicating the grade report
		Controller		X			Registration of teaching material contents and registration of master data	Adding/changing/deleting teaching material contents control function (CMS) and master data
		Tutor		X			Dispatching information to users	Sending mail, adding/changing bulletin boards
13	(Development tool) Built-in design supporting tool	Built in developer			X		Analyzing based on software requirements and extracting software component	Allocating software component Associating data and timing flow between software components
		Built in developer			X		Registering reusable software components with DB	Selecting software components Registering with DB Deleting from DB as necessary
		Built in developer			X		Designing using software components registered with DB	Searching for software components in DB Taking out software components and reallocating them

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[4] HA composition: System composition that realizes high availability

（２）**Quality in use requirement definition method and case studiess**

（a）Definition method

For definition of quality in use requirements, the contents to be realized are selected from a list of needs, risks and issues obtained through anticipating the usage scenarios for the specified stakeholders taking into account the degree of importance.

Based on the selected contents, quality characteristics in use that are considered important for the pertinent system/software products are determined referring to the standard quality in use model in ISO/IEC 25010, and the quality in use model for the target system/software product is created. After that, the contents of quality requirements are defined concretely and quantitatively using measures.
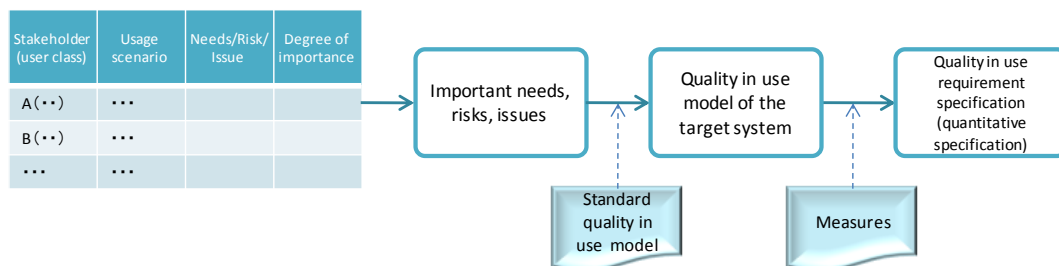
Fig. 2-3   Definition of quality in use requirements

（b）Standard quality model in use

The standard quality in use model was regulated in ISO/IEC 9126-1 (JIS X 0129-1), and it was revised in ISO/IEC 25010 after that.   The quality in use model that is regulated as standard in ISO/IEC 25010 is shown in Fig. 2-4. It is possible to determine the quality in use model for the target system/software product by determining important quality characteristics referring to this quality model and discuss the concrete quality requirements.

Fig. 2-4　Quality in Use Model[5]

The following are the contents of the quality characteristics composing the quality in use model of ISO/IEC 25010.

[1]　Effectiveness

Accuracy and completeness with which users achieve specified goals

[2]　Efficiency

Resources expended in relation to the accuracy and completeness with which users achieve goals

[3]　Satisfaction

Degree to which user needs are satisfied when a product or system is used in a specified context of use.　The following are the sub-characteristics.

Usefulness

Degree to which a user is satisfied with their perceived achievement of pragmatic goals, including the results of use and the consequences of use

Trust

Degree to which a user or other stakeholder has confidence that a product or system will behave as intended

Pleasure

Degree to which a user obtains pleasure from fulfilling their personal needs

Comfort

Degree to which the user is satisfied with physical comfort

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[5]　Quoted from ISO/IEC 25010, Japanese translation is temporary translation.

[4]　Freedom from risk

Degree to which a product or system mitigates the potential risk to economic status, human life, health or the environment. The following are the sub-characteristics.

Economic risk mitigation

Degree to which a product or system mitigates the potential risk to financial status, efficient operation, commercial property, reputation or other resources in the intended contexts of use

Health and safety risk mitigation

Degree to which a product or system mitigates the potential risk to people in the intended contexts of use

Environmental risk mitigation

Degree to which a product or system mitigates the potential risk to property or the environment in the intended contexts of use

[5]　Context coverage

Degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in both specified contexts of use and in contexts beyond those initially explicitly identified.　The following are the sub-characteristics.

Context completeness

Degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in all the specified contexts of use

Flexibility

Degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in contexts beyond those initially specified in the requirements

（c）Case Studies

Table 2-3 shows examples of needs and risks in use of system/software products and related quality characteristics and quality requirements.

Table 2-3 Relationship of important needs in use, quality characteristics and requirements (Case Study)1/3

Case #	System	Stakeholder	Important needs, risks in use	Quality characteristic	Sub-quality characteristic	Quality in use requirements
1	(Finance/insurance) Stock trading system	Securities company, Information vendor, Employee, Settlement system	Due to promotion of globalization and borderlessness in finance and advancement of PTS[6] inside the country, trading may flow outside if no effective system is provided	Effectiveness	Effectiveness	Connection spec. (protocol) determined after working with securities company Data processing performance
			System of securities company that connects with the Securities Exchange system is constructed by Securities Exchange according to connection spec. Therefore, if the behavior of a system on the Securities Exchange is different from spec., a system on securities company side may not operate properly and securities trading may not be made	Satisfaction	Trust	The requirement trace result is 100% in the processes from design ~ test
			If stock CB trading system shuts down or causes data deficit, Japanese economy will be thrown into confusion.	Freedom from risk	Economic risk mitigation	Assuring order property of data processing Data triplexing Complete duplexing of equipment
2	(Finance/insurance) Insurance product capitalization system	Agent Employee, Employee	Avoiding the risk of causing inconvenience to a policyholder due to incorrect calculation of insurance premium.	Effectiveness	Effectiveness	<N/A>
			Avoiding the risk of causing inconvenience to a policyholder due to incorrect calculation of insurance premium.	Freedom from risk	Economic risk mitigation	<N/A>
			Premium calculation, insurance posting system handles information directly connecting to customers' risks, so it needs to be used in a secure manner.	Context coverage	Context completeness	<N/A>
3	(Finance/insurance) Financial institute counter terminal system	Bank clerk	It is a premise that the financial terminal function properly.	Effectiveness	Effectiveness	Functionality
			It is the highest priority to provide a system that satisfies the user (bank clerk) of a financial terminal.	Satisfaction	Usefulness	Usability requirements
			Reduction of operation cost is important as a part of overall cost, and non-cost type figures such as reputation are also important.	Freedom from risk	Economic risk mitigation	Operation requirements

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[6] PTS; Abbreviation of Proprietary Trading System General name of the buy and sell system where securities companies buy and sell stocks, etc. without financial instrument exchange (stock market).

Table 2-3 Relationship of important needs in use, quality characteristics and requirements (Case Study) 2/3

Case #	System	Stakeholder	Important needs, risks in use	Quality characteristics	Sub-quality characteristics	Quality in use requirements
4	(Transport) Auto fare collection system using contactless IC card	Station staff, Passenger, Customer	Data on media (card) and system needs to be consistent.	Effectiveness	Effectiveness	Functional completeness of data
			Possible to pass the ticket gate smoothly with simple action even at busy times.	Satisfaction	Usefulness	Accurate and high speed processing of reading, writing and fare calculation
			Operation can be continued even at malfunction or disaster.	Freedom from risk	Economic risk mitigation	Autonomous distribution system configuration
5	(Electricity) Power supply, customer information control system	Meter reader, Receptionist, Operator	Incorrectness of usage objective loses appropriateness when carrying out business.	Effectiveness	Effectiveness	Consistency of overall flow of business and spec.
			The main section is sensitive to the usage state after operation starts, and convenience is required.	Satisfaction	Usefulness	Incorporation of improvement request from main section to the actual site
			The sales business is a business with higher priority.	Satisfaction	Trust	Operation state monitoring after starting operation
6	(Electricity) Information system providing customer information	Contractant, Employee	Drawing interest from a customer.	Satisfaction	Usefulness	Specifying a customer
			Dispatching messages for the effective usage of resources (electricity) and contributing to environmental protection.	Freedom from risk	Environmental risk mitigation	Providing update information
			Dispatching messages for the effective usage of resources (electricity) and contributing to reduction of customer's cost.	Context coverage	Context completeness	Providing update information
7	(Agriculture) Agricultural information system	Producer, Buyer	Harvesting at the most suitable time.	Effectiveness	Effectiveness	Monitoring the difference in dryness level of crops for each agricultural area using satellite images.
			Reducing problems of drying crops after harvest.	Efficiency	Efficiency	Possible to monitor dryness level of broad area using satellite image, without checking on the site.
			The displayed contents of the system must match with the actual status.	Satisfaction	Trust	Relative dryness degree of crops and dryness degree assumed from the satellite image should match.
8	(Disaster prevention) Earthquake early warning service	User (general)	Because this is extremely important social information directly related to human life and property, no stoppage or incorrect information is permissible.	Effectiveness	Effectiveness	Functional correctness of information without false reporting Processing speed (delay in unit of sec. affects life)
				Efficiency	Efficiency	Execution of duplication of system and distribution of data centers
				Satisfaction	Trust	Furnishing of 24 hours 365 days monitoring of overall system including terminals
				Freedom from risk	Health and safety risk mitigation	Processing speed (delay in unit of sec. affects life)

Table 2-3 Relationship of important needs in use, quality characteristics and requirements （Case Study）3/3

Case #	System	Stakeholder	Important needs, risk in use	Quality characteristics	Sub-quality characteristics	Quality requirements in use
9	(Content/information provision) EC SITE, Cyber mall	Consumer, Shop, Self company	Products that the customer wants are displayed and they are purchased properly.	Satisfaction	Usefulness	Matching content, search result display performance
			There is a sense of bargain and individuality.	Satisfaction	Pleasure	Point service, personalized recommendation
			Safe settlement is possible.	Freedom from risk	Economic risk mitigation	Personal information protection, electronic settlement
			PC, mobile phone or smart phone can be used anytime anywhere.	Context coverage	Context completeness	Display performance, screen configuration
10	(Contents/information provision) Multi player online game system used from mobile/PC	Player, Game operator	If satisfaction is not provided, the system itself is not used.	Satisfaction	Usefulness	Requirements in general
			Causing users to want to use the system continuously.	Satisfaction	Pleasure	Requirements in general
			Preventing flaming due to negative information against the game in order to eliminate illegal usage of the game.	Freedom from risk	Economic risk mitigation	Requirements in general （functions related to strength/progress degree of a player, requirements for communication functions in a game in particular）
11	(Content/information provision) Various information provision, Registration system	User	Providing information required by a user (meeting their needs)	Effectiveness	Effectiveness	Displaying the search function, list → detailed data, updating data in a short cycle (provision of latest information, etc.)
			Providing information that sufficiently satisfies a user	Satisfaction	Usefulness	Storage of default search conditions and search results for each usage objective
			Service (system) is easy to use and convenient for the user.	Satisfaction	Trust	Provision of usability in the regular web system range (manual is not necessary, usable intuitively)
			Possible to enjoy using a service (system) (there is a new discovery)	Satisfaction	Pleasure	Provision of information using images or animation, provision of recommended information
12	(School/education) Educational learning system, Contents control system	User, Controller, Tutor	Presenting the progress status of learning and the result correctly to the user. Even if they are used simultaneously, there is a need to give an appropriate response.	Effectiveness	Effectiveness	Learning history function Result aggregation function
			Making a user improve his/her academic ability and maintain	Satisfaction	Pleasure	Grade display function

Case #	System	Stakeholder	Important needs, risk in use	Quality characteristics	Sub-quality characteristics	Quality requirements in use
			continuous will to learn.			Bulletin board function
			Providing service to a user in such a manner as to promote continued learning, and the user can use it with no stress.	Freedom from risk	Economic risk mitigation	Response requirements Simultaneous connection requirements
			Providing accurate true/false results and grades. Providing appropriate curriculum.	Context coverage	Context completeness	Teaching material distribution function
13	(Development tool) Built-in design supporting tool	Built in developer	If design information is not recorded and reproduced properly, the target software for development will not be designed correctly.	Effectiveness	Effectiveness	All drawing information is restored properly.
			Because a new design technique is used, the advantage of using the technique itself is understood.	Satisfaction	Pleasure	Improvement of reusability of target software for development
			Even in a state where the PC environment cannot be specified completely, operation is carried out with satisfactory performance.	Context coverage	Context completeness	Not limiting action of other applications. Not locking OSs.

Table 2-4 is a result of summarization of important characteristics for users' needs.

Table 2-4 Important characteristics for users' needs (Case Study) 1/2

Case #	(Field)System	Outline	Effectiveness	Efficiency	Satisfaction				Freedom from risk			Context coverage	
			Effectiveness	Efficiency	Usefulness	Trust	Pleasure	Comfort	Economic risk mitigation	Health and safety risk mitigation	Environmental risk mitigation	Context completeness	Felicity
1	(Finane/insurance) Stock trading system	Making domestic or international financial transactions at high speed and with high reliability and safety	X			X			X				
2	(Finane/insurance) Insurance product capitalization system	Calculating correctly in a manner that gives rise to no economic risk	X						X				X
3	(Finane/insurance) Financial institute counter terminal system	Processing correctly as required at low cost	X		X				X				
4	(Transport) Auto fare collection system using contactless IC card	Functional completeness of data between card and system, accurate and high speed processing of reading/writing and fare calculation	X		X				X				
5	(Electricity) Power supply, customer information control system	Operating accurately and effectively for the business objectives	X		X	X							
6	(Electricity) Information system providing customer information	Providing latest information			X						X	X	
7	(Agriculture) Agricultural information system	Processing data accurately for efficient agricultural work	X	X		X							
8	(Disaster prevention) Earthquake early warning service	Processing life support information without discontinuance or false report	X	X		X					X		

*Shaded parts show specific characteristics in the Case Study # 1 ~ 3 (finance/insurance field), #4 ~ 8 (public field) and #9 ~ 13 (Web/content field).

Table 2-4 Important characteristics for users' needs (Case Study) 2/2

Case #	(Field)System	Outline	Effectiveness	Efficiency	Usefulness	Trust	Pleasure	Comfort	Economic risk mitigation	Health and safety risk mitigation	Environmental risk mitigation	Context completeness	Felicity
			Effectiveness	Efficiency	Satisfaction				Freedom from risk			Context coverage	
9	(Contents/information provision) EC SITE, Cyber mall	Possible to purchase desired items at any time safely			X		X		X			X	
10	(Contents/information provision) Multi player online game system used from mobile/PC	Providing satisfactory contents in a stable and continuous manner			X		X		X				
11	(Contents/information provision)Various information provision, Registration system	Possible to access desired information efficiently and happily	X		X	X	X						
12	(School/education) Educational learning system, Contents control system	Providing effective and attractive information to users, which they can use without stress	X				X		X		X		
13	(Development tool) Built-in design supporting tool	Operating in correct and satisfactory manner in any kind of environment	X				X					X	

*Shaded parts show specific characteristics in the Case Study # 1 ~ 3 (finance/insurance field), #4 ~ 8   (public field) and #9 ~ 13 (Web/content field).

Table 2-5 shows the summarized result of characteristics of quality in use model for each system field.

In the case of system/software products (#1 ~ 3) in the finance/insurance field, effectiveness and economic risk mitigation tend to be emphasized. For system/software products (#4 ~ 8) in the public field such as transportation, electricity and disaster prevention where improvement of the convenience related to local residents' lives, effectiveness, usefulness and trust tend to be emphasized. For system/software products (#9 ~ 13) in the web/content field where unspecified users handle information freely, pleasure tends to be emphasized.

Table 2-5 Quality in Use Characteristics for each system field (Case Study)

System field	Main user needs, risks	Quality in use characteristics
System/software product in finance/insurance field (#1 ~ #3)	・ If a useful system is not provided, transactions will outflow. (#1) ・ Avoiding the risk of causing inconvenience to a policyholder due to incorrect calculation of insurance premium. (#2) ・ It is a premise that financial terminals function correctly. (#3)	Effectiveness (Effectiveness)
	・ If stock CB trading system shuts down or causes data deficit, Japanese economy will be thrown into confusion. (#1) ・ Avoiding the risk of causing inconvenience to a policyholder due to incorrect calculation of insurance premium. (#2) ・ Reduction of operation cost is important as a part of overall cost, and non-cost type figures such as reputation are also important. (#3)	Economic risk mitigation (Freedom from risk)
System/software product in public field (#4 ~ #8)	・ Data on media (card) and system needs to be consistent. (#4) ・ Incorrectness of usage objective loses appropriateness when carrying out business. (#5) ・ Harvesting at the most suitable time. (#7) ・ Involving people's lives and property directly, so stoppage and false reporting are not permissible. (#8)	Effectiveness (Effectiveness)
	・ Possible to pass the ticket gate smoothly with simple action even at busy times. (#4) ・ The main section is sensitive to the usage state after operation starts, and convenience is required. (#5) ・ Drawing interest from a customer. (#6)	Usefulness (Satisfaction)
	・ The sales business is a business with higher priority. (#5) ・ The displayed contents of the system must match with the actual status. (#7) ・ Involving people's lives and property directly, so stoppage and false report are not allowed. (#8)	Trust (Satisfaction)
System/software product in web/content field (#9 ~ #13)	・ There is a sense of bargain and individuality. (#9) ・ Causing users to use a system continuously. (#10) ・ Possible to use a service (system) happily (there is a sense of new discovery).(#11) ・ Making a user improve his/her academic ability and maintain continuous will to learn. (#12) ・ Because a new design technique is used, the advantage of using the technique itself can be understood. (#13)	Pleasure (Satisfaction)

（3）**Quality requirement definition method and case studies of system/software products**

（a）Definition method

For definition of quality requirements of system/software products, needs in use and quality requirements are further materialized and outlined in detail in order to realize them as functions and services, the content of functional requirements and quality requirements are analyzed and the results are defined as the requirement specifications for system or software products.

In the same way as for the quality requirement in use, the important quality characteristics are selected at analyzing referring to the standard system/software product quality model in ISO/IEC 25010 and the quality model for the target product is created. After that, the contents of functional requirements and quality requirements are defined concretely and quantitatively using measures.
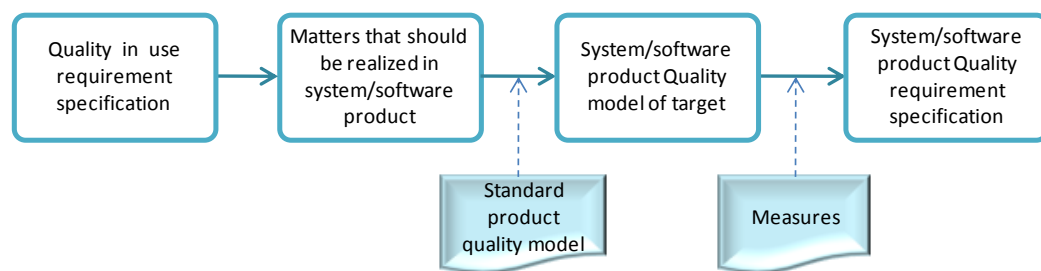
Fig. 2-5　Definition of system/software products quality requirements

（b）Standard system/software products quality model

The standard software product quality model is regulated in ISO/IEC 9126-1 (JIS X 0129-1), and it was revised in ISO/IEC 25010 afterwards. The quality model for system/software products that is regulated as the standard in ISO/IEC 25010 is shown in Fig. 2-6.

It is possible to determine the quality requirements by determining the quality model of the target system/software product through selecting important quality characteristics referring to this quality model.
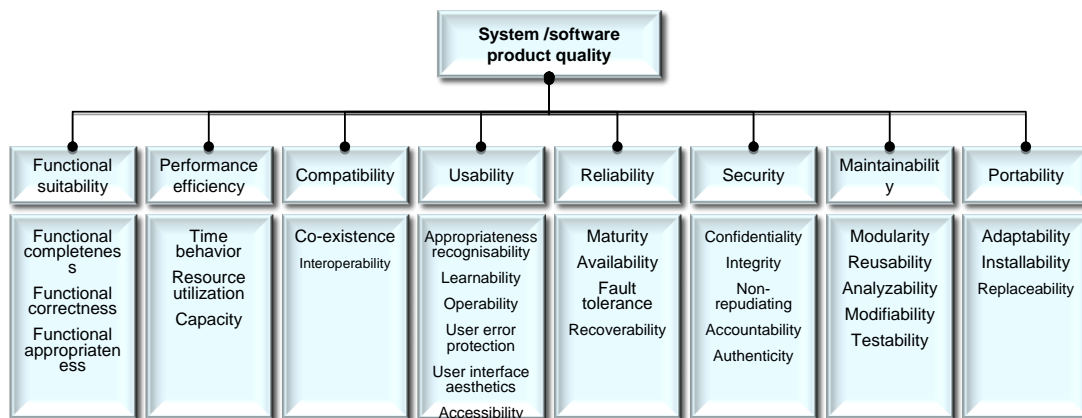
Fig. 2-6 System and Software Product Quality Model[7]

The following are the contents of the quality characteristics composing the quality model of system/software product in ISO/IEC 25010.

[1]   Functional Suitability

Degree to which a product or system provides functions that meet the stated and implied needs when used under specified conditions.   The following are the sub-characteristics.

Functional completeness

Degree to which the set of functions covers all the specified tasks and user objectives

Functional correctness

Degree to which a product or system provides the correct results with the needed degree of precision

Functional appropriateness

Degree to which the functions facilitate the accomplishment of specified tasks and objectives

[2]   Performance efficiency

Performance relative to the amount of resources used under stated conditions
The following are the sub-characteristics

Time behavior

Degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements

Resource utilization

Degree to which the amounts and types of resources used by a product or system when performing its

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7 Quoted from ISO/IEC 25010, Japanese translation is a temporary translation

functions meet requirements

Capacity

Degree to which the maximum limits of a product or system parameter meet requirements

[3] Compatibility

Degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions, while sharing the same hardware or software environment   The following are the sub-characteristics.

Co-existence

Degree to which a product can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product

Interoperability

Degree to which two or more systems, products or components can exchange information and use the information that has been exchanged

[4] Usability

Degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use
The following are the sub-characteristics.

Appropriateness recognisability

Degree to which users can recognize whether a product or system is appropriate for their needs

Learnability

Degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use

Operability

Degree to which a product or system has attributes that make it easy to operate and control

User error protection

Degree to which the system protects users against making errors

User Interface aesthetics

Degree to which the user interface enables pleasing and satisfying interaction for the user

Accessibility

Degree to which a product or system can be used by people with the widest range of characteristics and

capabilities to achieve a specified goal in a specified context of use

[5]   Reliability

Degree to which a system, product or component performs specified functions under specified conditions for a specified period of time

The following are the sub-characteristics.

Maturity

Degree to which a system meets needs for reliability under normal operation

Availability

Degree to which a system, product or component is operational and accessible when required for use

Fault tolerance

Degree to which a system, product or component operates as intended despite the presence of hardware or software faults

Recoverability

Degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the desired state of the system

[6]   Security

Degree to which a product or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization   The following are the sub-characteristics.

Confidentiality

Degree to which a product or system ensures that data is accessible only to those authorized to have access

Integrity

Degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data

Non-repudiation

Degree to which actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later (digital signature, etc.)

Accountability

Degree to which the actions of an entity can be traced uniquely to that entity

Authenticity

Degree to which the identity of a subject or resource can be proved to be the one claimed

[7] Maintainability

Degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers
The following are the sub-characteristics.

Modularity

Degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components

Reusability

Degree to which an asset can be used in more than one system, or in building other assets

Analyzability

Degree of effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified

Modifiability

Degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality (modifiability, stability in ISO/IEC 9126 series)

Testability

Degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met

[8] Portability

Degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another.
The following are the sub-characteristics.

Adaptability

Degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments

Installability

Degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment

Replaceability

Degree to which a product can be replaced by another specified software product for the same purpose in the same environment

（c）Case Studies

Table 2-6 shows case studies of the needs and risks for a system and software product, and quality characteristics and requirements corresponding to them.

Table 2-6 Relationship of important needs, system/software quality characteristics and requirement (Case Study) 1/3

Case #	System	Stakeholder	Important needs, risk for system/software product	Quality characteristics	Sub-quality characteristics	System/software product quality requirement
1	(Finance/insurance)Stock trading system	Securities company, Information vendor, Employee, Settlement system	If there is a function that does not work as expected, illegal data processing may be carried out and market may be confused.	Functional suitability	Functional completeness	Requirement trace result is 100% in the processes of design ~ test
			If incorrect data processing is carried out, significant loss of trust in the market will result.	Functional suitability	Functional correctness	Requirement trace result is 100% in the processes for designing ~ testing Evaluating quality using test density and bug density.
			While the mechanization of the orders placed by securities companies is promoted, if data is not processed promptly, funds will outflow to the market of other countries.	Performance efficiency	Time behavior	New order reception processing: 2mili. sec.
			If it's not possible to provide a system complying with user's needs, funds may outflow from the market.	Usability	Appropriateness recognisability	Connection spec. (protocol) determined after working with securities company.
			Incorrect order placed by a securities company or improper data transmission due to a fault in the system on the securities company side may bring confusion to the market.	Usability	Appropriateness recognisability	Checking the functional appropriateness of the amount of orders, and it is regarded as an error if the amount of orders exceeds a certain quantity. Improving the disconnection procedure for communication in order to prepare for a runaway system on the securities company side.
			System shutdown becomes a stoppage of the market.	Reliability	Availability, Fault tolerance	Availability over 99.999% Complete duplication of hardware
			If notice of order received or notice of agreement establishment sent to a securities company is changed or canceled afterwards, confidence in the market is lost significantly.	Security	Non-repudiation	Notification after triple synchronization of data
2	(Finance/insurance)Insurance product capitalization system	Agent Employee, Employee	Agent prints application forms necessary for insurance contract correctly.	Functional suitability	Functional correctness	Coordination to accurate calculation/reporting system of insurance premium
			When an agent calculates and reports the premium, they complete the operation within a certain standard.	Performance efficiency	Time behavior	Regulating a response returned from within the center to each system
			Many systems are related to each other, so the overall system should be operated efficiently through allocation of resources.	Performance efficiency	Resource utilization	<N/A>
			Connecting the insurance premium calculation data	Usability	User error protection	<N/A>

Ca se #	System	Stakeholder	Important needs, risk for system/software product	Quality character istics	Sub-quality character istics	System/software product quality requirement
			created by an agent to the posting system with no mistakes.			
			An agent reports the procedures up to our company's insurance premium reporting through consistent operation with no mistakes.	Usability	User interface aesthetics	Regulating on the screen HMI
			Providing to an agent according to the regulated service time.	Reliability	Availability, Fault tolerance, Recoverab ility	<N/A>
			Data access authority is regulated for each agent, so the handling of personal information is compensated.	Security	Confidenti ality	Disabling access to information other than that handled by an agent.
			Separation of operation and development is regulated, and it is designed to prohibit accessing real data directly from the development side.	Security	Integrity	<N/A>
			It is designed to be able to carry out track research by a log for illegal processing, etc.	Security	Accountab ility	<N/A>
3	(Finance/insura nce)Financial institute counter terminal system	Bank clerk	Functions of financial terminals work correctly.	Functional suitability	Functional correctnes s	<N/A>
			Operating as required by requirement spec.	Usability	Appropriat eness recognisa bility	Operation as the requirement spec.
			Trust is important for operation of financial terminals.	Reliability	Maturity	Operation as the requirement spec. or analogized spec.
			It is a matter of course that trouble recovery or degenerated operation are implemented.	Reliability	Fault tolerance	Trouble recovery or degenerated operation works as spec.
			It is a matter of course that financial system handling money is furnished with security functions.	Security	Confidenti ality	Operation as requirement spec.
			Comprehension is a necessary function from development side, too.	Maintaina bility	Analyzabili ty	Should comply with the in-company standard.

Table 2-6 Relationship of important needs, system/software quality characteristics and requirement

(Case Study) 2/3

Cas e #	System	Stakeholder	Important needs, risk for system/software product	Quality characteri stics	Sub-qualit y characteri stics	System/software product quality requirement
4	(Transport) Auto fare collection system using contactless IC card	Station staff, Passenger, Customer	Correct fare collection and high speed processing are requisite conditions for passing the ticket gate.	Functional suitability	Functional completene ss	Accurate and high speed processing of reading, writing and fare calculation
			Consistency of data of media (card) and system is necessary.	Functional suitability	Functional correctness	Functional completeness of data
			Mutual usage with other vendors is possible.	Compatibili ty	Interoperabi lity	＜N/A＞
			System operates stably.	Reliability	Maturity	Redundant type, Autonomous distribution
			There are many everyday transactions, so impact from operation shutdown is extremely large.	Reliability	Fault tolerance	Redundant type, Autonomous distribution
			Preventing leakage of personal information.	Security	Confidential ity	Encryption technology, operation control
			Preventing data falsification.	Security	Integrity	Encryption technology, operation control
5	(Electricity) Power supply, customer information control system	Meter reader, Receptionist, Operator	Handling important parameters related to claiming action.	Functional suitability	Functional correctness	Adjusting fare based on the auto detected meter value.
			There are a huge number of end users, so the impact is enormous if the system does not suit the objective.	Functional suitability	Functional appropriate ness	All specifications defined by the main section are complied with.
			It's used for very demanding business such as in call centers, so high performance is required.	Performanc e efficiency	Time behavior	Response in server per transaction should be within 3sec.
			Even if the business use terminal is lost, no customer information is decoded.	Security	Confidential ity	Data containing personal information located in the business use terminal should be encrypted in a manner that it cannot be decoded by humans.
			Because it handles customer information, authority should be controlled strictly for each business operation.	Security	Integrity	Limiting access to screens other than those used for business in charge.
6	(Electricity) Information system providing customer information	Contractant, Employee	Providing update information.	Functional suitability	Functional correctness	Specifying a customer and providing unique information.
			Providing update information.	Performanc e efficiency	Time behavior	Searching target information at high speed.
			Linking with various systems in the company.	Compatibili ty	Interoperabi lity	Unifying the communication method/technique.
			Conveying provided information effectively.	Usability	User interface aesthetics	Using the standard technology.
			Providing customer information.	Security	Integrity	Specifying a customer
7	(Agriculture) Agricultural information	Producer, Buyer	Providing correct information to the user.	Functional suitability	Functional correctness	Relative dryness degree of crops and dryness degree assumed from the satellite

Case #	System	Stakeholder	Important needs, risk for system/software product	Quality characteristics	Sub-quality characteristics	System/software product quality requirement
	system					image should match.
			It is requested to reduce user's trouble with drying crops after harvesting.	Performance efficiency	Time behavior	Indication of relative dryness degree for each agricultural area
			Output result of the system is effective/appropriate to the user.	Usability	Appropriateness recognisability	Relative dryness degree of crops and dryness degree assumed from the satellite image should match.
			Supporting business operation of the user.	Usability	Operability	Function to output the analysis result according to usage objective (in units of union, product type, etc.)
			Output information of the system is easy for the user to discriminate.	Usability	User interface aesthetics	Coloring indication of analysis result (with legend)
			Operating stably with no problems.	Reliability	Maturity	Operating for 24 hours
			Operating appropriately at harvest time of crops.	Reliability	Availability	Operating for 24 hours
8	(Disaster prevention) Earthquake early warning service	User (general)	It is socially important information, so social impact is large, therefore false reporting is not permissible.	Functional suitability	Functional correctness	When a server receives a warning from Meteorological Office, it transfers the warning to all terminals with no delay after processing it for a terminal.
			It is important information involving human lives and assets, so no delay is permitted even for a second.	Performance efficiency	Time behavior	When a server receives a warning from Meteorological Office, it transfers the warning to all terminals with no delay after processing it for a terminal.
			It is important information associated with human lives and assets, so it is not acceptable for service to stop.	Reliability	Maturity	Duplication of system, duplication of data center, duplication of lines and constant monitoring of terminals

Table 2-6 Relationship of important needs, system/software quality characteristics and requirement

(Case Study) 3/3

Case #	System	Stakeholder	Important needs, risk for system/software product	Quality characteristics	Sub-quality characteristics	System/software product quality requirement
9	(Contents/information provision)EC SITE, Cyber mall	Consumer, Shop, Own company	Realizing specifications of individual correctly and safety settlement.	Functional suitability	Functional correctness	Account settlement, Authentication
			Realizing comfortable shopping.	Performance efficiency	Time behavior	Performance
			Increasing mutual usage of services.	Compatibility	Interoperability	Purchase history control, point granting service, authentication
			Possible to search for desired product easily.	Usability	Appropriateness recognisability	Search, matching
			Maintaining the sales of a shop and continuing placing ads.	Reliability	Fault tolerance	Fail over
			Protecting customer's personal information。	Reliability	Recoverability	Backup
			Realizing correct individual authentication.	Security	Authenticity	Authentication
10	(Contents/information provision)Multi player online game system used from mobile/PC	Player, Game operator	It occurs frequently that many players access the function simultaneously that needs to carry out real time processing.	Performance efficiency	Time behavior	Requirement related to functions in general (functions with high cost such as data updating and data reference in particular).
			Used by many users.	Performance efficiency	Resource utilization	Requirements in general
			It is not used in the first place if it does not suit the needs whether overt or potential.	Usability	Appropriateness recognisability	Requirements in general
			If it is not satisfactory, continuous usage rate drops.	Usability	Learnability	Requirements in general (Requirements related to functions used at the start of the game in particular)
			User's needs relate to their interests, so it should feel comfortable.	Usability	User interface aesthetics	Requirements in general
11	(Contents/information provision)Various information provision, Registration system	User	It should work properly with no bugs.	Functional suitability	Functional correctness	Trouble occurrence rate n cases/scale or less
			Ensuring a response that does not cause stress in usage.	Performance efficiency	Time behavior	Online response within 3sec.
			It should be a service (system) that satisfies the requirements of the user.	Usability	Appropriateness recognisability	Collection and analysis of access log
			Possible to use instinctually without referring to manual or FAQ.	Usability	Learnability	Tool chip, operation comment, etc.
			Design and sense of unity for a screen is accepted by a user.	Usability	User interface aesthetics	Design (devising size or type of font, consistency of contents arrangement, etc.), unifying color, et.
			Target operation rate of the	Reliability	Maturity	System operation rate

Cas e #	System	Stakeholder	Important needs, risk for system/software product	Quality characteri stics	Sub-quality characteris tics	System/software product quality requirement
			system is 99.7%.			99.7%
			High trouble resistance is required.	Reliability	Fault tolerance	Hardware redundancy (clustering)
			When a problem occurs, it should be recovered within a short time.	Reliability	Maturity	Trouble recovery within 2 hours
			Controlling personal information。	Security	Confidentiali ty	Controlling access authority, individual authentication
			Blocking unauthorized external access and assuring data.	Security	Integrity	Monitoring/reporting unauthorized access
12	(School/educat ion) Educational learning system, Contents control system	User, Controller, Tutor	Indicating correct true/false results in order to store the academic results. Distribution and display of teaching material selected by the user correctly.	Functional suitability	Functional correctness	Result aggregation function Learning history storage function Teaching material distribution function
			A large number of accesses occur in a burst fashion according to the season or time zone, so appropriate response should be made.	Performan ce efficiency	Time behavior	Duration after receiving a request from a terminal till returning the server processing result would be within 5sec.
			Distributing appropriate teaching material according to information from CRM. Sending email at appropriate time zone and timing.	Compatibili ty	Interoperabil ity	Data link function Mail transmission function Point exchange function User information linking function
			Users are able to use services whenever necessary.	Reliability	Maturity	System operates for 24 hours 365 days, except during maintenance.
			Disabling use of teaching materials of E learning if not a proper user. Only users themselves are allowed to inquire about grades and refer to learning history.	Security	Confidentiali ty	Considering personal information protection Teaching material distribution function Member authentication function Content control function
13	(Development tool)Built-in design supporting tool	Built in developer	Design result can be stored and reproduced correctly.	Functional suitability	Functional correctness	Displaying previous data correctly from finishing to starting the application.
			It is a design tool, so drawing should be displayed with no stress so that human thought processes are not disturbed.	Performan ce efficiency	Time behavior	Drawing should be within 0.3s.
			It should not disturb the action of other applications because other Windows applications are operated simultaneously in most cases.	Compatibili ty	Co-existenc e	OS should not be locked. No apparent stopping of other applications
			Operation or appearance should not be complicated as a design tool.	Usability	User interface aesthetics	Making as simple as possible and menu should be up to 2 hierarchies.
			Facilitating a change of tools.	Maintainabi lity	Modularity	Module combining degree

Table 2-7 shows the result of showing the emphasized system/software product characteristics.

Case #	(Field) System	System outline	Functional Suitability			Performance efficiency			Compatibility		Usability					
			Functional completeness	Functional correctness	Functional appropriateness	Time behavior	Resource utilization	Capacity	Co-existence	Interoperability	Appropriateness recognizability	Learnability	Operability	User error protection	User interface aesthetics	Accessibility
1	(Finance/insurance) Stock trading system	Making domestic and international financial transactions at high speed and with high reliability and safety.	X	X		X					X					
2	(Finance/insurance) Insurance product capitalization system	Correct calculation that does not cause any economic risk		X		X	X						X	X	X	
3	(Finance/insurance)Financial institute counter terminal system	Processing correctly as required at low cost		X							X					
4	(Transport) Auto fare collection system using contactless IC card	Functional completeness of data, correct and high speed processing of reading, writing and fare calculation between card and system	X	X						X						
5	(Electricity)Power supply, customer information control system	Operating correctly and effectively towards the business objective		X	X	X										
6	(Electricity)Information system providing customer information	Providing update information		X		X				X					X	
7	(Agriculture) Agricultural information system	Accurate data processing for efficient agricultural work		X		X					X		X		X	
8	(Disaster prevention) Earthquake early warning service	Processing information related to human life with no stoppage or false reporting.		X		X										
9	(Contents/information provision) EC SITE, Cyber mall	Possible to purchase desired items safely at any time		X		X				X	X					
10	(Content/information provision) Multi player online game system used from mobile/PC	Providing satisfactory content stably and continuously				X	X				X	X			X	
11	(Contents/information provision)Various information provision, Registration system	Possible to access desired information efficiently and pleasantly		X		X					X	X			X	
12	(School/education) Educational learning system, Contents control system	Providing effective and attractive information to the user, and the user can use it with no stress.		X		X				X						
13	(Development tool) Built-in design supporting tool	Possible to operate with correct and satisfactory performance in any kind of environment.		X		X			X						X	

*Shaded parts show distinguishing characteristics in case studys #1 ~ 3 (finance/insurance field), #4 ~ 8 (public field) and #9 ~ 13 (web/content field).

Table 2-7 Emphasized system/software product quality characteristics (Case Study) 2/2

Case #	System	Characteristics	Reliability				Security					Maintainability					Portability		
			Maturity	Availability	Fault tolerance	Recoverability	Confidentiality	Integrity	Non-repudiation	Accountability	Authenticity	Modularity	Reusability	Analyzability	Modifiability	Testability	Adaptability	Installability	Replaceability
1	(Finance/insurance)Stock trading system	Making domestic and international financial transactions at high speed and with high reliability and safety.		X	X				X										
2	(Finance/insurance) nsurance product capitalization system	Correct calculation that does not cause any economic risks		X	X	X	X	X		X									
3	(Finance/insurance)Financial institute counter terminal system	Processing correctly as required at low cost	X		X		X							X					
4	(Transport)Auto fare collection system using contactless IC card	Functional completeness of data, correct and high speed processing of reading, writing and fare calculation between card and system	X		X		X	X											
5	(Electricity)Power supply, customer information control system	Operating correctly and effectively towards the business objective					X	X											
6	(Electricity)Information system providing customer information	Providing update information						X											
7	(Agriculture) Agricultural information system	Accurate data processing for efficient agricultural work	X	X															
8	(Disaster prevention) Earthquake early warning service	Processing information related to human life with no stoppage or false reporting.	X																
9	(Contents/information provision) EC SITE, Cyber mall	Possible to purchase desired items safely at any time			X	X					X								
10	(Contents/information provision) Multi player online game system used from mobile/PC	Providing satisfactory contents stably and continuously																	
11	(Contents/information provision) Various information provision, Registration system	Possible to access desired information efficiently and pleasantly	X		X		X	X											
12	(School/education)Educational learning system, Content control system	Providing effective and attractive information to the user and the user can use it with no stress.	X				X												
13	(Development tool) Built-in design supporting tool	Possible to operate by correct and satisfactory performance in any kind of environment.												X					

*Shaded parts show distinguishing characteristics in case studys #1 ~ 3　(finance/insurance field), #4 ~ 8　(public field) and #9 ~ 13　(web/content field).

No answers stated that maintainability and portability were particularly emphasized in any cases, however it seems that individual handling is carried out respectively. However, system errors that have occurred in the past were often caused by human error in maintenance and porting work, and it is undeniable that other quality characteristics tend not to be emphasized.

However, system and software products for the future must cope with our changing society and business environment promptly and flexibly. Moreover, the technologies for this purpose, for example cloud computing have started to spread. Therefore, it is expected that needs and risks related to improvement and maintenance of system and software products will be diversified and increase, and at the same time maintainability and portability will become more important in the future.

Table 2-8 shows the summarized result of the quality model's characteristics of system and software products for each system field. In the case of system and software products in the finance/insurance field (#1 ~ 3), appropriateness recognizability, availability or confidentiality are emphasized in the system and software products in order to mitigate economic risk. Further, in the case of system and software products in the public field (#4 ~ 8), maturity and integrity will be valued in order to realize usefulness and reliability, and for system/software products (#9 ~ 13) in the web/content field, time behavior and appropriateness recognizability for handling necessary information when necessary will be emphasized.

Table 2-8 System/software product quality characteristics of for each system field (Case) 1/2

System field	Needs and risks of main system/software products	Product quality characteristics
System/software products in the finance/insurance field (#1 ~ #3)	・ If there is a function that does not work as expected, illegal data processing may be carried out and market may be confused. (#1) ・ Agent prints application forms necessary for insurance contract correctly. (#2) ・ Functions of financial terminals work correctly. (#3)	Functional correctness (Functional suitability)
	・ While the mechanization of the orders placed by securities companies is promoted, if data is not processed promptly, funds will outflow to the market of other countries. (#1) ・ When an agent calculates and reports the premium, they complete the operation within a certain standard. (#2)	Time behavior (Performance efficiency)
	・ If it's not possible to provide a system complying with user's needs, funds may outflow from the market. (#1) ・ Incorrect order placed by a securities company or improper data transmission due to a fault in the system on the securities company side may bring confusion to the market. (#1) ・ Operating as required by requirement spec. (#3)	Appropriateness recognizability (Usability)
	・ System shutdown becomes a stoppage of the market. (#1)	Availability (Reliability)
	・ System shutdown becomes a stoppage of the market. (#1) ・ It is a matter of course that trouble recovery or degenerated operation are implemented. (#3)	Fault tolerance (Reliability)
	・ Data access authority is regulated for each agent, so the handling of personal information is compensated. (#2) ・ It is a matter of course that financial system handling money is furnished with security functions. (#3)	Confidentiality (Security)

Table 2-8 System/software product quality characteristics of for each system field (Case) 2/2

System field	Needs and risks of main system/software products	Product quality characteristics
System/software products in the public field (#4 ~ #8)	・ Consistency of data of media (card) and system is necessary. (#4) ・ Handling important parameters related to claiming action. (#5) ・ Providing update information (#6) ・ Providing correct information to the user. (#7) ・ It is socially important information, so social impact is large, therefore false reporting is not permissible. (#8)	Functional correctness (functional suitability)
	・ It is used for business with a high degree of busyness such as call center business, high performance is required. (#5) ・ It is requested to reduce user's trouble with drying crops after harvesting. (#7) ・ It is important information involving human lives and assets, so no delay is permitted even for a second. (#8)	Time behavior (performance efficiency)
	・ System operates stably. (#4) ・ Operating stably with no problems. (#7) ・ It is important information involving human lives and assets, so no delay is permitted even for a second. (#8)	Maturity (reliability)
	・ Preventing data falsification. (#4) ・ Because it handles customer information, authority should be controlled strictly for each business operation. (#5) ・ Providing customer information. (#6)	Integrity (security)
System/software products in web/content field (#9 ~ #13)	・ Realizing specification of individual correctly and safe settlement. (#9) ・ It should work properly with no bugs. (#11) ・ Indicating correct true/false results in order to store the academic results. (#12) ・ Distributing and displaying teaching materials selected by a user correctly. (#12) ・ Design result can be saved and reproduced. (#13)	Functional correctness (functional suitability)
	・ Realizing comfortable shopping. (#9) ・ It occurs frequently that many players simultaneously access a function that needs to carry out real time processing. (#10) ・ Ensuring a response that does not cause stress in usage. (#11) ・ A large number of accesses occur in a burst fashion according to the season or time zone, so appropriate response should be replied. (#12) ・ It is a design tool, so drawing should be displayed with no stress so that human thought processes are not disturbed. (#13)	Time behavior (performance efficiency)
	・ Possible to search for the desired product easily. (#9) ・ It is not used in the first place if it does not suit the needs whether it is overt or potential. (#10) ・ It should be a service (system) that satisfies the requirements of a user. (#11)	Appropriateness recognizability (usability)
	・ User's needs relate to their interests, so it should feel comfortable. (#10) ・ Design and sense of unity of a screen is accepted by a user. (#11) ・ Operation and appearance are not complicated as a design tool. (#13)	User interface aesthetics (usability)

2.1.3　Relationship between Quality in Use Model and System/Software Product Quality Model

Quality requirements of system/software products are defined based on quality in use requirements, so the system/software product quality model and quality in use model have a deep relationship.

Table 2-9 shows the relationship of quality in use model obtained through the preceding example research and system/software product quality model.

Table 2-9 Relationship of quality in use model and product quality model (Case Study) 1/3

Case #	（Field）System	System outline	Emphasized quality in use characteristics (quality in use model)	Emphasized System/software product quality characteristics (system/software product quality model)
1	(Finance/insurance) Stock trading system	Making domestic and international financial transaction at high speed and with high reliability and safety.	Effectiveness Trust Economic risk mitigation	Functional completeness, Functional correctness Time behavior Appropriateness recognizability Availability, Fault tolerance, Non-repudiation
2	(Finance/insurance) Insurance product capitalization system	Correct calculation that does not cause any economic risks.	Effectiveness Economic risk mitigation Context completeness	Functional correctness Time behavior, Resource utilization User error protection, User interface aesthetics Availability, Fault tolerance, Recoverability Confidentiality, Integrity, Accountability
3	(Finance/insurance) Financial institute counter terminal system	Processing correctly as required at low cost.	Effectiveness Usefulness Economic risk mitigation	Functional correctness, Appropriateness recognizability Maturity, Fault tolerance Confidentiality Analyzability

Table 2-9 Relationship of quality in use model and product quality model (Case Study) 2/3

Case#	(Field) System	System outline	Emphasized quality in use characteristics (quality in use model)	Emphasized System/software product quality characteristics (system/software product quality model)
4	(Transport) Auto fare collection system using contactless IC card	Functional completeness of data, correct and high speed processing of reading, writing and fare calculation between card and system.	Effectiveness Usefulness Economic risk mitigation	Functional completeness, Functional correctness Interoperability Maturity, Fault tolerance Confidentiality, Integrity
5	(Electricity) Power supply, customer information control system	Operating correctly and effectively towards the business objective.	Effectiveness Usefulness Trust	Functional correctness, Functional appropriateness Time behavior Confidentiality, Integrity
6	(Electricity) Information system providing customer information	Providing update information.	Usefulness Environmental risk mitigation Context completeness	Functional correctness Time behavior Interoperability User interface aesthetics Integrity
7	(Agriculture) Agricultural information system	Accurate data processing for efficient agricultural work.	Effectiveness Efficiency Trust	Functional correctness Time behavior Appropriateness recognizability, Operability, User interface aesthetics Maturity, Availability
8	(Disaster prevention) Earthquake early warning service	Processing information related to human life with no stoppage or false reporting.	Effectiveness Efficiency Trust Health and safety Trust Health and safety risk mitigation	Functional correctness Time behavior Maturity

Table 2-9 Relationship of quality in use model and product quality model (Case Study) 3/3

Case#	(Field)System	System outline	Emphasized quality in use characteristics (quality in use model)	Emphasized System/software product quality characteristics (system/software product quality model)
9	(Contents/information provision) EC SITE, Cyber mall	Possible to purchase desired items safely at any time.	Usefulness Pleasure Economic risk mitigation Context completeness	Functional correctness Time behavior Interoperability Appropriateness recognizability Fault tolerance, Recoverability Authenticity
10	(Contents/information provision) Multi player online game system used from mobile/PC	Providing satisfactory contents stably and continuously.	Usefulness Pleasure Economic risk mitigation	Time behavior, Resource utilization Appropriateness recognizability, Learnability, User interface aesthetics
11	(Contents/information provision) Various information provision, Registration system	Possible to access desired information efficiently and pleasantly.	Effectiveness Usefulness Trust Pleasure	Functional correctness Time behavior Appropriateness recognizability, Learnability, User interface aesthetics Maturity, Fault tolerance, Confidentiality, Integrity
12	(School/education) Educational learning system, Content control system	Providing effective and attractive information to the user, and the user can use it with no stress.	Effectiveness Pleasure Economic risk mitigation Context completeness	Functional correctness Time behavior Interoperability Maturity Confidentiality
13	(Development tool) Built-in design supporting tool	Possible to operate with correct and satisfactory performance in any kind of environment.	Effectiveness Pleasure Context completeness	Functional correctness Time behavior Co-existence User interface aesthetics Modularity

Further, the summarized results for the characteristics of quality in use model and system/software product quality model for each system field are shown in Table 2-10. These can be used as a reference when investigating the quality model when constructing similar system/software products.

E.g.: when creating system/software products in the finance/insurance field
[check point]
・ Is the quality related to effectiveness and economic risk mitigation considered in the quality requirement definition in use?
・ Is the quality related to functional correctness, time behavior, appropriateness recognizability, availability, fault tolerance and confidentiality considered in the quality requirement definition of system/software products?

Table 2-10 Relationship of quality models for each system field (Case Study)

System field	Emphasized quality characteristics for quality in use requirements (quality in use model)	Emphasized quality characteristics for quality requirements of system/software products (system/software product quality model)
System/software products in finance/insurance field ((#1 ~ #3)	Effectiveness (Effectiveness) Economic risk mitigation (freedom from risk)	Functional correctness (functional suitability) Time behavior (performance efficiency) Appropriateness recognizability (usability) Availability (reliability) Fault tolerance (reliability) Confidentiality (security)
System/software products in public field (#4 ~ #8)	Effectiveness (effectiveness) Usefulness (satisfaction) Trust (satisfaction)	Functional correctness (functional suitability) Time behavior (performance efficiency) Maturity (reliability) Integrity (security)
System/software products in web/content field (#9 ~ #13)	Pleasure (satisfaction)	Functional correctness (functional suitability) Time behavior (performance efficiency) Appropriateness recognizability (usability) User interface aesthetics (usability)

2.2 Evaluation of System/Software Product Quality

This section describes activities at each phase and execution methods for quality requirement evaluation of system/software products.

2.2.1 Activity Content for Quality Evaluation Phase

Phase of quality evaluation in the quality life cycle of system/software products is shown in Fig. below.
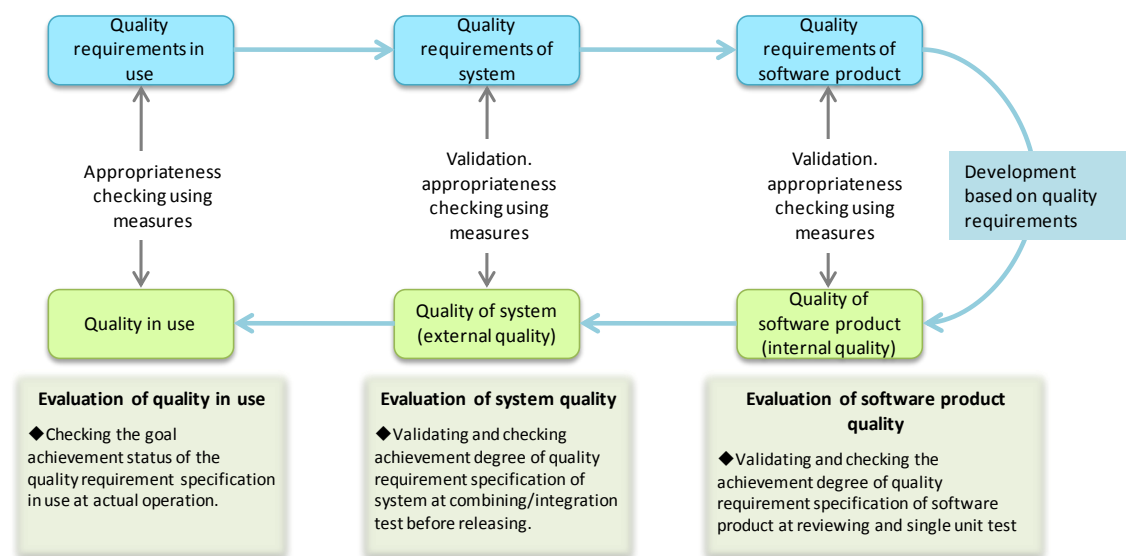
Fig. 2-7 Quality evaluation in the quality life cycle

The following is the activity content of each phase of quality evaluation.

(1) Evaluation of software product quality

Evaluating to what extent the quality requirement specification is complied with for the software products (various documents, source codes) which are not executable at the development stage and what sort of quality is acquired when the system is made using measures.

(2) Evaluation of system quality

Evaluating to what extent quality requirement specification is complied with for the system acquired through combining and integrating software products using measures.

(3) Evaluation of quality in use

Evaluating the realization degree of quality requirement specifications of system in the specified usage state and by specified users using measures.

2.2.2 Quality Evaluation Method and Case Studies

（1）**Quality evaluation method**

Quality evaluation process for system/software products is determined in JIS X 0133-1 (ISO/IEC 14598), and it is shown in Table2-11.

Table 2-11 Quality evaluation process for system/software products

Process	Description of execution
①Establishment of evaluation requirements	Clarifying types and characteristics of the target system/software products for evaluation and clarifying quality characteristics to be evaluated using quality mode.
②Specification of evaluation	Selecting measures for quality characteristics and checking measurement methods and evaluation standards in order to select measurement method (measures), establishing the evaluation standard for a measurement method and establishing the standard for comprehensive evaluation.
③Design of evaluation	Creating the evaluation plan
④Execution of evaluation	Collecting measured values through reviewing or testing, comparing the result with the standard to evaluate each quality characteristic and carrying out a comprehensive evaluation.

①Embellishment of evaluation requirements and ②Specification of evaluation in Table2-11 should be carried out at each phase of quality requirement definition (phase of quality requirement in Fig. 2-7) for each target for evaluation.

Next, the relationship between quality life cycle of system/software product and software life cycle process (SLCP) is shown in the Fig. below.
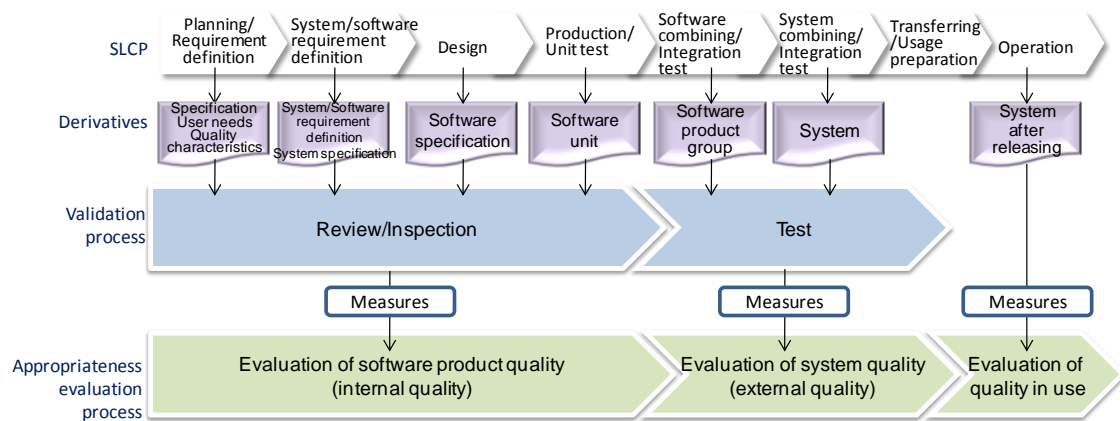
Fig. 2-8 Relationship of quality life cycle and SLCP

Quality evaluation method is as below according to SLCP.

(1) Evaluation method of software product quality

The important quality characteristics of software products are determined as a quality model from "Planning/Requirement definition" to "Fabrication/Unit test", and the contents of each characteristic are determined as specifications quantitatively using the internal quality measured volume (internal quality measures). Then, for the deliverable actually created[8], the value of measures in the specification is measured and quality is evaluated.

(2) Evaluation method for system quality

From "Software combining/integrating test" to "Transferring/Usage preparation", the important quality characteristics of a system are determined as a quality model, and the contents of each characteristic are determined as a specification quantitatively using external quality measured volume (external quality measures). Then, for the deliverable, the value of measures in the specification is measured and quality is evaluated.

(3) Evaluation method of quality in use

In the processes after "Usage", important quality characteristics at utilization are determined as a quality model, specification is made using quality measured volume in use (quality(in use) measures), the contents are measured and quality is evaluated. Quality in use is according to the "Satisfaction of users", and it is evaluated quantitatively according to the result of hearing about the requirement specification or questionnaire survey in or after use of a product.

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8   Deliverables from Planning/Requirement definition to fabrication/unit test include specifications, requirement definitions, design documentation and individual software.

（2）**Case Studies**

Examples of measures used for quality evaluation can be referred to in the places mentioned below in each example result of <<Example 1>> ~ <<Example 13>> in Appendix B.

- Quality in use   ④Used measures
- Quality of product   ④Used measures

In Chapter 2, the quality requirement definition of system/software products based on the quality life cycle model in ISO/IEC 25000 series and activity contents and execution method of quality evaluation are described using examples.

In order to realize an environment where users can use system/software products safely and securely, it is important to clarify various stakeholders related to the product, understand the needs and risks from the viewpoint of each stakeholder and determine the quality specification of the product based on the contents using measures in a detailed manner. However, it requires substantial cost to realize high reliability and high quality, so it is necessary to investigate to what extent needs and risks can be supported under the restrictions of budget, etc.

Further, it is also important to evaluate and realize the quality of the developed system and software products using measures in the quality specification.

3. Measures used for Quality Requirement Definition and Quality Evaluation

In this chapter, a measure set corresponding to a quality model in ISO/IEC 25010, which is recommended for use in quality requirement definition and quality evaluation is introduced. A measure set was created based on the knowledge of WG members, referring to the result of utilization status research of measures performed targeting the companies that carry out quality assurance activities using measures before others. Moreover, trends related to usability evaluation are also indicated.

3.1 Creation of Measures Set based on the Quality Model of ISO/IEC 25010

In order to evaluate quality, the contents of quality requirements should be defined quantitatively using measures in advance as a premise.

Inside the country, as shown in Table 3-1 List of deliverables related to measures of system/software product, deliverables related to the measures that indicate quality characteristics quantitatively are provided centering on the quality model of ISO/IEC 9126-1 (JIS X 0129-1).

Table 3-1 List of deliverables related to measures of system/software products

Abbreviated code	Deliverables related to measures
ISO/IEC 9126-2	TS X 0111-2: Software engineering-Product quality-Part 2: External metrics by JIS X 0129-1, Japanese Standards Association
ISO/IEC 9126-3	TS X 0111-3: Software engineering-Product quality-Part 3: Internal metrics by JIS X 0129-1, Japanese Standards Association
ISO/IEC 9126-4	TS X 0111-4: Software engineering-Product quality-Part 4: Quality in use metrics by JIS X 0129-1, Japanese Standards Association
Nonfunctional	Nonfunctional requirement grade list of items related to nonfunctional requirements of system infrastructure, Information-Technology Promotion Agency, Japan Software Engineering Center
Critical Infrastructure	Critical infrastructure information system reliability council report, Information-Technology Promotion Agency, Japan Software Engineering Center
ESQR	Embedded system development management guide: ESQR, Information-Technology Promotion Agency, Japan Software Engineering Center
JUAS	User Vender Collaboration Research Project II Report "Nonfunctional Requirement Specification Definition Guideline", Ministry of Economy, Trade and Industry - Information Service Industry Div., NTT Data Institute of Management Consulting, Inc., Japan Users Association of Information Systems
JEITA	SLA Guideline for IT system for the private sector 3rd edition, Japan Electronics and Information Technology Industries Association, Solution Service Business Committee

However, the ISO/IEC 9126 series was revised and reinforced as ISO/IEC 25000 SQuaRE series through integration with the ISO/IEC 14598 series, and the quality model of ISO/IEC 9126-1 was revised to the quality model of ISO/IEC 25010. Along with this, measures presented in ISO/IEC

9126-2, ISO/IEC 9126-3 and ISO/IEC 9126-4 are planned to be revised, too.

In order to cope with changes in circumstances promptly, WG held a discussion about the measure set that copes with new quality characteristics in use of ISO/IEC 25010 and sub quality characteristics in the quality characteristics of system/software products.   In the discussion, in addition to the knowledge of WG members, the research result related to the utilization state of measures at the actual development sites is used as a reference.   (Concrete content of discussion of measures set are shown in Appendix.)

3.2 Initial Set of Quality in Use Measures and System/Software Quality Measures

3.2.1   Composition and Usage Method

A measure set is shown for each quality in use characteristic and sub quality characteristic of ISO/IEC 25010 and for each product quality characteristic and sub quality characteristic with items shown below.

Table 3-2 Items and meanings of measure set

Item	Meaning
ID	Serial No. in quality characteristics
Sub quality characteristic	Name of sub quality characteristic
Up to unit test	Meaning that it can be used for evaluation of internal quality.
After combined test	Meaning that it can be used for evaluation of external quality.
Measure	Name of measure
Explanation of measure	Indicating for what sort of evaluation purpose a metric can be used. Evaluation methods are also indicated partially as an example.
Reference	Indicating the abbreviated code of deliverables in which pertinent measures are described. Supplemental information is partially attached following the abbreviated codes.
Referential information	Indicating the recommended degree to be used for evaluating the pertinent sub quality characteristics. ◎: Highly recommended for use ○: Recommended for use In the case of measures related to product quality characteristics, it is divided into the utilization promotion degree to the review/inspection "Up to unit test" and the utilization promotion degree to tests "After combined test".

The table below shows the included number of measure sets of quality in use characteristics and the included number of measure sets of quality characteristics for product.

Table 3-3 Measure set of quality in use characteristics

Quality characteristics	Sub quality characteristics	No. of measures
Effectiveness	Effectiveness	4
Efficiency	Efficiency	7
Satisfaction	Usefulness (*)	3
	Trust (*)	0
	Pleasure (*)	0
	Comfort (*)	0
Freedom from risk	Economic risk mitigation(*)	9
	Health and safety risk mitigation (*)	1
	Environmental risk mitigation(*)	2
Context coverage	Context completeness (*)	0
	Flexibility (*)	3
Total		29

Table 3-4 Measure set of product quality characteristics

Quality characteristics	Sub quality characteristics	No. of measures	
		Up to unit test	After combined test
Functional suitability	Functional completeness	1	1
	Functional correctness	2	4
	Functional appropriateness	7	6
Performance efficiency	Time behavior	5	5
	Resource utilization	5	5
	Capacity (*)	9	11
Compatibility (*)	Co-existence	1	1
	Interoperability	2	2
Usability	Appropriateness recognizability	3	4
	Learnability	0	3
	Operability	7	6
	User error protection (*)	4	4
	User interface aesthetics (*)	1	1
	Accessibility (*)	3	2
Reliability	Maturity	12	11
	Availability (*)	11	5
	Fault tolerance	3	3
	Recoverability	2	2
security (*)	Confidentiality (*)	9	9
	Integrity (*)	6	3
	Non-repudiation (*)	2	2
	Accountability (*)	2	2
	Authenticity (*)	3	3
Maintainability	Modularity (*)	1	0
	Reusability (*)	1	1
	Analyzability	4	4
	Modifiability	5	7
	Testability	2	3
Portability	Adaptability	3	3
	Installability	4	4
	Replace ability	5	9
Total		125	126

・ (*) shows new characteristics in ISO/IEC 25010.

A measure set does not provide a definition for a concrete evaluation method.   This is because it's not possible to determine uniformly as there are various measurement and evaluation methods for evaluation purposes.   It is preferable to refer to the definition of evaluation methods in the reference when actually using the set.

3.2.2　Initial Set of Measures related to Quality in Use Characteristics

（1）**Effectiveness**

Measures related to effectiveness (accuracy and completeness with which users achieve specified goals) are shown.

Table 3-5 Quality in use characteristics: Effectiveness Measures

ID	Quality characteristics	Measure	Explanation of measure	Reference	Referential information
	Effectiveness	Accuracy and completeness with which users achieve specified goals			
Efe-1	Effectiveness	**Work effectiveness**	How accurately the specified goal is achieved. E.g.) Compare the number of tasks completed accurately and total number of tasks	ISO/IEC 9126-4	◎
Efe-2	Effectiveness	**Failure frequency**	How much operational failure has occurred during work. E.g.) Compare the number of operational failures and total number of operations	ISO/IEC 9126-4	◎
Efe-3	Effectiveness	**Work completeness**	To what extent are tasks completed. E.g.) Compare the number of completed tasks and the number of attempted tasks.	ISO/IEC 9126-4	○
Efe-4	Effectiveness	**Software damage**	How much software is damaged.	ISO/IEC 9126-4	○

（2）**Efficiency**

Measures related to efficiency (degree of resources expended in relation to the accuracy and completeness with which users achieve goals) are shown.

Table 3-6 Quality in use characteristics: Efficiency Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information
	Efficiency	Degree of resources expended in relation to the accuracy and completeness with which users achieve goals			
Efi-1	Efficiency	**Work duration**	How much time is required to complete the task.	ISO/IEC 9126-4	◎
Efi-2	Efficiency	**Auto measurement of qualitative effects**	How much qualitative effect is acquired.	JUAS, evaluation of items that cannot be converted into an amount of money easily (qualitative evaluation/KPI)	○
Efi-3	Efficiency	**Work efficiency**	How efficiently and accurately the task is achieved.	ISO/IEC 9126-4	○
Efi-4	Efficiency	**Economic productivity**	How efficiently and accurately in terms of expense the task is achieved.	ISO/IEC 9126-4	○
Efi-5	Efficiency	**Productive ratio**	How much of the total time is spent by the user carrying out productive activities.	ISO/IEC 9126-4	○
Efi-6	Efficiency	**Relative user efficiency**	How efficiently the user can work compared with a skilled operator.	ISO/IEC 9126-4	○
Efi-7	Efficiency	**Overall manufacturing lead time ratio**	To what extent the targeted overall lead time is realized.	JUAS	○

（3）**Satisfaction**

Measures related to satisfaction (degree to which user needs are satisfied when a product or system is used in a specified context of use) are shown. However, measures related to trust, pleasure and comfort among the four sub quality characteristics are not indicated because no pertinent ones were acquired from examples or existing deliverables.

Table 3-7 Quality in use characteristics: Satisfaction Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information
	Usefulness	Degree to which a user is satisfied with their perceived achievement of programmatic goals, including the results of use and the consequences of use			
Sa-1	Usefulness	**Satisfaction scale**	How much satisfaction is gained from usage.	ISO/IEC 9126-4	◎
Sa-2	Usefulness	**Discretionary utilization**	How many potential users actually use this system.	ISO/IEC 9126-4	◎
Sa-3	Usefulness	**No. of customer claims**	How many claims are made by customers.	JUAS	◎
	Trust	Degree to which a product or system will behave as intended			
	Pleasure	Degree to which a user obtains pleasure from fulfilling their personal needs			
	Comfort	Degree to which the user is satisfied with physical comfort			

（4）**Freedom from risk**

Measures related to freedom from risk (degree to which a product or system mitigates the potential risk to economic status, human life, health or the environment) are shown.

Table 3-8 Quality in use characteristics: Freedom from risk Measures

ID.	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information
	Economic risk mitigation	Degree to which a product or system mitigates the potential risk to financial status, efficient operation, commercial property, reputation or other resources in the intended contexts of use			
Fr-1	Economic risk mitigation	**Return of investment (ROI)**	Ratio of effective amount against invested amount. Monitoring the effect that can be converted into a monetary amount including reduction in personnel expenses, shrinkage of inventory assets, reduction of stock, reduction of material cost through concentrated purchase. Payout time (inverse number to ROI) is normally from 2 to 10 years. In the case of reconstruction, payout time is prolonged compared with new development.	JUAS, effectiveness Evaluation of items that can be converted into an amount of money (qualitative evaluation)	◎
Fr-2	Economic risk mitigation	**Comparison with other companies (benchmark)**	How the status of own company is compared with other top class companies in the industry or in same business. E.g.) (IT investment amount/sales) of own company / (IT investment amount / sales) of target company for comparison, etc.	JUAS	◎

ID.	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information
Fr-3	Economic risk mitigation	**Balance score card (BSC)**	How IT investment is effective from 4 viewpoints; finance, customer, business operation processes and HR development	JUAS, evaluation by general index	◎
Fr-4	Economic risk mitigation	**Ratio of revenue for each new customer**	How much revenue is made from each customer when starting new product/new service. There are two types of customer, new and existing. E.g.) Compare actual revenue from new customers and objective revenue from new customers	JUAS	○
Fr-5	Economic risk mitigation	**Opportunity loss**	It is not a loss occurring from actually deploying the system, it is how much opportunity to gain profit is lost due to not deploying the system (how much profit is missed).	JUAS	○
Fr-6	Economic risk mitigation	**IT asset investment**	How effectively the IT investment amount is used. E.g.) Effective amount/IT investment amount	JUAS	○
Fr-7	Economic risk mitigation	**Economic damage**	How much economic damage has occurred.	ISO/IEC 9126-4	○
Fr-8	Economic risk mitigation	**No. of delayed cases from delivery time**	How often delay in delivery time has occurred.	JUAS	○
Fr-9	Economic risk mitigation	**No. of missing item cases**	How many cases of missing items have occurred.	JUAS	○
	Health and safety risk mitigation	Degree to which a product or system mitigates the potential risk to people in the intended contexts of use			
Fr-10	Health and safety risk mitigation	**Degree of nuisance to customers**	How much bad influence is given to a user. E.g.) No. of affected people x time x severity	Important infrastructure	◎
	Environmental risk mitigation	Degree to which a product or system mitigates the potential risk to property or the environment in the intended contexts of use			
Fr-11	Environmental risk mitigation	**Degree of compliance with Law on Promoting Green Purchasing**	How much support is given to reducing environmental burden. Whether investigation has been made into minimizing disposal of items throughout the life cycle.	Nonfunctional, Environmental management Devise to reduce environmental burden Usability, standard compatibility	◎
Fr-12	Environmental risk mitigation	**Objective value of CO2 emission**	Presence and content of objective CO2 emission amount CO2 emission amount at operation is basically linked to power consumption. This amount plus the CO2 emission amount from production/disposal becomes the emission amount of overall life cycle.	Nonfunctional, CO2 emission amount	○

（５）**Context coverage**

Measures related to context coverage (degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in both specified contexts of use and in contexts beyond those initially explicitly identified) are shown. However, measures related to context appropriateness are not indicated because no pertinent ones were acquired from examples or existing deliverables.

Table 3-9 Quality in use characteristics: Context coverage Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information
	Context completeness	Degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in all the specified contexts of use			
	Flexibility	Degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in contexts beyond those initially specified in the requirements			
Co-1	Flexibility	**Ratio of number of days required for actual recover against the planned number of days for recovery from disaster**	How many days are actually required till operating normally or fail soft state from non operational state of system due to occurrence of disaster, compared with the number of days defined in advance. Possible to set by disaster type, such as widespread disaster or local disaster	JUAS	◎
Co-2	Flexibility	**Degree of skill to switch to a backup machine**	How much is learnt through daily training performed in order to switch to a backup machine or recover easily.	JUAS	◎
Co-3	Flexibility	**Support and execution rate against hardware alarms**	To what extent are standards followed when taking an action for a hardware malfunction alarm. E.g.) Compare the number of times action is taken following the standard and the total number of occurrences of hardware failures	JUAS	○

3.2.3 Initial Set of Measures related to System and Software Product Quality Characteristics

（1）**Functional suitability**

Measures related to functional suitability (degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions) are indicated.

Table 3-10 System/software product quality characteristics: Functional suitability Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential info.	
					Up to unit test	After combined test
	Functional completeness	Degree to which the set of functions covers all the specified tasks and user objectives				
Fu-1	Functional completeness	**Completeness of functional implementation**	How correctly the functional contents stated in the requirement specification are implemented with no omissions. E.g.) Compare the number of missing functions detected during evaluation and the number of functions stated in the requirement specification.	ISO/IEC 9126-2	◎	◎
	Functional correctness	Degree to which a product or system provides the correct results with the necessary degree of precision				
Fu-2	Functional correctness	**Correctness**	How much the required specific accuracy standard is actually complied with. E.g.) Compare the number of data items implemented with the specific standard of accuracy and the number of data items requiring the specific standard of accuracy.	ISO/IEC 9126-3	◎	◎
Fu-3	Functional correctness	**Functional correctness of calculation**	How accurate a calculation result can be obtained against the calculation result stated in the specification. E.g.) Compare the number of incorrect calculations detected during evaluation and the number of correct calculations stated in the specification.	ISO/IEC 9126-2	○	◎
Fu-4	Functional correctness	**Functional correctness of manual description**	To what extent is the description in the manual consistent with the actual operation contents. E.g.) Compare the total number of target items and the number of items for which the difference between the description in the manual and actual operation exceeds the allowable range as judged by a user.	JUAS, Functional correctness		◎
Fu-5	Functional correctness	**Functional correctness to the expectation**	To what extent are results rationally expected actually obtained. E.g.) Carry out the test and compare the adequately expected result and the number of results as judged by a user as having unacceptable differences.	ISO/IEC 9126-2		◎
	Functional appropriateness	Degree to which the functions facilitate the accomplishment of specified tasks and objectives				

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential info.	
					Up to unit test	After combined test
Fu-6	Functional appropriateness	**Specification change rate**	How much are specifications changed against overall specification. E.g.) Compare the total number of specifications and changed specifications.	JUAS	◎	◎
Fu-7	Functional appropriateness	**Completeness of functional implementation**	How many functions stated in the requirement specification are implemented. E.g.) Compare the number of functions implemented incorrectly or fault functions detected during evaluation and the number of functions stated in the requirement specification.	ISO/IEC 9126-2	◎	◎
Fu-8	Functional appropriateness	**Functional appropriateness**	How many functions with no problem are implemented for the appropriate functions for pursuing a specific task. E.g.) Compare the number of appropriate functions for pursuing specific tasks and the number of functions from which a problem is detected.	ISO/IEC 9126-2	◎	◎
Fu-9	Functional appropriateness	**Compliance rate to software design policy**	How many of the items required in the software design policy are complied with. E.g.) Compare the number of items required to be complied with in the software design policy and the number of items actually complied with.	JUAS, Maintainability, standard compliance	◎	○
Fu-10	Functional appropriateness	**Presence of acquisition of standard (compliance standard, product safety standard)**	Whether the required standards including product safety standards are obtained. E.g.) Compare the number of standards and the number of obtained standards.	Non functional, Compliance standard, Product safety standard	◎	○
Fu-11	Functional appropriateness	**Stability of functional specification**	How many functional changes are made after starting the development in relation to the functions in the requirement specification. E.g.) Compare the number of functions changed after starting the development and the number of functions stated in the requirement specification.	ISO/IEC 9126-2	○	○
Fu-12	Functional appropriateness	**Excess degree of function**	How many functions that are not required are included, apart from the functions required and functions that are included implicitly to meet requirements.	JUAS	○	

（2）**Performance efficiency**

Measures related to performance efficiency (degree of performance relative to the amount of resources used under stated conditions) are indicated.

Table 3-11 System/software product quality characteristics: Performance efficiency Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
	Time behavior	Degree to which the response and processing time and throughput rates of a product or system, when performing its functions, meet requirements				
Pe-1	Time behavior	**Response time**	Duration from giving an instruction to start a batch of tasks till receiving the first response. Average time, max. time, etc. are included.	ISO/IEC 9126-3	◎	◎
Pe-2	Time behavior	**Turnaround time**	Duration from giving an instruction to start a batch of tasks till completion of tasks. Average time, max. time, etc. are included.	ISO/IEC 9126-3	◎	◎
Pe-3	Time behavior	**Throughput**	How many tasks can be processed per unit of time.	ISO/IEC 9126-3	◎	○
Pe-4	Time behavior	**Response compliance rate at normal, at peak, and at degenerate operation**	How many responses are actually obtained when using at normal, peak and degenerate operation of online system stated in the requirement specification.	Nonfunctional	○	◎
Pe-5	Time behavior	**Processing margin rate at normal, peak and degenerate operation**	How much margin for work is there at normal, peak and degenerate operation.	Nonfunctional, online throughput	○	○
	Resource utilization	Degree to which the amounts and types of resources used by a product or system when performing its functions meet requirements				
Pe-6	Resource utilization	**Data volume**	Volume of data retained by the system E.g.) Primary storage portion of master type table or main transaction data If only main data volume is determined, there is a risk that disc will be added due to data for which investigation is missed in the post process.	Nonfunctional	◎	◎
Pe-7	Resource utilization	**Memory capacity**	Capacity of main memory of a computer required to carry out specified processing.	JUAS	◎	◎
Pe-8	Resource utilization	**Hard disc capacity (of server, etc.)**	Capacity of hard disc of server, etc. that is required when carrying out specific processing.	JUAS	◎	○
Pe-9	Resource utilization	**I/O device**	No. of I/O devices required to carry out specific processing.	JUAS	◎	○
Pe-10	Resource utilization	**CPU utilization rate**	Ratio of program CPU usage per unit of time while in operation E.g.) Check from the CPU utilization rate at starting degree for the system and the vacant level of CPU slot.	Nonfunctional, resource expandability CPU expandability		◎
Pe-11	Resource utilization	**Storage period**	Necessary storage period for data used by system infrastructure including OS and middleware log among data to which the system refers. It is determined for the type of data as necessary.	Nonfunctional, storage period	○	
	Capacity	The degree to which the maximum limits of a product or system parameter meet requirements				
Pe-12	Capacity	No. of bases	No. of bases where system operates	Nonfunctional, No. of bases	◎	◎
Pe-13	Capacity	No. of business operation functions	Number of business operation functions furnished for a system	Nonfunctional	◎	◎
Pe-14	Capacity	No. of batch processing cases	No. of batch processing cases per unit of time	Nonfunctional	◎	◎

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
Pe-15	Capacity	**Increase rate of data volume**	How much of the data volume handled in a system increases or decreases according to increase or decrease of business operation from the start of system operation. It can be compared with the average value of starting day or static state after starting as necessary. E.g.) Compare data volume per unit of time in the past and current data volume per unit of time.	Nonfunctional	◎	◎
Pe-16	Capacity	**No. of online requests**	No. of requests received per unit of time E.g.) No. of requests in moving in/out processing of the resident information system or settlement processing of the net shopping system	Nonfunctional	◎	○
Pe-17	Capacity	**No. of users increase rate**	How great is the rate of increase or decrease in the number of users due to increase or decrease in the No. of user registrations/deletions from the start of the system operation. It can be compared with the average value of the starting day or steady state after starting in some cases. E.g.) Compare the number of users in the past and the current number of users	Nonfunctional, increasing degree of business operation amount	○	◎
Pe-18	Capacity	**Transaction protection**	Appearance of extremely large load in a short period from the load at normal time, presence of protection or countermeasures for the state exceeding the anticipated peak of business operation amount	Nonfunctional, supporting spike load	○	◎
Pe-19	Capacity	**(Max.) No. of simultaneous accesses**	How many people access the system simultaneously at a certain time. The max. number of simultaneous accesses means the upper limit of the No. of simultaneous connections to the system, but it must be noted that the number of simultaneous accesses sometimes indicates the max. value.	Nonfunctional	○	◎
Pe-20	Capacity	**(Unique) No. of users**	The number of users (end users) using a system For instance, in the case of a web site, the same person sometimes accesses multiple times (page view) in a certain period, so the number of people actually visiting maybe small.	Nonfunctional, system characteristics, No. of users	○	○
Pe-21	Capacity	**Load limit of I/O device**	How much is the absolute limit value of the utilization rate of I/O device required to comply with the functions. E.g.) Emulating the state where a system reaches the max. load.	ISO/IEC 9126-2		○
Pe-22	Capacity	**Max. utilization rate of transmission system**	How much is the absolute limit value of transmission required to comply with the functions. E.g.) Evaluating the value required for a system to reach the max. load.	ISO/IEC 9126-2		○

（３）**Compatibility**

Measures related to compatibility (degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions, while sharing the same hardware or software environment) are indicated.

Table 3-12 System/software product quality characteristics: Compatibility Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
	Co-existence	Degree to which a product can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product				
Co-1	Co-existence	**Usable co-existence**	Degree to which that target software can be used with no restrictions or faults when it is used with other software at the same time	ISO/IEC 9126-2	○	○
	Interoperability	Degree to which two or more systems, products or components can exchange information and use the information that has been exchanged				
Co-2	Interoperability	**Presence of connection with external system**	Checking the degree of impact from usage of a system according to the type and number of external systems to be linked (outside of div., outside of a company, social infrastructure system, etc.) E.g.) No. of external system connections	Nonfunctional, external system connection	○	○
Co-3	Interoperability	**Interface consistency (protocol)**	How accurately is interface protocol implemented. (E.g.) Compare the number of correct interface protocol implementations as shown in the spec. and the number of interface protocol implementations according to the specification.	ISO/IEC 9126-3	○	
Co-4	Interoperability	**Data exModifiability based on data format**	How accurately is implementation of data exchange format determined between linking systems. E.g.) Compare the number of data formats regarded as being smoothly exchanged with other software or systems and the total number of data formats to be exchanged.	ISO/IEC 9126-2		○

（4）Usability

Measures related to usability (degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use) are indicated.

Table 3-13 System/software product quality characteristics: Usability Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information Up to unit test	Referential information After combined test
	Appropriateness recognizability		Degree to which users can recognize whether a product or system is appropriate for their needs			
Us-1	Appropriateness recognizability	**Description completeness**	How many functions (or types of functions) are stated in the manual, among all usable functions. Or, how far is it possible to understand the functions when reading a manual.	ISO/IEC 9126-3	○	○
Us-2	Appropriateness recognizability	**Completeness of user's documentation and/or help function**	How many functions are stated in the manual and/or help function, among all usable functions. Or, how accurately the function can actually be operated.	ISO/IEC 9126-3	○	○
Us-3	Appropriateness recognizability	**Understandable I/O**	How easy is it to understand input/output? (Input) how easy is it to understand which data should be input where. (Output) how easy is it to understand the contents to be output.	ISO/IEC 9126-2	○	○
Us-4	Appropriateness recognizability	**Degree of understanding of function**	How many user interface functions can be understood easily among all usable user interface functions.	ISO/IEC 9126-2		○
	Learnability		Degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with satisfaction, functional completeness, effectiveness and efficiency in a specified context of use.			
Us-5	Learnability	**Processing time (learning time)**	Time required to carry out business operation processing referring to manual, guide, etc. Time for correction of errors in processing is included.	JUAS		○
Us-6	Learnability	**Ease of help access**	How many targeted help items can be found using the help function.	ISO/IEC 9126-2		○
Us-7	Learnability	**Learning ease for execution of work in use**	Time required from learning the operation method of specified task to starting the operation efficiently.	ISO/IEC 9126-2		○
	Operability		Degree in relation to labor for operation and control			
Us-8	Operability	**Monitoring information**	No. of monitoring items and the contents of monitoring performed for overall system or hardware/software comprising a system (including business applications) in order to maintain quality of a system. E.g.) Life or death monitoring, error monitoring, resource monitoring and performance monitoring are included E.g.) Monitoring of life or death, monitoring of errors, monitoring of resources and monitoring of performance are included.	Nonfunctional, operation monitoring	○	○

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
Us-9	Operability	**Monitoring of system level**	No. of monitoring items and contents for the state of overall system or multiple servers, etc. making up hardware/software (including business operation applications) that make up the system, which is carried out to judge whether the system is in a sufficient state to function as a system. E.g.) Monitoring of backup or job is included.	Nonfunctional	○	○
Us-10	Operability	**Ratio of clarification of operation start conditions, etc.**	How clearly are operation conditions including start, interruption or finish of operation stated.	JUAS, Operability	○	○
Us-11	Operability	**Operational consistency**	How consistently can similar operations be carried out in the system. E.g.) Compare the number of operations that behave inconsistently and the total number of operations that behave similarly.	ISO/IEC 9126-3	○	○
Us-12	Operability	**Message clarity**	How easily can messages from a system be understood. E.g.) Compare the number of messages that are understood easily and the total number of implemented messages	ISO/IEC 9126-3	○	○
Us-13	Operability	**Customizing possibility**	How many functions and operational procedures can a user customize for the operation.	ISO/IEC 9126-3	○	○
Us-14	Operability	**Monitoring possibility**	How much monitoring can be realized among all required monitoring functions.	ISO/IEC 9126-3	○	
	User error protection	Degree to which the system protects users against making errors				
Us-15	User error protection	**Mis-operaiton ratio**	How much mis-operation occurs during operation. E.g.) Compare the number of incorrect operations occurring with a function to prevent incorrect operations furnished and the number of incorrect operations occurring without it.	JUAS	○	○
Us-16	User error protection	**Error correctionability (in use)**	To what extent can errors can be corrected or recovered easily during operation. E.g.) Measure the number of recovery operations carried out and the time from occurrence to recovery.	ISO/IEC 9126-2	○	○
Us-17	User error protection	**Avoidance of incorrect operation**	How many functions have incorrect operation avoidance capability. E.g.) Compare the number of functions implemented to avoid critical or serious malfunctions being caused by incorrect operation and the number of incorrect operation patterns based on it.	ISO/IEC 9126-3	○	○

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
Us-18	User error protection	**Error message obviousness**	With what percentage is a message that can be recovered presented among the error states. E.g.) Compare the number of corrected errors through error messages and the total number of corrected errors.	ISO/IEC 9126-2	○	○
	User interface aesthetics	Degree to which the user interface enables pleasing and satisfying interaction for the user				
Us-19	User interface aesthetics	**Appearance customizability of user interface**	To what extent can the appearance of the user interface factors be customized as the user desires. E.g.) Number of functions that can be customized, time or the number of operations required for customization	ISO/IEC 9126-3	○	○
	Accessibility	Degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use				
Us-20	Accessibility	**Physical accessibility**	How many functions can a user with a physical handicap access. E.g.) Evaluate using a check list where functions that should be accessible are determined.	ISO/IEC 9126-3	○	○
Us-21	Accessibility	**No. of languages**	How many languages that should be handled are supported, taking into account the accessibility for each person with a language skill. E.g.) Count the number of translatable languages	Nonfunctional, multiple language support	○	○
Us-22	Accessibility	**Interface factor clearness**	How easily can the interface factors be understood.	ISO/IEC 9126-3	○	

（５）**Reliability**

Measures related to reliability (degree to which a system, product or component performs specified functions under specified conditions for a specified period of time) are indicated.

Table 3-14 System/software product quality characteristics: Reliability Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
	Maturity	Degree to which a system meets needs for reliability under normal operation				
Re-1	Maturity	**Test density**	Ratio of the number of set tests against the scale of software	JUAS, reliability	◎	◎
Re-2	Maturity	**Failure elimination**	No. of corrected and eliminated failures	ISO/IEC 9126-2	◎	◎
Re-3	Maturity	**Test coverage rate**	How great is the coverage rate in units of statement when a test is carried out for each program.　Or, how many tests including all passes are performed.	Critical infrastructure JUAS	◎	◎
Re-4	Maturity	**Test plan appropriateness**	How many plans are made against the number of tests that should be performed in order to meet the requirements.	ISO/IEC 9126-3	◎	
Re-5	Maturity	**Test completeness**	How many reviews and test are carried out against the number of tests that should be performed in order to meet the requirements.	ISO/IEC 9126-2	○	◎
Re-6	Maturity	**Bug density**	The ratio of the number of detected bugs against the scale of software	Critical infrastructure	○	◎
Re-7	Maturity	**Defect convergence rate**	How much have detected defects decreased.	Critical infrastructure ESQR	○	○
Re-8	Maturity	**No. of cases pointed out at review**	No. of defects detected at review	Critical infrastructure	○	○
Re-9	Maturity	**Review indication density**	No. of detected defects against the scale of review per unit	Critical infrastructure	○	○
Re-10	Maturity	**Fault elimination rate**	No. of corrected faults against the detected faults	Critical infrastructure ESQR	○	○
Re-11	Maturity	**Missing rate**	The rate of defects that are not picked out at the review of the present process but are clarified in the post process	Critical infrastructure Maturity	○	○
Re-12	Maturity	**Fault detection**	No. of detected faults	ISO/IEC 9126-3	○	
Re-13	Maturity	**Test maturity**	How many tests have passed among all tests that should be performed in order to meet the requirements.	ISO/IEC 9126-2		○
	Availability	Degree to which a system, product or component is operational and accessible when required for use				
Re-14	Availability	**Working ratio**	To what extent can the service actually be provided against the service time regulated in the operation schedule or objective recovery standard. Calculate for each system target	Nonfunctional, working ratio		◎

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
			(online system, networks service, etc.) or for target time (operation duration, response time, reception time, etc.).			
Re-15	Availability	**Operation time (normal, special day)**	Information related to operation time of a system and cessation operation Special day indicates a day where a different schedule from normal operation schedule is defined, such as holidays, public holidays or beginning or end of month.	Nonfunctional, continuity, availability Operation schedule	○	○
Re-16	Availability	**RTO (Recovery Time Objective), (Objective recovery standard)**	Objective for what failure should be recovered how much and how quickly when a failure causing cessation of business occurs. E.g.) RTO: Recovery time objective, RLO: Recovery Level Objective, RPO (Recover Point Objective)	Nonfunctional	○	○
Re-17	Availability	**Batch processing normal finish ratio**	How much of batch processing is completed within a given time.	Critical infrastructure	○	○
Re-18	Availability	**Service switching time**	Time required to restart business after using a measure (e.g. switching a server in a cluster composition) for the expected trouble (e.g. cases where business is disconnected temporarily due to trouble with hardware, etc.).	Nonfunctional	○	○
Re-19	Availability	**Service time**	Time zone from starting the operation of application service till finishing it	JEITA, IT service, application operation service, common to business operation	○	
Re-20	Availability	**Reception time**	Service time zone in which the operation contact receives support	JEITA, IT service, support desk service, coping with support	○	
Re-21	Availability	**(trouble) handling time**	Operation time zone in which trouble is detected during operation of a system and it is handled	JEITA, IT service, support desk service, handling a trouble	○	
Re-22	Availability	**Handling time for job operation**	Operation time zone in which job operation is carried out	JEITA, IT service, application operation service, routine task	○	
Re-23	Availability	**Service provision time zone (general inquiries, trouble handling)**	Service provision time zone (general inquiries), call receiving service time during general inquiries, service provision time zone (handling trouble) call receiving service time to handle trouble	JEITAIT service, maintenance service, help desk	○	
Re-24	Availability	**Service time of operation**	Ratio of time during which facilities can be used against the regulated time	JEITAIT process management, facility control, availability control (operation control)	○	

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
Re-25	Availability	**Operation time (management time)**	Time in which a center operates its service and it is monitored	JEITAIT resource, facility, center operation	○	
	Fault tolerance	Degree to which a system, product or component operates as intended despite the presence of hardware or software faults				
Re-26	Fault tolerance	**Functional shut down avoidance**	How many faults causing shut down occur	ISO/IEC 9126-2		◎
Re-27	Fault tolerance	**Redundancy (machines)**	Contents and the number of preventive or avoidance measures retained in order to maintain provision of required services against faults occurring on networking devices including routers and switches, servers, terminals, external memory devices or lines.	Nonfunctional, fault tolerance server	○	○
Re-28	Fault tolerance	**Segment division**	Contents and the number of segment divisions performed to improve the reliability of network	Nonfunctional	○	○
Re-29	Fault tolerance	**Fault notification time**	Time from detecting an error (error of network service, fault in routine job operation, etc.) till report of fault state is sent	JEITAIT service, network service, fault control	○	
	Recoverability	Degree to which, in the event of an interruption or failure, a product or system can recover the data directly affected and re-establish the desired state of the system				
Re-30	Recoverability	**Operation quality ratio**	To what extent is inconvenience caused due to occurrence of a fault. E.g. Ratio of the number of instances of inconvenience to a user due to a failure, against total asset scale	JUAS, Fault expansion prevention measure		◎
Re-31	Recoverability	**Backup utilization range (supporting backup)**	Contents determined for the following backup Backup utilization range, backup acquisition interval, backup storage period, automatization range of backup, backup method, data recovery range	Nonfunctional	○	○
Re-32	Recoverability	**Fault recovery time**	Time from fault detection till the service is recovered	JEITAIT service, network service, fault control	○	

（6）**Security**

Measures related to security (degree to which a product or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization) are indicated.

Table 3-15 System/software product quality characteristics: Security Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential informaiton	
					Up to unit test	After combined test
	Confidentiality		Degree to which a product or system ensures that data is accessible only to those authorized to have access			
Se-1	Confidentiality	**Operation limiting degree in a measure for a system**	Contents and number of operational limitations including installation limitation of software and usage limitation	Nonfunctional, Usage limitation	◎	◎
Se-2	Confidentiality	**Access surveillance performance**	To what extent is access to system or data monitored according to requirement. E.g.)Compare the number of accesses by a user to system and data recorded in the access history database and actual number of accesses	ISO/IEC 9126-2	◎	◎
Se-3	Confidentiality	**Access control performance**	To what extent can access to the system be controlled. E.g.) Compare the number of detected illegal operations and the number of illegal operations stated in the specification	ISO/IEC 9126-2	◎	◎
Se-4	Confidentiality	**Illegal monitoring target (device)**	Presence of acquisition of log, its range and contents for monitoring illegal access to service, storage, etc. or illegal packets on a network.	Nonfunctional	○	○
Se-5	Confidentiality	**Detection range of illegal communication**	Presence of detection of illegal action or illegal communication in a system, its range and contents, through tracking/monitoring illegal actions on a network.	Nonfunctional, detection of fraud	○	○
Se-6	Confidentiality	**Communication control**	Contents and the number of control items to shut down illegal communication	Nonfunctional, network measure, network control	○	○
Se-7	Confidentiality	**Network convergence measure**	Contents and the number of measures for convergence due to attack on a network	Nonfunctional, avoidance of service stop attack	○	○
Se-8	Confidentiality	**Presence of encryption of transmission data**	Presence of encryption and its content for keeping confidential data secret at transmission or storage	Nonfunctional, keeping data secret, data encryption	○	○
Se-9	Confidentiality	**Data encryption**	How correctly is the encryption/decryption of data items stated in the requirement spec. implemented. E.g.) Compare the number of data items that are implemented as spec. and can be encrypted/decrypted and	ISO/IEC 9126-3	○	○

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential informaiton	
					Up to unit test	After combined test
			the number of data items of required data encryption/decryption functions.			
	Integrity		Degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data			
Se-10	Integrity	**Preventive property of data damage**	To what extent can the phenomenon of serious data damage or minor data damage be prevented. E.g.) Compare the number of data damage instances actually occurring and the number of operation and access times where data damage or breakage is expected to occur.	ISO/IEC 9126-2	◎	◎
Se-11	Integrity	**Enhancement of measures by secure coding, web server setting, etc.**	Contents and the number of measures related to unique threats and vulnerability of application	Nonfunctional, Web implementation measures	○	○
Se-12	Integrity	**Presence of execution of web diagnostics**	Contents and the number of security diagnostics for web server and web application performed for the web site	Nonfunctional	○	○
Se-13	Integrity	**Risk handling range after starting operation**	Contents and handling range of risks discovered after starting operation	Nonfunctional, revision of security risk measures	○	
Se-14	Integrity	**Security risk revising frequency**	The number of times to review security risks after starting operation E.g.) It is performed when an event related to security occurs (occasionally) on a regular basis.	Nonfunctional, security risk control Security risk revision	○	
Se-15	Integrity	**Security batch application range**	Application range, policy and the contents of application timing regarding application of security batch for handling vulnerability, etc. of a target system.	Nonfunctional, security patch application	○	
	Non-repudiation		Degree to which actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later (digital signature, etc.)			
Se-16	Non-repudiation	**Key management**	Contents of key management E.g.) Key management using software (controlling access by setting software, etc. on secret key information). Key management using tamper resistance device (control using a dedicated device for which attack resistance is enhanced by physical devices such as IC cards).	Nonfunctional	○	○
Se-17	Non-repudiation	**Presence of utilization of digital signature**	Presence of deployment of digital signature that enables proof that information is properly processed and stored and to detect falsification of information	Nonfunctional, data validation	○	○
	Accountability		Degree to which the actions of an entity can be traced uniquely to that entity			
Se-18	Accountability	**Acquisition of log**	Presence of acquisition of log, the number of log items and contents that are obtained in order to check "when", "who", "from where" "what is carried out" and "what happens as a result" and to use measures promptly.	Nonfunctional, Fraud surveillance	◎	◎

| ID | Sub quality characteristics | Measure | Explanation of measure | Reference | Referential informaiton | |
					Up to unit test	After combined test
Se-19	Accountability	**Log storage time**	Period of storing a log in order to check the illegal action and to retain the trail of correct processing	Nonfunctional	○	○
	Authenticity	Degree to which the identity of a subject or resource can be proved to be the one claimed				
Se-20	Authenticity	**Authentication of an entity with control authority**	Presence of authentication and the method used to identify an entity who has control authority to prevent abuse of the authority (system administrator or business administrator) or an entity who uses the assets (user, machine, etc.) when an attacker obtains control authority. E.g.) There are authentication methods using ID/password or IC card.	Nonfunctional, access/utilization limitation, authentication function	◎	○
Se-21	Authenticity	**Establishment of control rules**	Contents and the number of rules for addition, updating or deletion of information necessary for authentication. E.g.) Necessary information used to specify an entity uniformly for authentication includes ID/password, fingerprints, iris and vein.	Nonfunctional, control method	○	○
Se-22	Authenticity	**Presence of in-company regulations, rules, laws and guidelines that should by obeyed**	Presence of measures and their contents including organization regulations, rules, laws and guidelines regarding information security that users should observe	Nonfunctional, preconditions, restrictions Compliance regarding information security	○	○

（7）**Maintainability**

Measures related to maintainability (degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers) are indicated.

Table 3-16 System/software product quality characteristics: Maintainability Measures

| ID | Sub quality characteristics | Measure | Explanation of measure | Reference | Referential information | |
					Up to unit test	After combined test
	Modularity	Degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components				
Ma-1	Modularity	**Condensability**	How strong is the relation between the function factors and information factors in a class or package . E.g.) LCOM◎ (Lack of Cohesion in Methods)		○	
	Reusability	Degree to which an asset can be used in more than one system, or in building other assets				
Ma-2	Reusability	**Execution of reusability**	How many target assets that are controlled in a reusable library can be reused.	JUAS, reusability, portability	○	○

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
			E.g.) The number of target assets for reuse that are controlled in the reusable library			
	Analyzability		Degree of effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified			
Ma-3	Functional appropriateness	**Conformance rate to coding code**	To what extent is the coding code determined in advance complied with	JUAS	◎	
Ma-4	Analyzability	**Maintenance document sufficiency**	With regard to the maintenance document that leads to improvement of analyzability, how many documents are actually prepared
E.g.) The number of documents such as function specifications, DB cross reference, data item cross reference, transaction reference, change procedure (organizational change, institutional change, change of limit amount), etc.	JUAS, Analyzability Maintainability	○	○
Ma-5	Analyzability	**Execution record**	How sufficiently is the system state recorded.
E.g.) Compare the number of items of which execution log is recorded as spec. and the number of items for which a log is required.	ISO/IEC 9126-3	○	○
Ma-6	Analyzability	**Diagnosis function sufficiency**	To what extent are diagnostic functions prepared, or to what extent do they work for analyzing the cause.
E.g.) Compare the number of implemented diagnostic functions and the number of diagnostic functions required in the spec.
Count the number of specific operations that became the cause of trouble and that could be identified by diagnostic function.	ISO/IEC 9126-3	○	○
Ma-7	Analyzability	**Trial audit ability (trouble analysis ability)**	To what extent can specific operations that became the cause of trouble be identified.
E.g.) Count the number of causes that are identified	ISO/IEC 9126-2		○
	Modifiability		Degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality (Modifiability and stability in ISO/IEC 9126 series)			
Ma-8	Modifiability	**Scale up**	Contents to be prepared for increase in the business operation amount in the future, the number of increasable servers	Nonfunctional, enhancement of server processing ability	○	○
Ma-9	Modifiability	**Localization degree of correction impact (appearance degree of trouble after a change)**	To what extent can the trouble caused as an aftereffect of maintenance be prevented.
E.g.) Count the number of trouble instances that are affected by maintenance.	ISO/IEC 9126-2	○	○
Ma-10	Modifiability	**Maintainability standard functional completeness ratio**	How well does the maintainability conform to applicable rules, standards and agreements	ISO/IEC 9126-3	○	○

| ID | Sub quality characteristics | Measure | Explanation of measure | Reference | Referential information | |
					Up to unit test	After combined test
			E.g.) Compare the number of items from which functional completeness is required and that it is complied with and the number of items requiring functional completeness in the spec.			
Ma-11	Modifiability	Change recording ability, Change history recording ratio	How appropriately are changes to spec. and program module recorded as a comment in the code.	ISO/IEC 9126-3 JUAS, modifiability	○	○
Ma-13	Modifiability	Influence rate of change	How much bad influence occurs after correction. E.g.) Compare the number of bad influences detected after correction and the number of corrected cases.	ISO/IEC 9126-3	○	
Ma-14	Modifiability	Change execution elapsed time	How easily can software be changed in order to solve the trouble.	ISO/IEC 9126-2		○
Ma-15	Modifiability	Change success rate	To what extent can software system be operated after maintenance. E.g.) Compare the number of troubles within a certain period before maintenance and the number of troubles in the same period after maintenance.	ISO/IEC 9126-2		○
Ma-16	Modifiability	Software change control ability	How easily can software be changed in order to solve the problem. E.g.) Count the number of changes carried out to solve the problem.	ISO/IEC 9126-2		○
	Testability	Degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met				
Ma-17	Testability	Functional completeness of embedded test functions	How completely are test functions and facilities implemented. E.g.) Compare the number of test functions implemented as specification and the number of required test functions.	ISO/IEC 9126-3	○	
Ma-18	Testability	Autonomous testability	How independently can software be tested. E.g.) Compare the number of tests that can be simulated by stub out of the tests depending on other systems and the total number of test dependencies to other systems.	ISO/IEC 9126-3	○	
Ma-19	Testability	Usability of embedded test functions	How easily can the operation test be carried out without preparing the test functions.	ISO/IEC 9126-2		○
Ma-20	Testability	Retesting efficiency	How easily can the operation test be carried out to judge the usage of software. E.g.) Observe the behavior of user or maintainer who tests the software system after maintenance	ISO/IEC 9126-2		○
Ma-21	Testability	Test restartability	How easily can the operation test be carried out from the restart point after maintenance.	ISO/IEC 9126-2		○

（8）**Portability**

Measures related to portability (degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another) are indicated.

Table 3-17 Quality characteristics of system/software product: Portability Measures

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
	Adaptability	Degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments				
Po-1	Adaptability	**Presence of adoption of specific product**	Is there any impact on the support contents from open source product or the 3rd party product (ISV/IHV) specified by a user. E.g.) No specific product is specified, specific product is specified partially, products for which support is difficult are specified.	Nonfunctional, specification of specific product	◎	◎
Po-2	Adaptability	**Target range**	Necessary storage time of data that is used by system infrastructures such as OS and middleware log among all data referred to by the system. It is determined for each data type as necessary. The target range (archive, referable range) should be also determined when selecting the target data for storage.	Nonfunctional	◎	◎
Po-3	Adaptability	**Multiple language supportability (number of languages)**	To what extent are the functions for which accessibility to each language skill holder should be taken into account supported. E.g.) Prepare necessary technologies to support multiple languages and a check list of notes beforehand and evaluate the support status.	Nonfunctional, supporting multiple languages	○	○
	Installability	Degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment				
Po-4	Installability	**System transfer time**	How much time and trouble is required from making a transfer work plan to full operation. E.g.) System transfer time, system stoppable day/time, presence of parallel operation	Nonfunctional, transferring time Schedule of transfer	◎	○
Po-5	Installability	**Ease of implementation performance**	How easily can software be implemented and set in the operation environment. E.g.) Compare the number of implemented operations changed successfully and the total number of implemented operations for which changes were attempted.	ISO/IEC 9126-2	○	◎
Po-6	Installability	**Rehearsal range**	To what extent should the transfer rehearsal be carried out. E.g.) No rehearsal, only main normal cases, all normal cases, normal cases	Nonfunctional, rehearsal	○	○

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combined test
			+ error cases that are cut back to the state before transfer, normal case + error cases that are recovered from system trouble			
Po-7	Installability	**Presence of external cooperative rehearsal**	Is external cooperative rehearsal necessary to reduce system transfer risks? E.g.) Absent (no change of external connection spec.), Present (external connection spec. is changed)	Nonfunctional	○	○
	Replaceability		Degree to which a product can be replaced by another specified software product for the same purpose in the same environment			
Po-8	Replaceability	**Transfer data amount**	Amount of business data that needs to be transferred on the system before transferring (including a program). E.g.) No target for transfer, less than 1TB, less than 1PB, 1PB or more	Nonfunctional, transferring target (data), transferring data amount	◎	◎
Po-9	Replaceability	**Complexity of transfer tool (number of conversion rules)**	How complicated is the shifting work to secure the functional correctness of data transfer tool.	Nonfunctional	◎	◎
Po-10	Replaceability	**No. of base development steps**	Content of development method for multiple steps and the number of procedures that are required when transferring a system and at new development. Difficulty level is reversed according to risk at development of base and difficulty level of simultaneous development becomes high in some cases.	Nonfunctional, transferring method, system development method	○	◎
Po-11	Replaceability	**Transferring contents of facilities/equipment**	Contents of the target facilities for transferring that are used in the system before transferring are replaced with new facilities in the new system	Nonfunctional, transferring target (equipment) Transferring facilities	○	○
Po-12	Replaceability	**User support function consistency**	How consistent is the new component with the existing user interface. E.g.) Compare the number of new functions that are considered not to be consistent with own expectations and not acceptable and the number of new functions	ISO/IEC 9126-2	○	○
Po-13	Replaceability	**Work division of user/vendor of transferring**	To what extent are the experience and knowledge of users depended on in the validation of business operation result after validation and transferring the transfer data.	Nonfunctional, transferring plan Transferring work division		◎
Po-14	Replaceability	**Functional comprehensibility**	How long can the similar functions to software before transfer be used. E.g.) Compare the number of functions that bring the same result and are not changed and the number of functions that have been the target of continuation from software before transfer.	ISO/IEC 9126-2		◎

ID	Sub quality characteristics	Measure	Explanation of measure	Reference	Referential information	
					Up to unit test	After combin ed test
Po-15	Replaceability	**Continuous usage of data**	How long can the same data as software before transfer be used continuously. E.g.) Compare the number of data confirmed as usable continuously from software before transfer and the number of data planned to be able to use from software before transfer.	ISO/IEC 9126-2		◎
Po-16	Replaceability	**Transfer media amount**	The amount of target media for transfer and the number of media types required at transfer.	Nonfunctiona l, transferring media		○

3.3 Domestic Trends related to Usability Evaluation of System by Measures

This section indicates the result of additional research into quality in use of system/software product, which is generally called usability.

（1）International trends related to usability evaluation

Inside the country, an e-government usability guideline[9] was announced by the Cabinet Office in July 2009.　This guideline was created to be used at new planning for new development and refurbishment, design/development, operation and evaluation stages in order to improve usability of systems including online application systems of each office and ministry in an effective and continuous manner.

Usability improvement processes consist of 4 stages from ① to ④ mentioned below.

〔4 stages of usability improvement process〕
 ① Setting of basic policy and objective for improvement of usability
 ② Monitoring and investigation of user characteristics and business operation
 ③ Technological investigation for realization of usability improvement
 ④ Investigation of user interface

This guideline indicates the efforts that each office and ministry should work on with regard to the stages of ① ~ ③.　In ④, the common design guidelines that each office and ministry need to incorporate in the design of online application systems, etc. is indicated.　Based on this, a user interface is supposed to be investigated individually taking into account the characteristics of each procedure.

Moreover, "Appendix 6[10]" of this guideline shows 8 methods in Table 3-18 as a method guide for improvement of usability.

Table 3-18 Methods to improve usability

Methods
1. Anticipated user group questionnaire research
2. Anticipated user group interview research
3. Target system user questionnaire research
4. Target system user interview research
5. Help desk information analysis
6. Log analysis
7. Usability test
8. Prototype creation/test

9　http://www.kantei.go.jp/jp/singi/it2/guide/security/kaisai_h21/dai37/h210701gl.pdf
10　http://www.kantei.go.jp/jp/singi/it2/guide/security/kaisai_h21/dai37/h210701gl_f.pdf

Further, the said "Appendix 7" shows the examples of measurement items, target setting and measurement method of quality in use.

Table 3-19 Measurement item, target setting and measurement method of quality in use [11]

Quality attribute	Measurement item example	Target setting example	Measurement method example
Effectiveness	Completion ratio of procedures for a first time user	・More than ○○% of users who use for the first time complete the procedures. *The following points are set as conditions as necessary for a first time user. ・Being able to process a procedure using paper with no problem. ・Not accepting advice from others. ・Referring to a manual.	■Usability test ・Requesting non-users to take actual procedures and checking the ratio of completion of procedures. ■Questionnaire ・Carrying out the questionnaire and checking the ratio of completion of procedures at the first time of usage. ■Log analysis ・Checking the ratio of first time users who complete the procedures based on the system log (usage history).
	No. of inquiries to help desk	・Reduce the number of inquiries about usability by ○○% of the result of the previous year.	■Hearing ・Acquiring the number of inquiries about usability at the help desk and checking it.
Efficiency	Average required time, No. of clicks from log-in to completion of procedure	・Setting the average required time till completion of procedures by a user within ○○min. ・Setting the number of clicks till completion of procedures by a person in charge who understands the relevant business and system within ○○.	■Usability evaluation ・Requesting a user to carry out the actual procedures and checking the average required time "from login to completion of procedure". ・Checking the number of clicks by a person in charge who understands the relevant system till completion of procedures. ■Questionnaire ・Carrying out the questionnaire and checking the average required time "from login to completion of procedure". ■Log analysis ・Checking the average required time "from login to completion of procedure" based on the system log (usage history).
	Ratio of time required for the procedure using paper or magnetic media and the online procedure	・Set the ratio of the average time required for the online procedure and the average time required for the procedure using paper within "○ vs ○". ・Set the average time required for the online procedure and the average time required for the procedure using magnetic media within "○ vs ○".	■Usability test ・Asking users to carry out the actual procedure online and checking the average time required "from login to completion of procedure", and at the same time hearing the average time required for paper or magnetic media and comparing both of them. ■Questionnaire ・Carrying out a questionnaire to check the average time required "from login to completion of procedure" using online and paper or magnetic media, and comparing both of them.
	Ratio of time required between a user and skilled operator	・Set the ratio of the average time required for a user and time required for a person in charge who understands the relevant business and system within "○ vs ○". *Set the following matters as user's conditions as necessary. ・Procedure using paper can be carried out with no problem. ・Not accepting advice from others. ・Referring to a manual. ・Using for the first time. *Reference ・The figure showing how much time a user requires compared with a skilled operator is called NE ratio. In the case of standard operation	■Usability test ・Asking a user to carry out the actual procedure to check the average time required "from login to completion of procedure" and comparing it with the time required for a person in charge who understands the relevant system. ■Questionnaire ・Carrying out a questionnaire to check the average time required "from login to completion of procedure" using paper or magnetic media and comparing both of them. ■Log analysis ・Checking the average time required for a user "from login to completion of procedure" based on the system log (usage history) and comparing it with the time required for a person in charge who understands the relevant system.

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[11] Reprinted from "E-government usability guideline appendix", P45 "Appendix 7 Measurement items, objective setting and measurement method examples of quality in use" by Cabinet Office.

Quality attribute	Measurement item example	Target setting example	Measurement method example
		system, when NE ratio exceeds 4.5 times, it is said that a serious problem is hidden. For instance, in the case of the operation system of an automobile, it is recommended to control the NE ratio at under two.	
Satisfaction	Degree of satisfaction of a system user	・○○% of users feel "easy to use" after utilization.	■Questionnaire ・Carrying out a questionnaire targeting experienced users to ask about usability of the relevant system (preparing the options such as agree strongly, agree, kind of agree, kind of disagree, disagree, disagree completely).
	Desired reuse rate of a system user	・○○% of users feel "wish to use again".	■Questionnaire ・Carrying out a questionnaire for experienced users to ask whether they would like to continue using the relevant system (preparing the options such as agree strongly, agree, kind of agree, kind of disagree, disagree, disagree completely).

（２）Example of effort made by the private sector related to usability evaluation

With regard to the evaluation of usability of system/software products using measures, Human Centered Design Organization (HCD-Net) has investigated an evaluation method to visualize the contents with which usability can be judged bad intuitively, in addition to the evaluation method through questionnaire for users.

According to the definition by HCD-Net, good usability is not just making things IT[12], but it is only that fewer operations are required compared with the operations carried out by human up to now. Based on this idea, HCD-Net considers the indirect operation time/direct operation time when a developer can measure the operation time, etc. as one of the measures to evaluate a comprehensive user interface. Concretely speaking, NEM evaluation (Novice Expert ratio Method) can be considered[13]. NEM evaluation is a method of monitoring the problems of usability quantitatively from NE ratio gained through comparison of operation time for a designer and a general user or beginner user.

[NE ratio: Novice Expert ratio]
Value showing how many times greater the operation time for a general user becomes when the operation time of a designer (skilled person) is set at 1.
NE ratio = operation time of general user / operation time of a skilled person

In the case of standard operation system, it is said that a serious problem is hidden if the NE ratio exceeds 4.5 times. NE ratio can be used to measure "Effectiveness" and it is actually used for the evaluation of each system of e-GOV, e-TAX and Ministry of Justice. There are measures related to operational performance using the NE ratio as shown below.

[Operational performance]
Value showing whether the number of target operations for improvement (usability of product) is many or few.
Operational performance = S − NEh/S
NEh = No. of operational steps with high NE ratio
S = Total number of operational steps

The following classification is considered as the evaluation axis for a user interface.

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[12] Some systems have more input procedures after introducing IT.
[13] As per U'eyes Design Co., Ltd. Yasuhisa Ito, Human Centered Design Organization (HCD-Net) The 1st HCD research presentation 2009, Foundation of NEM (Novice Expert ratio Method), 2009, 12.11

[Evaluation classification of usability of a system/software product]
- ・ Measures related to information composition
- ・ Measures related to screen composition
- ・ Measures related to interactive rules
- ・ Measures related to visual design

With regard to evaluation of screen composition and interactive rules, complexity of appearance (No. of crossed flows, etc.) when the actual operation procedures considered to be carried out by a user are made into a flow is considered as one of the evaluation targets.

4. Quality Requirement Definition Example forThree System field

In this chapter, the examples of quality requirement definition of characteristic system/software products are introduced along with each phase with regard to three fields; Finance/Insurance, Public and Web/Content.

The phases of quality requirement definition are Specification of users' needs (Fig. 4-1), Definition of quality requirement in use (Fig. 4-2) and Definition of quality requirement for system/software products (Fig. 4-3).

Stakeholder (user class)	Usage scenario	Needs/Risk/ Issue	Degree of importance
A(・・)	・・・	・・・	・・・
B(・・)	・・・	・・・	・・・
・・・	・・・	・・・	・・・

Fig. 4-1 Specification of users' needs (re-posted)
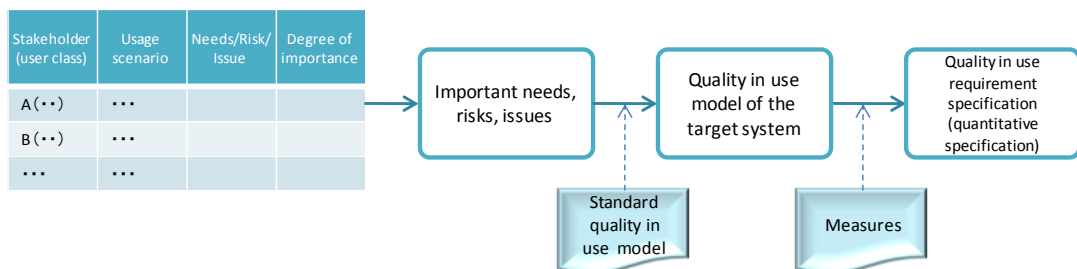
Fig. 4-2 Definition of quality in use requirements (re-posted)
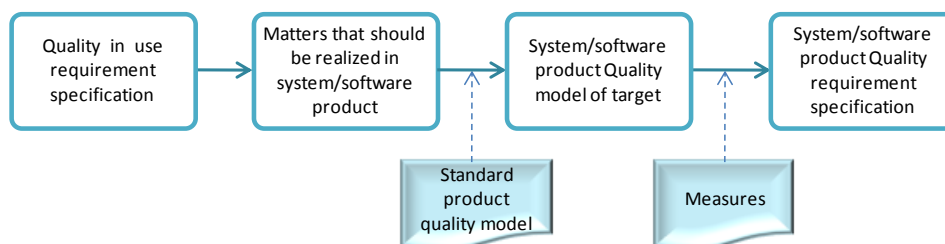
Fig. 4-3 Definition of quality requirements for system/software products (re-posted)

Examples of quality requirement definition in use and examples of quality requirement definition for system/software products show required needs, quality requirement examples and measures for each distinguishing quality characteristic. These measusres show a measureset created according to the knowledge of WG members and opinions expressed from the development site of example research mentioned in Chapter 3.

4.1 Example of Quality Requirement Definition of Finance/Insurance Field (#1 – #3)

The following are the distinguishing quality requirement definition examples for system/software products in the finance/insurance field obtained from the preceding examples.

（１）**Example of users' needs**

Example of users' needs for system/software products in the finance/insurance field are shown in Table 4-1.

Table 4-1 Example of users' needs for system/software products in the finance/insurance field

Case#	System	Stakeholder	User class				Usage scenario	Pertinent example of function
			1	2	3	4		
1	(Finance/insurance) Stock trading system	Securities company		X			Placing new orders, changing or canceling orders	Checking the order data and returning an acceptance notice
		Securities company		X			Receiving the result of checking up processing	Returning a contract result notice
		Information vendor			X		Receiving market information	Transmitting market information
		Stock div.			X		Monitoring the market	Receiving an inquiry from the trading control terminal, creating pertinent data and sending it back to the terminal
		Stock div.			X		Taking a regulatory measure including cessation of trading	Stopping trading of target shares, etc. upon indication from the trading control terminal
		Settlement system				X	Receiving contract data and carrying out the settlement processing	Sending contract data to settlement system on a regular basis
2	(Finance/insurance) Insurance product capitalization system	Agent		X			Insurance premium amount can be calculated correctly with the contents input on the trial calculation screen of insurance product	Calculating insurance premiums with the contents input on the trial calculation screen for each product
		Agent		X			Creating an estimate based on calculated premium	Creating an estimate to be presented to a customer according to the result of premium calculation
		Agent		X			Creating an application form	Creating an application to be presented to a customer according

Case#	System	Stakeholder	User class 1	User class 2	User class 3	User class 4	Usage scenario	Pertinent example of function
							based on calculated premium	to the result of premium calculation
		Agent		X			Reporting the contents of insurance contract concluded with a customer to a company	Carrying out posting process to the system of an insurance company from creation data of application form
		Employee		X			Checking data reported by an agent	Indicating errors in data to be posted/processed
3	(Finance/insurance) Financial institute counter terminal system	Bank clerk		X			Carrying out the counter business	Communicating with a host, inputting electronic statement and displaying the result

User class	(targets)
1	Beginner (person)
2	Intermediate (person)
3	Advanced (person)
4	Others (system)

（２）**Example of Quality in Use Requirement Definition**

Example of quality requirement in use for system/software products in the finance/insurance field is shown in Table 4-2.　According to the example, effectiveness and freedom from risk are considered as distinguishing quality characteristics in use.

Table 4-2 Example of quality requirement in use for system/software products in the finance/insurance field

Characteristic #	Main example of users' needs and risk	Quality in use characteristics: (quality in use model)	Example of quality in use requirement	Example of evaluation measures (recommended measures by WG)
1	・If a useful system is not provided, transactions will outflow.　(#1) ・Avoiding the risk of causing inconvenience to a policyholder due to incorrect calculation of insurance premium. (#2) ・It is a premise that financial terminals function correctly. (#3)	Effectiveness (Effectiveness)	・Connection spec. (protocol) determined after working with securities company Data processing performance (#1) ・Functionality	・Work effectiveness ・Failure frequency ・Work completion degree ・Software damage
2	・If stock CB trading system shuts down or causes data deficit, Japanese economy will be thrown into confusion. (#1) ・Avoiding the risk of causing inconvenience to a policyholder due to incorrect calculation of insurance premium. (#2) ・Reduction of operation cost is important as a part of overall cost, and non-cost type figures such as reputation are also important. (#3)	Economic risk mitigation (Freedom from risk)	・Assuring order property of data processing, Data triplexing, Complete duplexing of equipment ・Operation requirements	・Return On Investment (ROI) ・Comparison with other companies (benchmark) ・Balance score card (BSC) ・Ratio of revenue per new customer ・Opportunity loss ・IT asset investment ・Economic damage ・No. of delays of delivery time ・No. of missing part cases

（３）Example of Quality Requirement Definition for System/Software Products

Example of quality requirements for system/software products in the finance/insurance field is shown in

Table 4-3. According to the example, functional correctness, time behavior, availability, fault tolerance and confidentiality are considered as distinguishing quality characteristics for system/software products.

Table 4-3 Example of quality requirements for system/software products in the finance/insurance field

Chara cterist ic #	Main example of needs and risks of system/software products	Quality characteristics of product (quality model of product)	Example of quality requirements of product	Example of evaluation measures (measures recommended by WG)
1	・ If there is a function that does not work as expected, illegal data processing may be carried out and market may be confused. (#1) ・ Agent prints application forms necessary for insurance contract correctly. (#2) ・ Functions of financial terminals work correctly. (#3)	Functional correctness (Functional suitability)	・ Requirement trace result should be 100% in the processes of design ~ test, quality evaluation using test density and bug density. ・ Coordination to accurate calculation/reporting system of insurance premium	・ Accuracy ・ Functional correctness of calculation ・ Functional correctness of manual description ・ Functional correctness towards expectation
2	・ While the mechanization of the orders placed by securities companies is promoted, if data is not processed promptly, funds will outflow to the market of other countries. (#1) ・ When an agent calculates and reports the premium, they complete the operation within a certain standard. (#2)	Time behavior (Performance efficiency)	・ New order reception processing: 2mili. sec. ・ Regulating a response returned from in the center to each system	・ Response time ・ Turnaround time ・ Throughput ・ Response observance ratio at normal, peak and degenerating operation ・ Processing margin ratio at normal, peak and degenerating operation
3	・ If it's not possible to provide a system complying with user's needs, funds may outflow from the market. (#1) ・ Incorrect order placed by a securities company or improper data	Appropriateness recognizability (Usability)	・ Connection spec. (protocol) determined after working with securities company (#1)	・ Functional completeness of description ・ Functional completeness of user document and/or help function ・ Understandable I/O ・ Degree of function understanding

Chara cterist ic #	Main example of needs and risks of system/software products	Quality characteristics of product (quality model of product)	Example of quality requirements of product	Example of evaluation measures (measures recommended by WG)
	transmission due to a fault in the system on the securities company side may bring confusion to the market. (#1) ・ Operating as required by requirement spec. (#3)			
4	・ System shutdown becomes a stoppage of the market. (#1)	Availability (Reliability)	・ Availability over 99.999%, Complete duplication of hardware	・ Operation rate ・ Operation time (regular, specific day) ・ RTO (Recovery time objective), (Recovery standard objective) ・ Batch processing normal finish rate ・ Service switching time ・ Service time ・ Reception time ・ (Trouble) handling time ・ Handling time of job operation ・ Service provision time zone (general inquiries, trouble handling) ・ Service time of operation ・ Operation time (management time)
5	・ System shutdown becomes a stoppage of the market. (#1) ・ It is a matter of course that trouble recovery or degenerated operation are implemented. (#3)	Fault tolerance (Reliability)	・ Availability over 99.999%, Complete duplication of hardware	・ Function breakdown avoidance ・ Redundancy (equipment) ・ Segment division ・ Trouble notification time
6	・ Data access authority is regulated for each agent, so the handling of personal information is compensated. (#2) ・ It is a matter of course that financial system handling money is furnished with security functions. (#3)	Confidentiality (Security)	・ Prohibiting access to other information than that which an agent deals with	・ Operation limitation degree in the countermeasures for the system ・ Access audit property ・ Access controllability ・ Illegal monitoring target (device) ・ Detection range of illegal communication ・ Communication control ・ Convergence measures for network ・ Presence of encryption of transmission data ・ Encryption of data

4.2 Example of Quality Requirement Definition in the Public Field (#4 – #8)

The following is the distinguishing example of quality requirement definition for system/software products in the public field obtained from the preceding examples.

（１） **Example of users' needs**

Example of users' needs for system/software products in the public field is shown in Table 4-4.

Table 4-4 Example of users' needs for system/software products in the public field

Case #	System	Stakeholder	User class 1	2	3	4	Usage scenario	Pertinent function
4	(Transport) Auto fare collection system using contactless IC card	Station staff		X			Issuing/selling IC cards	Issuing new IC cards (registration of information) and selling them to customers
		Passenger	X				Passing the ticket gate by presenting an IC card	Reading/writing IC card, controlling ticket gate door, processing usage information
		Customer	X				Shopping using IC card	Device or network capable of reading and writing IC card is required at the shop
		Passenger	X				Charging money to IC card	Ticketing machine writes the amount of money paid to the IC card
		Station staff		X			Registering for re-issuance of IC card in the event of loss	Re-issuance and registration for lost or damaged IC cards (new card registration, invalidation of old card)
5	(Electricity) Power supply, customer information control system	Meter reader		X			Reading the value indicated on the wattmeter and reporting the amount used to the customer	Extracting the indicated value from electricity meter to the business use terminal using communication function. Calculating the amount used and electricity rate based on the indicated value and issuing the slip.
		Receiver		X			Researching the usage result and consulting to respond to inquiries about electricity usage method from customers	Indicating a record of figures indicated on a meter and electricity amount used for each time zone. Indicating parameters and analysis result for consulting.
		Operator		X			Starting or stopping electricity supply upon application from a customer to move in or out	Turning on or off the electric power meter from business use terminal using communication function. Calculating amount of electricity used at moving out on the business use terminal using communication function.
6	(Electricity) Information system providing customer information	Contractant	X				Referring to customer information	Specifying the customer
		Contractant	X				Referring to customer information	Providing latest information
		Contractant	X				Checking notices	Sending mail
		Employee		X			Handling inquiries	Accumulating history
7	(Agriculture) Agricultural information system	JA staff Agriculture worker		X			Monitoring the growth status of crops	Indication on maps of agricultural fields, indication of growth status of crops (coloring)
		Buyer		X			Checking the	Outputting production history

Case #	System	Stakeholder	User class 1	2	3	4	Usage scenario	Pertinent function
		including retailer					production site of crops	information of crops
8	(Disaster prevention) Earthquake early warning service	User (general)	X				When an occurrence of a strong quake is detected, receiving the alert automatically before it comes	Sounding alarm, flashing a lamp, stopping a machine automatically and calling associated people for emergency assembly (automatically) based on the received alert

User class	(targets)	
1	Beginner	(person)
2	Intermediate	(person)
3	Advanced	(person)
4	Others	(system)

（2）**Example of quality in use requirement definition**

Example of quality requirement in use for system/software products in the public field is shown in Table 4-5. According to the example, effectiveness, usefulness and trust are considered as distinguishing quality characteristics in use.

Table 4-5 Example of quality in use requirements for system/software products in the public field

Characteristic #	Main example of users' needs and risks	Quality in use characteristics: (quality in use model)	Example of quality requirement in use	Example of evaluation measures (measures recommended by WG)
1	・ Data on media (card) and system needs to be consistent. (#4) ・ Incorrectness of usage objective loses appropriateness when carrying out business. (#5) ・ Harvesting at the most suitable time. (#7) ・ Involving people's lives and property directly, so stoppage and false reporting are not permissible. (#8)	Effectiveness (Effectiveness)	・ Functional completeness of data ・ Consistency of overall flow of business and spec. ・ Monitoring the difference of dryness level of crops of each agricultural area using satellite images. ・ reliability (suspension is not allowed), Functional correctness (false report is not permissible), Processing speed (delay in units of sec. affects life)	・ Work effectiveness ・ Failure frequency ・ Work completion degree ・ Software damage
2	・ Possible to pass the ticket gate smoothly with simple action even at busy times. (#4) ・ The main section is sensitive to the usage state after operation starts, and convenience is required. (#5) ・ Drawing interest from a customer. (#6)	Usefulness (Satisfaction)	・ Accurate and high speed processing of reading, writing and fare calculation ・ Incorporation of improvement request from main section to the actual site ・ Specifying the customer	・ Satisfaction scale ・ Usage of discretion ・ No. of claims made by customers
3	・ The sales business is a business with higher priority. (#5) ・ The displayed contents of the system must match with the actual status. (#7) ・ Involving people's lives and property directly, so stoppage and false report are not allowed. (#8)	Trust (Satisfaction)	・ Operation state monitoring after starting operation ・ Relative dryness degree of crops and dryness degree assumed from the satellite image should match. ・ reliability (suspension is not allowed)	N/A

（3）**Example of quality requirement definition for system/software products**

Example of quality requirements for system/software products in the public field is shown in Table 4-6. According to the example, functional correctness, time behavior, maturity and integrity are considered as distinguishing quality characteristics.

Table 4-6 Example of quality requirements for system/software products in the public field

Characteristic #	Main example of needs and risks of system/software products	Quality characteristics of product (quality model of product)	Example of quality requirement of product	Example of evaluation measures (measures recommended by WG)
1	・ Consistency of data of media (card) and system is necessary. (#4) ・ Handling important parameters related to claiming action. (#5) ・ Providing update information (#6) ・ Providing correct information to the user. (#7) ・ It is socially important information, so social impact is large, therefore false reporting is not permissible. (#8)	Functional correctness (functional suitability)	・ Functional completeness of data ・ Adjusting fare based on the auto detected meter value. ・ Specifying the customer and providing unique information ・ Relative dryness degree of crops and dryness degree assumed from the satellite image should match. ・ When a server receives a warning from the Meteorological Office, it transfers the warning to all terminals with no delay after processing it for a terminal.	・ Accuracy ・ Functional correctness of calculation ・ Functional correctness of manual description ・ Functional correctness compared to expectation
2	・ It is used for business with a high degree of busyness such as call center business, high performance is required. (#5) ・ It is requested to reduce user's trouble with drying crops after harvesting. (#7) ・ It is important information involving human lives and assets, so no delay is permitted even for a second. (#8)	Time behavior (performance efficiency)	・ Response in the server per transaction should be within 3sec. ・ Searching the objective information (authentication information, business information) from a large amount of data at high speed. ・ Indication of relative dryness degree for each farmland ・ When a server receives a warning from the Meteorological Office, it transfers the warning to all terminals with no delay after processing it for a terminal.	・ Response time ・ Turnaround time ・ Throughput ・ Response observance ratio at normal, peak and degenerated operation ・ Processing margin ratio at normal, peak and degenerated operation

Chara cterist ic #	Main example of needs and risks of system/software products	Quality characteristics of product (quality model of product)	Example of quality requirement of product	Example of evaluation measures (measures recommended by WG)
3	・ System operates stably. (#4) ・ Operating stably with no problems. (#7) ・ It is important information involving human lives and assets, so no delay is permitted even for a second. (#8)	Maturity (reliability)	・ Redundant type, Autonomous distribution ・ Operating for 24 hours ・ Duplication of system, duplication of data center, duplication of lines and constant monitoring of terminals	・ Test density ・ Fault elimination ・ Test coverage rate ・ Functional appropriateness of test plan ・ Test completeness ・ Bug density ・ Nonconformity convergence rate ・ No. of cases pointed out at review ・ Density of pointing out at review ・ Nonconformity elimination rate ・ Missing rate ・ Fault detection ・ Test maturity
4	・ Preventing data falsification. (#4) ・ Because it handles customer information, authority should be controlled strictly for each business operation. (#5) ・ Providing customer information. (#6)	Integrity (security)	・ Encryption technology, operation control ・ Limiting access to other screens than those necessary for business taken charge of ・ Specifying a customer	・ Preventive property of data damage ・ Enhancing countermeasure by setting secure coding, web server, etc. ・ Presence of execution of web diagnostics ・ Handling range of risk after starting operation ・ Security risk reviewing frequency ・ Security patch application range

4.3 Example of quality requirement definition in the web/content field (#9 – #13)

The following is the distinguishing example of quality requirement definition for system/software products in the web/content field obtained from the preceding examples.

（1）**Example of users' needs**

Example of users' needs for system/software products in the web/content field is shown in Table 4-7.

Table 4-7 Example of users' needs for system/software products in the web/content field

Case#	System	Stakeholder	User class 1	2	3	4	Usage scenario	Pertinent function
9	(Contents/information provision) EC SITE, Cyber mall	Consumer	X				Shopping	Searching products, authorizing individuals and making settlement
		Shop		X			Displaying products	Registering products, writing ad statements and controlling inventory
		Shop		X			Selling products	Making settlement, controlling inventory, controlling customers and carrying out distribution delivery
		Management		X			Placing an ad	Making recommendations, personalization
		Management		X			Recovering from errors	Notifying with mail when an error occurs
10	(Contents/information provision) Multi player online game system used from mobile/PC	Player	X				Purchasing items used for games	Purchasing items using e-money (updating e-money balance granting items)
		Player	X				Playing games	Functions in general that configure each game
		Game operator			X		Determining cause and recovering errors if a problem occurs with a game	Displaying action history of a player Recording operation log of system
11	(Contents/information provision) Various information provision, Registration system	User	X				Searching or referring to desired information by specifying various conditions	Searching target information accurately and speedily, and returning a quick response (no stress for usage)
		User	X				Storing information of each individual in a system, including search results (bookmarks) and booking for participation in an event	A system should be created firmly so that no personal information leaks
		User	X				Possible to use for 24 hours 365 days	Necessary to form HA composition[14] in order to minimize

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[14] HA composition: System composition that realizes high availability

Case#	System	Stakeholder	User class				Usage scenario	Pertinent function
			1	2	3	4		
							except during regular maintenance time zone	the risk of inability to provide service
12	(School/education) Educational learning system, Content control systems	User	X				Learning on web	Recording usage status, learning history and true/false result, and indicating the grade report
		Controller		X			Registration of teaching material contents and registration of master data	Adding/changing/deleting teaching material contents control function (CMS) and master data
		Tutor		X			Dispatching information to users	Sending mail, adding/changing bulletin boards
13	(Development tool) Built-in design supporting tool	Built in developer			X		Analyzing based on software requirements and extracting software component	Allocating software component Associating data and timing flow between software components
		Built in developer			X		Registering reusable software components with DB	Selecting software components Registering with DB Deleting from DB as necessary
		Built in developer			X		Designing using software components registered with DB	Searching for software components in DB Taking out software components and reallocating them

User class	(targets)	
1	Beginner	(person)
2	Intermediate	(person)
3	Advanced	(person)
4	Others	(system)

（２）**Example of quality requirement definition in use**

Example of quality requirements in use for system/software products in the web/content field is shown in Table 4-8. According to the example, pleasure is considered as the distinguishing quality characteristic.

Table 4-8 Example of quality in use requirements for system/software products in the web/content field

Characteristic #	Main example of users' needs and risks	Quality in use characteristics (quality in use model)	Example of quality in use requirements	Example of evaluation measures (measures recommended by WG)
1	・ There is a sense of bargain and individuality. (#9) ・ Causing users to use a system continuously. (#10) ・ Possible to use a service (system) happily (there is a sense of new discovery).(#11) ・ Making a user improve his/her academic ability and maintain continuous will to learn. (#12) ・Because a new design technique is used, the advantage of using the technique itself can be understood. (#13)	Pleasure (satisfaction)	・Point service, personalized recommendation ・Provision of information using image or animation, provision of recommended information ・Grade display function, Community function ・Because a new design technique is used, the advantage of using the technique itself can be understood.	N/A

（3）**Example of quality requirement definition for system/software products**

Example of quality requirements for system/software products in the web/content field is shown in

Table 4-9. According to the example, functional correctness, time behavior, appropriateness recognizability and user interface aesthetics are considered as distinguishing quality characteristics for system/software products.

Table 4-9 Example of quality requirements for system/software products in the web/content field

Characteristic #	Main example of needs and risks of system/software products	Quality characteristics of product (quality model of product)	Example of quality requirements of product	Example of evaluation measures (measures recommended by WG)
1	・ Realizing specification of individual correctly and safe settlement. (#9) ・ It should work properly with no bugs. (#11) ・ Indicating correct true/false results in order to store the academic results. (#12) ・ Distributing and displaying teaching materials selected by a user correctly. (#12) ・ Design result can be saved and reproduced. (#13)	Functional correctness (functional suitability)	・ Account settlement, Authentication ・ Trouble occurrence rate n cases/scale or less ・ Result aggregation function, Learning history storage function, Teaching material distribution function ・ Displaying previous data correctly at finish→starting application	・ Accuracy ・ Functional correctness of calculation ・ Functional correctness of description in manual ・ Functional correctness towards the expectation
2	・ Realizing comfortable shopping. (#9) ・ It occurs frequently that many players simultaneously access a function that needs to carry out real time processing. (#10) ・ Ensuring a response that does not cause stress in usage. (#11) ・ A large number of accesses occur in a burst fashion according to the season or time zone, so appropriate response should be replied. (#12) ・ It is a design tool, so drawing should be displayed with no stress so that human thought processes are not disturbed. (#13)	Time behavior (performance efficiency)	・ Performance ・ Online response within 3sec. ・ Requirement related to functions in general (functions with high cost such as data updating and data reference in particular). ・ Duration after receiving a request from a terminal till returning the server processing result should be within 5sec. ・ Drawing should be within 0.3s.	・ Response time ・ Turnaround time ・ Throughput ・ Response observation rate at normal, peak, degenerated operation ・ Processing margin rate at normal, peak, degenerated operation
3	・ Possible to search for the	Appropriateness	・ Search, matching ・ Collection and analysis	・ Functional completeness of

Characteristic #	Main example of needs and risks of system/software products	Quality characteristics of product (quality model of product)	Example of quality requirements of product	Example of evaluation measures (measures recommended by WG)
	desired product easily. (#9) ・ It is not used in the first place if it does not suit the needs whether it is overt or potential. (#10) ・ It should be a service (system) that satisfies the requirements of a user. (#11)	recognizability (usability)	of access log	description ・Functional completeness of users documentation and/or help function ・Understandable I/O ・Function understandable degree
4	・ User's needs relate to their interests, so it should feel comfortable. (#10) ・ Design and sense of unity of a screen is accepted by a user. (#11) ・ Operation and appearance are not complicated as a design tool. (#13)	User interface aesthetics (usability)	・Design (devising size or type of font, consistency of content arrangement, etc.), unifying color, etc. ・As simple as possible Menu should be up to 2 hierarchies	・Customizability of appearance of user interface

Conclusion

In order to realize an environment where safe and secure system/software products can be used in people's life and social economic activities, it is required to visualize the quality of the product, evaluate whether it meets the user's needs objectively and establish quality.
So, Software Metrics Advancement Project Product Quality Metrics WG has worked on establishing measures that can be used commonly for these activities and summarized the contents in order to promote quality assurance activity.

This report compiles the quality assurance activities based on the ISO/IEC 25000 series, which is a successor series to the ISO/IEC 9126 series and describes the quality model of ISO/IEC 25010 that was established quite recently.   Moreover, measure sets that correspond to this quality model and can be used commonly are also indicated.

For the IT industry of our company to promote innovation in the future, it is important to develop a common awareness promptly for new ideas about quality and establishment methods for system/software products.   Further, it is also important to take action for new ideas about quality and establishment method for system/software products prior to others and develop them internationally so that not only can we establish a common awareness but also impress the world with our country's high reliability and high quality.   It will be a pleasure for us if the quality assurance activities using measures mentioned in this report are of some help.

AppendixA : Execution Outline of Prior Case Study Research related to Quality Assurance Activities Using Measures

A. 1. Research Objective

In order to realize system/software products, it is necessary to determine the quality requirements taking into account users' needs and criticality of utilization. Generally, users' needs and criticality vary according to the field where information system/software products are used.

So, this research is carried out targeting the companies that take the lead in carrying out quality assurance activities using measures to find usage scenarios and needs that are valued by system/software products in multiple fields, quality characteristics set to realize the pertinent needs and usage examples of measures to evaluate them. And based on the contents obtained, investigation is held into the objective evaluation index of information system/software products and the quality standard (how to measure) is visualized in order to help form social common awareness.

A.2 Research Target

The targets are information system/software products that are used to realize high additional value for various products and services (including not only the information system that functions independently but also information system/software products that link with and control installed systems or other software).

A.3. Research Method and Research Content

Questionnaire is carried out using the following questions.

Q1. Outline of main system software products used and their usage scenario (choice/description type)

Q2. Quality in use characteristics that are considered for system/software products;, product quality characteristics (choice type)

Q3. Quality in use characteristics of Q2;, reason for considering the product quality characteristics (required needs, functional requirements, risks, etc.) (description type)

Q4. Measures that are used/desired for use as quality characteristics for product in answers to Q2 for the evaluation at development (choice type from measures table for each quality characteristic of product)

Q5. Measures that are used/desired to use for quality in use characteristics answers for Q2 for the evaluation of products in actual usage (choice type from measures table for quality in use characteristics)

Based on the content above, the following contents are summarized.

1) Relationship of needs, requirements and quality characteristics for information system/software products

   Based on Q1, 2 and 3, outline of examples, usage scenario (main stakeholders and usage method), quality in use (emphasized quality characteristics, functions) and product quality(emphasized quality characteristics, functions) are organized.

2) Usage status of measures and creation of measure set

   Based on Q4 and 5, the status of measure actually used is clarified.
   Further, based on the result of this research and knowledge of WG members, a typical measure set corresponding to quality in use characteristics and product quality characteristics of ISO/IEC 25010 is created.

A. 4. Measures Provision Organization

For Q4 and Q5, the answer is obtained by sorting out the literature related to measures in the Table below and using created measures table.

Table A-1 Target measures for research

Abbreviated code	Deliverables related to measures
ISO/IEC 9126-2	TS X 0111-2: Quality of software product – Part 2: External measuring method by JIS X 0129-1 Software engineering-Product quality-Part 2: External metrics, Japanese Standards Association
ISO/IEC 9126-3	TS X 0111-3: Quality of software product – Part 3: Internal measuring method by JIS X 0129-1 Software engineering-Product quality-Part 3: Internal metrics, Japanese Standards Association
ISO/IEC 9126-4	TS X 0111-4: Quality of software product – Part 4: Quality measuring method in use by JIS X 0129-1 Software engineering-Product quality-Part 4: Quality in use metrics, Japanese Standards Association
Nonfunctional	Nonfunctional requirement grade List of items in relation to nonfunctional requirements of system infrastructure, Information-Technology Promotion Agency, Japan Soft Engineering Center
Critical infrastructure	Critical infrastructure information system reliability council report, Information-Technology Promotion Agency, Japan Software Engineering Center
ESQR	Embedded system development management guide: ESQR, Information-Technology Promotion Agency, Japan Software Engineering Center
JUAS	User Vender Collaboration Research Project II Report "Nonfunctional Requirement Specification Definition Guideline", Ministry Economy, Trade and Industry - Information Service Industry Div., NTT Data Institute of Management Consulting, Inc., Japan Users Association of Information Systems
JEITA	SLA Guideline of IT system for private sectors 3rd edition, Japan Electronics and Information Technology Industries Association, Solution Service Business Committee

Above mentioned research results are contained in Appendix B.

AppendixB : Preceding examples related to quality assurance activities using measures

Table B-1 Outline of information system/software product for which replies were given

Case #	(Field)System	Outline	Architecture	Processing form	Replying company
1	(Finance/Insurance) Stock trading system	Processing orders and contracts made by securities company and also processes and provides trading information/market information.	Client/server	Online transaction processing	Supplier
2	(Finance/Insurance) Insurance product capitalization system	Assisting the processes from trial calculation to reporting insurance premium by an insurance agency.	Mainframe, Client/server, Intranet/Internet	Dialogue processing/Real time processing, Online transaction processing	Acquirer
3	(Finance/Insurance) Financial institution counter terminal system	Assisting the contact desk business of bankers by communicating with host, inputting electrical statements and displaying the results.	Client/server	Dialogue processing/Real time processing	Supplier
4	(Transport) Auto fare collection system using contactless IC card	It allows passage through the ticket wicket by presenting an IC card in which money is charged.	Autonomous distribution	Batch processing, Online transaction processing	Acquirer
5	(Electricity) Power supply, customer information control system	It uses information obtained from a voltmeter with communication function: smart meter for reading a meter, settlement (tax amount), sales activities, etc.	Mainframe, Client/server	Batch processing, Online transaction processing	Acquirer
6	(Electricity) Information system providing customer information	It provides various types of information including contract contents and usage status to contractants.	Intranet/Internet	Dialogue processing/Real time processing	Acquirer
7	(Agriculture) Agricultural information system	For carrying out growth forecasts, agricultural field information analysis and production control by associating various information from agricultural site with a map.	Client/server	Online transaction processing	Supplier
8	(Disaster prevention) Earthquake early warning service	The service calculates seismic intensity forecast and arrival time and transmits the result promptly based on initial	Client/server	Dialogue processing/Real time processing	Acquirer

Case #	(Field)System	Outline	Architecture	Processing form	Replying company
		motion data of the first wave (P wave) provided by the Meteorological Office.			
9	(Content/information provision) EC SITE, Cyber mall	Website that consolidates multiple page electronic shops on the Internet to one site and sells various products.	Intranet/Internet, Others (mobile)	Batch processing, Dialogue processing/Real time processing, Online transaction processing	Supplier
10	(Content/information provision) Multi player online game system used from mobile/PC	For carrying out RPG simultaneously in one world by multiple players on mobile or PC using a network (Internet).	Intranet/Internet	Batch processing, Dialogue processing/Real time processing, Online transaction processing	Supplier
11	(Contents/information provision)Various information provision, Registration system	For providing various information to users through the Internet, and users request materials or apply for participation in events under the system.	Intranet/Internet	Dialogue processing/Real time processing	Acquirer
12	(School/education) Educational learning system, Contents control system	Users learn through a web system, tutors follow up for improvement of academic ability and control the learning contents under this system.	Intranet/Internet	Batch processing, Online transaction processing	Supplier
13	(Development tool)Built-in design supporting tool	Supporting tool for analyzing based on software requirements, searching, acquiring and aligning software components and designing and implementing built-in software.	Stand alone	Dialogue processing/Real time processing	Supplier

Total 13 replies were obtained; 3 from the finance/insurance field (#1 ~ #3), 4 from the public field (#4 ~ #8) and 4 from the web/content field (#9 ~ #13).

The following is the result of sorting out the examples from << Example 1>> to <<Example 13>> using the items in Table B-2.

Table B-2 Items of example result

Outline of example	Indicating the target system outline, field, usage stage, related built-in system, architecture and system progressing form for the example. Serving as a reply to Q1
Usage Scenario	Indicating main stakeholders and usage scenarios of the target system and main functions required for the pertinent usage scenario. Serving as a reply to Q1
Quality in use	Indicating the quality characteristics and sub quality characteristics emphasized as needs in use and quality in use, and measure examples used for definition and evaluation of quality in use. Serving as a reply to Q2, 3, 5
Product Quality	Indicating the quality characteristics and sub quality characteristics emphasized as needs in use and quality in use, and measure examples used for definition and evaluation of quality in use. Serving as a reply to Q2, 3, 4

<<Case Study # 1>>

Outline of example	
Case # : System	1: Stock trading system
System outline	This information system receives order data, etc. from a securities company, carries out checking process (agreement) and sends a processing result, and at the same time notifies the order and agreement result to an information vendors, etc.
Field	Finance/Insurance
Usage stage of system (business type)	Finance/insurance business
Utilization stage of system	Agreement/Delivery
Related built-in system	＜N/A＞
Architecture	Client/server
System processing form	Online transaction processing

Usage Scenario		
Stakeholder	Usage scene (Use case, Usage method)	Required main functions
Securities company	Placing new orders, changing or canceling orders	Checking the order data and returning an acceptance notice
Securities company	Receiving the result of checking up processing	Returning a contract result notice
Information vendor	Receiving market information	Transmitting market information
Our stock division	Monitoring the market	Receiving an inquiry from the trading control terminal, creating pertinent data and sending it back to the terminal
Our stock division	Taking a regulatory measure including cessation of trading	Stopping trading of target shares, etc. upon indication from the trading control terminal
Settlement system	Receiving contract data and carrying out the settlement processing	Sending contract data to settlement system on a regular basis

Quality in use				
①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements	④Used measures *
Due to promotion of globalization and borderlessness of finance and advancement of PTS inside the country, if a useful system is not provided, a transaction may outflow.	Effectiveness	Effectiveness	Connection spec. (protocol) determined after working with securities company Data processing performance	【Internal standard】・ Work effectiveness ・Work completion degree ・Mistake frequency ・Handling time ・Operation time ・Reception time ・Handling time of job usage ・Handling time for media usage ・Service time ・Operation ratio ・Meas operation ratio ・Operation ratio control ・Operation service time・Ensuring seismic resistancet/seismic isolation capability ・Operation time (management time) ・mean operation ratio ・Online system operation ratio ・Batch processing normal finish ratio
System of securities company that connects with the system of Securities Exchange is constructed by Securities Exchange according to connection spec. Therefore, if the behavior of the system on the Securities Exchange is different from the spec., the system on the securities company side does not operate correctly and stock exchange may not be established.	Satisfaction	Trust	Requirement trace result from design ~ test processes should become 100%.	【Internal standard】・ Satisfaction scale ・ Satisfaction questionnaire slip ・ User satisfaction ・ Service provision time zone (handling trouble) ・ Service provision time zone (general inquiry) ・ , recognizability to users ・ Fault notification time ・Fault recovery time ・ Recovery time ・ Aggregation report interval ・ Aggregation report interval ・ Check cycle of asset control ・ Failure rate ・ Aggregation report interval ・ Fault recovery time ・ Aggregation report interval ・ Hardware trouble ratio ・ Network trouble recovery time observation ratio
If the stock CB trading system halts or data loss occurs, confusion will occur in the economy of our country.	Freedom from risk	Economic risk mitigation	Assuring order properties of data processing Data triplexing Complete duplexing of equipment	【Internal standard】・ Software damage ・ Return on investment (ROI) ・ Discovery and detection time for antivirus measures

Other quality characteristics and sub characteristics in use that should be considered	
Efficiency	Efficiency
Satisfaction	Usefulness

Product Quality

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
If there is a function that does not work as expected, illegal data processing may be carried out and market may be confused.	Functional suitability	Functional completeness	Requirement trace result in design ~ test process should be 100%.	(Checking that requirement factors are incorporated for all items in design ~ test process)	(Checking that requirement factors are incorporated for all items in design ~ test process)
If incorrect data processing is carried out, significant loss of trust in the market will result.	Functional suitability	Functional correctness	Requirement trace result in design ~ test process should be 100%. Quality evaluation by test density and bug density	【Internal standard】・ Correctness of calculation ・ Accuracy ・ Correctness of manual description ・ Density of inspection	【Internal standard】・ Correctness to expectations ・ Correctness of calculation ・ Accuracy ・ Correctness of manual description ・ Density of inspection
While the mechanization of the orders placed by securities companies is promoted, if data is not processed promptly, funds will outflow to the market of other countries.	Performance efficiency	Time behavior	New order reception processing: 2mili. secs.	【Internal standard】・ Response time ・ Throughput ・ Turn around time ・ Response observance ratio at normal times (when online system is used) ・ Response observance ratio at peak (when online system is used) ・ Response observance ratio at degeneration (when online system is used) ・ Response observance degree at normal times (when batch system is used) ・ Response observance degree at peak (when batch system is used) ・ Response observance degree at degeneration (when batch system is used) ・ Processing margin ratio at normal times (when online system is used) ・ Processing margin ratio at peak (when online system is used) ・ Processing margin ratio at degeneration (when online system is used) ・ Processing margin ratio at normal times (when batch system is used) ・ Processing margin ratio at peak (when batch system is used) ・ Processing margin ratio at degenerating (when batch system is used) ・ Throughput ・ Provision business	【Internal standard】・ Response time (mean time till response) ・ Response time (response time ratio in the worst case) ・ Throughput ・ MeanThroughput ・ Throughput at max. load ・ Turn around time ・ Turn around time (turn around average time) ・ Turn around time (turn around time ratio in the worst case) ・ Stand-by time ・ Response observance ratio at normal times (when online system is used) ・ Response observance ratio at peak (when online system is used) ・ Response observance ratio at degeneration (when online system is used) ・ Response observance degree at normal times (when batch system is used) ・ Response observance degree at peak (when batch system is used) ・ Response observance degree at degeneration (when batch system is used) ・ Processing margin ratio at normal times (when online system is used) ・ Processing margin ratio at peak (when online system is used) ・ Processing margin ratio at degeneration (when online system is used) ・ Processing margin ratio at normal times (when batch system is used) ・ Processing margin ratio at peak (when batch system is used) ・ Processing margin ratio at degenerating (when batch system is used) ・ Throughput ・ Provision business

Product Quality					

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
If it's not possible to provide a system complying with user's needs, funds may outflow from the market.	Usability	Appropriateness recognizability	Connection spec. (protocol) determined after working with securities company	【 Internal standard 】・ Description completeness ・ Demonstration explanation ability ・ Functional clarity ・ Function understanding level ・Functional completeness of user documentation and/or help function	【 Internal standard 】・ Description completeness ・ Demonstration explanation accessibility ・Demonstration explanation accessibility in use ・ Demonstration explanation effectiveness ・ Functional definiteness ・ Function understanding level ・Understandable I/O ・ Restriction condition at construction
Incorrect order placed by a securities company or improper data transmission due to a fault in the system on the securities company side may bring confusion to the market.	Usability	Appropriateness recognizability	Checking the functional appropriateness of the amount of orders, and it is regarded as error if the amount of order exceeds a certain quantity. Improving the shutdown procedure of communication in order to prepare for runaway in the system on the securities company side.	【 Internal standard 】・ Demonstration explanation ability ・ Functional clarity ・ Function understanding level ・Functional completeness of user documentation and/or help function ・ Description completeness	【 Internal standard 】・ Demonstration explanation accessibility ・Demonstration explanation accessibility in use ・ Demonstration explanation effectiveness ・ Functional definiteness ・ Function understanding level ・ Understandable I/O ・ Restriction condition at construction ・ Degree of attainment of learning of usage method for a product or system satisfactorily, safely, effectively and efficiently by regulated users and under regulated usage conditions.
Shutting down a system means shutting down a market.	Reliability	Availability	Availability over 99.999%	【Internal standard】・ Operation time (normal) ・ Presence of stoppage of plan ・ Target business range ・ Service changeover time ・ Requirement degree of business continuation ・ RPO (Recovery Point Objective) ・ RTO (Recovery Time Objective) ・ System restart objective ・ Operation ratio	【 Internal standard 】・ Availability ・ Operation time (normal) ・ Presence of stoppage of plan ・ Target business range ・ Service changeover time ・ Requirement degree of business continuation ・ RPO (Recovery Point Objective) ・ RTO (Recovery Time Objective) ・ System restart objective ・ Operation ratio
System shutdown becomes a stoppage of the market.	Reliability	Fault tolerance	Complete duplication of hardware	【Internal standard】・ Protectability of data damage ・ Failure avoidance ・ Incorrect operation avoidance ・ Redundant (equipment) (for server trouble) ・ Redundant (component) (for server trouble) ・ Redundant (equipment) (for terminal trouble) ・ Redundant (equipment) (for trouble with equipment composing network) ・ Redundancy of line ・ Redundancy of route ・ Segment division ・ Redundancy (machine) ・Backup method ・ Data recovery range ・ Data integrity ・ Recovery policy ・ Storage location distribution degree ・ Disaster handling range ・ Trace function implementation ratio between sub-systems ・ Test coverage ratio ・ Risk resolving ratio ・ Test check system by a 3rd person - 1 ・ Test check system by a 3rd person - 2 (Checking rate of pointed out matters) ・ Countermeasure rate for protective device	【 Internal standard 】・ Protectability of data damage ・ Function cessation avoidance ・ Failure avoidance ・ Incorrect operation avoidance ・ Trace function implementation ratio between sub-systems ・ Test coverage ratio ・Degree of skill proficiency in switching to backup machine ・ Risk resolving ratio ・ Test check system by a 3rd person - 1 ・ Test check system by a 3rd person - 2 (Checking rate of pointed out matters) ・ Countermeasure rate for protective device ・ Ratio of the number of successful instances of avoiding discontinuance ・ Ratio of the number of occurrences of mis operation in a fault countermeasure ・ Ratio of execution of preventive training
If notice of order received or notice of agreement	Security	Non-repudiation	Making a notice after triple period of data	【 Internal standard 】・ Access auditability ・ Presence of encryption of transmission data ・ Access controllability ・	【Internal standard】・ Access auditability ・ Presence of encryption of transmission data ・ Access controllability ・

Product Quality				

①Important needs, risks	②Quality characteristics and sub characteristics	③Quality requirements Up to unit test	④Used measures *	
			Up to unit test	After combined test
establishment sent to a securities company is changed or canceled afterwards, confidence in the market is lost significantly.			Protectability of data damage ・ Authentication of an entity with control authority ・ Operation limiting degree for the countermeasure on the system ・ Operation limit degree by physical measures ・ Establishment of control rules ・ Acquisition of log ・ Illegal monitoring target (device) ・ Illegal monitoring target（Network） ・ Illegal monitoring target (intruder・Illegal operation, etc.) ・ Communication control ・ Detection range of unauthorized communication ・ Network convergence measures ・ Presence of in-company regulation, rule, law, guideline, etc. that should be observed ・ Presence of execution of network diagnosis ・ Risk analysis range	Protectability of data damage ・ Authentication of an entity with control authority ・ Operation limiting degree for the countermeasure on the system ・ Operation limit degree by physical measures ・ Establishment of control rules ・ Acquisition of log ・ Illegal monitoring target (device) ・ Illegal monitoring target（Network） ・ Illegal monitoring target (intruder・Illegal operation, etc.) ・ Communication control ・ Detection range of unauthorized communication ・ Network convergence measures ・ Presence of in-company regulation, rule, law, guideline, etc. that should be observed ・ Presence of execution of network diagnosis ・ Risk analysis range

*[Internal standard]: Measures used as in-company standard *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics of products that should be considered	
Performance efficiency	Resource utilization
Compatibility	Co-existence, Interoperability
Usability	Learnability, Operability, User Interface aesthetics
Reliability	Maturity, Recoverability
Security	Confidentiality, Integrity, Accountability, Authenticity
Maintainability	Modularity, Analyzability, Modifiability, Testability
Portability	Adaptability

<<Case Study # 2>>

Outline of example

Case # : System	2 : Insurance product capitalization system
System outline	Trial calculation, posting system of insurance products
Field	Finance/Insurance
Usage stage of system (business type)	Finance/insurance business , Others
Utilization stage of system	Master control, Agreement/Delivery,　Customer control
Related built-in system	＜N/A＞
Architecture	Mainframe, Client/server, Intranet/Internet
System processing form	Dialogue processing/Real time processing, Online transaction processing

Usage Scenario

Stakeholder	Usage scenario (Use case, Usage method)	Required main functions
Agent	Insurance premium amount can be calculated correctly with the contents input on the trial calculation screen of insurance product	Calculating insurance premiums with the contents input on the trial calculation screen for each product
Agent	Creating an estimate based on calculated premium	Creating an estimate to be presented to a customer according to the result of premium calculation
Agent	Creating an application form based on calculated premium	Creating an application to be presented to a customer according to the result of premium calculation
Agent	Reporting the contents of insurance contract concluded with a customer to a company	Carrying out posting process to the system of an insurance company from creation data of application form
Employee	Checking data reported by an agent	Indicating errors in data to be posted/processed

Quality in use

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements	④Used measures *
Avoiding the risk of causing inconvenience to a policyholder due to incorrect calculation of insurance premium.	Effectiveness	Effectiveness	＜N/A＞	【Internal standard】・ Work effectiveness ・ Work completion degree ・ Mistake frequency ・ Handling time ・ Operation time ・ Reception time ・ Handling time of job usage ・ Service time ・ Operation ratio ・ Mean operation ratio ・ Max. stop time ・ Operation ratio control ・ Online system operation ratio ・Batch processing normal finish ratio
Avoiding the risk of causing inconvenience to a policyholder due to incorrect calculation of insurance premium.	Freedom from risk	Economic risk mitigation	＜N/A＞	＜N/A＞
Premium calculation, insurance posting system handles information directly connecting to customers' risks, so it needs to be used in a secure manner.	Context coverage	Context completeness	＜N/A＞	【Internal standard】・ Review frequency of security risk ・ Review range of security risk ・ Risk handling range after starting operation ・ Risk measure policy ・ Security patch application range ・ Security patch application policy ・ Security patch application timing

*[Internal standard]: Measures used as in-company standard　　*[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics in use that should be considered

None in particular

Product Quality				

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
Agent prints application forms necessary for insurance contract correctly.	Functional suitability	Functional correctness	Coordination to accurate calculation/reporting system of insurance premium	＜N/A＞	＜N/A＞
When an agent calculates and posts the premium, the operation is completed within a certain standard.	Performance efficiency	Time behavior	Regulating response of turnback in the center for each system	＜N/A＞	*Measures values are not collected for the target mentioned below, but it was checked whether requirements are complied with at revising in a large scale or at new establishment using a load test, etc.　However, it is checked as the index for operation.。 【Internal standard】・ Response time ・ Response time (mean time till response) ・ Response time (response time ratio in the worst case) ・ Throughput ・ Mean Throughput ・ Throughput at max. load ・ Turn around time (turn around average time) ・ Turn around time (turn around time ratio in the worst case) ・ Stand-by time ・ Response observance ratio at normal times (when online system is used) ・ Response observance ratio at peak (when online system is used) ・ Response observance ratio at degeneration (when online system is used) ・ Response observance degree at normal times (when batch system is used) ・ Response observance degree at peak (when batch system is used) ・ Response observance degree at degeneration (when batch system is used) ・ Processing margin ratio at normal times (when online system is used) ・ Processing margin ratio at peak (when online system is used) ・ Processing margin ratio at degeneration (when online system is used) ・ Processing margin ratio at normal times (when batch system is used) ・ Processing margin ratio at peak (when batch system is used) ・ Processing margin ratio at degenerating (when batch system is used) ・ Printing margin rate at degeneration ・Printing margin ratio at peak ・ Printing margin rate at degeneration ・ Throughput
Many systems are related to each other, and overall system is operated efficiently by allocating resources.	Performance efficiency	Resource utilization	Checking for each project using a check sheet.　Collection is not carried out as measures value.	＜N/A＞	*The targets mentioned below are checked using a check sheet at designing the operation.。 It is not collected as a measures value.　。 【Internal standard】・ Number of users ・ No. of simultaneous accesses ・ Data volume ・ No. of online request cases ・No. of batch processing cases ・ Increase ratio in the number of users ・ Increase rate of simultaneous accesses ・ Storage period ・ Target range ・ CPU Usage Ratio ・ Network equipment setting range ・ Scale up ・ CPU Time ・ Memory capacity ・ Transmission ・ Hard disc capacity of server, etc. ・ I/O device ・ Space ・ Environment
＜N/A＞	Usability	Operability	Checking for each project using a check sheet.　Collection is not carried out as measures value.	＜N/A＞	*The targets mentioned below are checked using a check sheet at designing the operation.。 It is not collected as a measures value.　。 【Internal standard】・ Operation time (normal) ・ Data recovery range ・Backup usage range ・Range of backup automization ・Backup acquisition interval ・Backup storage period ・Backup method ・ Monitoring information ・ Monitoring interval ・ Monitoring system level ・Monitoring the process level ・ Monitoring database level ・ Monitoring server (node) level ・ Monitoring terminal/network equipment level ・ Presence of setting of development environment ・ Presence of setting environment for test ・ Presence of job control system ・ Presence of execution of configuration control ・ Presence of execution of change control ・ Presence of execution of release control *It is included in the control items for operation targeting the following.。 【Not internal standard】・ Presence of execution of incident control ・ Presence of execution of problem control ・ Percentage of mis-operation ・ Percentage of serious misoperation ・ Ratio of clarification of operation start conditions, etc. ・ Minimization of intervention operation ・ Ratio of intervention operation
It is necessary to connect the insurance premium	Usability	User error protection	＜N/A＞	＜N/A＞	＜N/A＞

Product Quality				

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
calculation data created by an agent to the posting system with no mistakes.					
An agent should be able to report up to insurance contract, posting through consistent operation with no mistakes.	Usability	User Interface aesthetics	Regulating on the screen HMI	＜N/A＞	＜N/A＞
Service time is regulated, and service is provided to the agent at such time.	Reliability	Availability	＜N/A＞	＜N/A＞	【Internal standard】・ Operation time (normal) ・ Operation time (specified day) ・ Presence of stoppage of plan ・ Target business range ・ RTO (RECOVERY TIME OBJECTIVE) ・ RLO (RECOVERY LEVEL OBJECTIVE) ・ System restart objective ・ Operation ratio
Service is provided to the agent according to the regulated service time.	Reliability	Fault tolerance	Checking for each project using a check sheet. Collection is not carried out as measures value.	＜N/A＞	【Internal standard】・ Redundant (equipment) (for server trouble) ・ Redundant (equipment) (for trouble with equipment composing network) ・ Redundant (component) (for trouble with equipment composing network) ・ Redundancy of line ・ Redundancy of route ・ Segment division ・ Redundancy (machine) ・ Backup method
Service is provided to the agent according to the regulated service time.	Reliability	Recoverability	＜N/A＞	＜N/A＞	＜N/A＞
Data access authority is regulated for each agent, so the handling of personal information is compensated.	Security	Confidentiality	It's not possible to access other information than those handled by agent.	＜N/A＞	＜N/A＞
Separation of operation and development is regulated, and it is designed to prohibit accessing real data directly from the development side.	Security	Integrity	＜N/A＞	＜N/A＞	【Internal standard】・ Acquisition of log ・ Log storage period
It is designed to be able to carry out track research by a log for illegal processing, etc.	Security	Accountability	＜N/A＞	＜N/A＞	【Internal standard】・ Presence of in-company regulation, rule, law, guideline, etc. that should be observed ・ Presence of execution of Web diagnosis

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics of product that should be considered	
Maintainability	Modularity, Reusability

<<Case Study # 3>>

Outline of example	
Case # : System	3 : Financial institution counter terminal system
System outline	System to perform financial service counter business online
Field	Finance/Insurance : Service counter business
Usage stage of system (business type)	Finance/insurance business
Utilization stage of system	Agreement/Delivery
Related built-in system	Business use terminal device system
Architecture	Client/server
System processing form	Dialogue processing/Real time processing

Usage Scenario		
Stakeholder	Usage scenario (Use case, Usage method)	Required main functions
Bank clerk	Carrying out the service counter business	Communication with a host, inputting electronic statement, displaying the result

Quality in use				
①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements	④Used measures *
It is a premise that functions work correctly on financial terminals.	Effectiveness	Effectiveness	Functionality	【Not internal standard】 ・ Work effectiveness ・ Work completion degree ・ Mistake frequency ・ Handling time ・ Operation time ・ Reception time ・ Handling time of job usage ・ Handling time for media usage・ Handling time for outputting slips ・ Handling time of job usage ・ Handling time for media usage ・ Handling time for outputting slips ・ Service time ・ Operation ratio ・Mean Operation ratio ・ Max. stop time ・ Operation ratio control ・ Operation Service time ・ Ensuring seismic resistancet/seismic isolation capability ・ Operation time (management time) ・ Mean Operation ratio ・ Max. stop time ・ Online system operation ratio ・ Batch processing normal finish ratio ・
The highest priority is to provide a system complying with a user (bank clerk) of a financial terminal.	Satisfaction	Usefulness	Usability requirements	【Not internal standard】 ・ Satisfaction scale ・ Satisfaction questionnaire slip ・ Usage of discretion ・ User satisfaction ・ Service provision time zone (handling trouble) ・ Service provision time zone (general inquiry) ・, recognizability to users ・Patch application interval ・ Fault notification time ・Fault recovery time ・ Revised version/ application interval of patch application ・ Recovery time ・ Aggregation report interval ・ Revised version/time interval of patch application ・ Aggregation report interval ・ Check cycle of asset control ・ Failure rate ・ Aggregation report interval ・ Fault recovery time ・ Aggregation report interval ・ Hardware trouble ratio ・ Network trouble recovery time observation ratio ・
Reduction of operation cost is important as a part of overall cost. Non-cost type figures such as reputation are also important.	Freedom from risk	Economic risk mitigation	Operation requirements	【Not internal standard】 ・ Economic damage ・ Software damage ・ Return on investment (ROI) ・ Discount cash flow (DCF) ・ Auto measurement of qualitative effect ・ Ratio of overall manufacturing lead time ・ Ratio of lead time for each process ・ No. of delayed delivery cases ・ No. of claims from customer ・ No. of missing items ・ Percentage of revenue from new customers ・ Ratio of revenue from existing customers ・Balance ・Score・Card (BSC) ・ Comparison with other company (benchmark) ・ Opportunity loss ・ Real option ・ IT asset investment ・Health and safety of user ・ Safety of personnel to be affected by usage of the system ・ Customer inconvenience degree ・ Band capacity ・ Economic damage ・Detection time of fire wall ・ Discovery and detection time for antivirus measures ・ Detection time for illegal access (IDS) ・ Detection of falsification (detection time of data falsification) ・

*[Internal standard]: Measures used as in-company standards   *[Not internal standard]: Measures used at the site as other than in-company standards

Other quality characteristics and sub characteristics in use that should be considered	
Efficiency	Efficiency
Satisfaction	Trust
Context coverage	Context completeness, Flexibility

Product Quality

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
It is a premise that functions work correctly on financial terminals.	Functional suitability	Functional correctness	Functionality	【Internal standard】 ・Number of users ・No. of clients ・No. of bases ・Presence of usage of specific product 【Not internal standard】 Correctness of calculation ・Accuracy ・Correctness of manual description ・Density of inspection ・Functional appropriateness ・Completeness of function implementation ・Coverage of function implementation ・Stability of functional specification (variable system) ・Regional expansion ・System usage range ・No. of languages ・Presence of standard acquisition ・Acquisition of (conforming standard, product safety standard) standard ・Acquisition of (environment protection) standard ・Excess degree of (electromagnetic interference) function ・Claim rate by users	【Internal standard】 ・Correctness to expectations ・Correctness of manual description ・Functional appropriateness ・Completeness of function implementation ・Coverage of function implementation ・Number of users ・No. of clients ・No. of bases ・Presence of usage of specific product ・Claim rate by users 【Not internal standard】 ・Correctness of calculation ・Accuracy ・Density of inspection ・Stability of functional specification ・Regional expansion ・System usage range ・No. of languages ・Acquisition of (conforming standard, product safety standard) standard ・Acquisition of (environment protection) standard ・Acquisition of (electromagnetic interference) standard ・Excess degree of functions
It is a matter of course for a user (bank clerk) that appropriateness recognizability is implemented.	Usability	Appropriateness recognizability	It should operate as requirement spec.	【Internal standard】 Operation time (normal) ・Operation time (specified day) ・Data recovery range ・Usage possibility of external data ・Backup usage range ・Range of backup automization ・Backup acquisition interval ・Backup storage period ・Backup method ・Monitoring information ・Monitoring interval ・Monitoring the process level ・Monitoring database level ・Monitoring storage level ・Monitoring terminal/network equipment level ・Presence of connection with external systems ・Presence of monitoring system ・Presence of job control system ・Presence of execution of configuration control ・Presence of execution of change control ・Presence of execution of release control ・Restriction at operation 【Not internal standard】 Description completeness ・Demonstration explanation ability ・Functional clarity ・Function understanding level ・Functional completeness of user documentation and/or help function ・Restriction condition at construction ・Ease of	【Internal standard】 ・Consistency of operation in use ・Operation time (normal) ・Operation time (specified day) ・Data recovery range ・Usage possibility of external data ・Backup usage range ・Range of backup automization ・Backup acquisition interval ・Backup storage period ・Backup method ・Monitoring information ・Monitoring interval ・Monitoring the process level ・Monitoring database level ・Monitoring storage level ・Monitoring terminal/network equipment level ・Manual preparation level ・Presence of connection with external systems ・Presence of monitoring system ・Presence of job control system ・Presence of execution of configuration control ・Presence of execution of change control ・Presence of execution of release control ・Restriction at operation 【Not internal standard】 ・Description completeness ・Demonstration explanation accessibility ・Demonstration explanation accessibility in use ・Demonstration explanation effectiveness ・Functional

Product Quality				
			④Used measures *	
①Important needs, risks	②Quality characteristics and sub characteristics	③Quality requirements Up to unit test	Up to unit test	After combined test
			obtaining explanatory material ・ Number of functions exceeding user image ・ Ratio of people who have learnt business operation ・ Input appropriateness check ・ Cancellability of user operation ・Undo possibility for user operation ・ Possibility of customization ・ Physical accessibility ・ Monitorability of usage (or operation) status ・ Operation consistency ・ Message clarity ・ Interface factor clarity ・ Operation error recoverability ・ Monitoring system level ・ Monitoring server (node) level ・ Network・Monitoring at packet level ・ Range of time cycle setting ・ Presence of setting of development environment ・ Presence of setting environment for test ・ Manual preparation level ・ Remote monitoring point ・ Remote operation range ・ Presence of execution of internal control handling ・ Presence of setting of service disc ・ Presence of execution of incident control ・ Presence of execution of problem control ・ Setting degree of index/objective of operability evaluation ・ Ratio for service provision (execution) time ・ Percentage of mis-operation ・ Percentage of mis-operation ・ Ratio of clarification of operation start conditions, etc. ・ Minimization of intervention operation ・ Ratio of intervention operation ・ Ratio of requirement settlement for construction of operation organization ・ Ratio of conditions that can detect errors ・ Ease of mistake correction ・ Ratio of recovery from incorrect operation ・ Possibility of work cancellation ・ Availability of default value ・ Attractive mutual effect ・ Appearance customization of user interface	definiteness ・ Function understanding level ・ Understandable I/O ・ Restriction condition at construction ・ Learnability of functions ・Learnability for execution of work in use ・ Effectiveness of user documentation and/or help system ・Effectiveness of user document and/or help system in use ・ Ease of help access ・ Help usage frequency ・ Ease of obtaining explanatory material ・ Number of functions exceeding user image ・ Ratio of people who have learnt business operation ・ Error correction ease ・ Error correctability in use ・Default value availability in use ・ Availability ・ Message comprehension in use ・ Error message legibility ・Operation error recoverability in use ・ Human error operation occurrence interval in use ・ Operation cancellability ・ Possibility of customization ・ Operation procedure reduction ・ Physical accessibility ・ Monitoring system level ・ Monitoring server (node) level ・ Network・ Monitoring at packet level ・ Range of time cycle setting ・ Presence of setting of development environment ・ Presence of setting environment for test ・ Remote monitoring point ・ Remote operation range ・ Presence of execution of internal control handling ・ Presence of setting of service disc ・ Presence of execution of incident control ・ Presence of execution of problem control ・ Setting degree of index/objective of operability evaluation ・ Ratio for service provision (execution) time ・ Percentage of mis-operation ・ Percentage of mis-operation ・ Ratio of clarification of operation start conditions, etc. ・ Minimization of intervention operation ・ Ratio of intervention operation ・ Ratio of requirement settlement for construction of operation organization ・ Ratio of conditions that can detect errors ・ Ease of mistake correction ・ Ratio of recovery from incorrect operation ・ Possibility of work cancellation ・ Availability of default value ・ Attractive mutual effect ・ Possibility of customizing interface appearance
Reliability is required for operation of financial terminals.	Reliability	Maturity	It should work as required in spec. or analogical spec.	【Internal standard】 Review indication density ・ Number of review indication cases ・ Operation time (normal) ・ Operation time (specified day) ・ Presence of stoppage of plan ・ Target business range ・ Service changeover time ・ Requirement degree of business continuation ・ RPO (RECOVERY POINT OBJECTIVE) ・ RTO (RECOVERY TIME OBJECTIVE) ・ RLO (RECOVERY LEVEL OBJECTIVE) 【Not internal standard】	【Internal standard】 No. of fault removal ・ Test completeness ・ Test maturity ・ Number of review indication cases ・ Bug density ・ Test case density ・ Test density ・ Fault discovery rate ・ Operation time (normal) ・ Operation time (specified day) ・ Presence of stoppage of plan ・ Target business range ・ Service changeover time ・ Requirement degree of business continuation ・ RPO (RECOVERY POINT OBJECTIVE) ・ RTO (RECOVERY TIME OBJECTIVE) ・ RLO (RECOVERY LEVEL OBJECTIVE)

			④Used measures *	
Product Quality				
①Important needs, risks	②Quality characteristics and sub characteristics	③Quality requirements Up to unit test	Up to unit test	After combined test
			・Fault detection ・ No. of fault removal ・ Test plan appropriateness ・ Missing rate ・ Slippage rate ・ Bug density ・ Test case density ・ Trouble density of system test ・ Failure convergence rate ・ Fault removal rate ・ Control statement mixture rate ・ Test density ・ Fault discovery rate ・ Fault occurrence density ・ Specification change rate ・ Specification change convergence ratio ・ No. of vending cases ratio ・ System restart objective ・ Operation ratio ・ Protectability of data damage ・ Failure avoidance ・ Incorrect operation avoidance ・ Redundant (equipment) (for server trouble) ・ Redundant (component) (for server trouble) ・ Redundant (equipment) (for terminal trouble) ・ Redundant (component) (for terminal trouble) ・ Redundant (equipment) (for trouble with equipment composing network) ・ Redundant (component) (for trouble with equipment composing network) ・ Redundancy of line ・ Redundancy of route ・ Segment division ・ Redundancy (machine) ・ Redundancy (component) ・ Redundancy (disc) ・Backup method ・ Data recovery range ・ Data integrity ・ Recovery policy ・ Storage location distribution degree ・ Storage method ・ Disaster handling range ・ Quality evaluation value ・ Work period evaluation value ・ Requirement specification format utilization degree ・ Irregular processing implementation ratio ・ Trace function implementation ratio between sub-systems ・ Preparation state of test environment ・ Test coverage ratio ・Degree of skill proficiency in switching to backup machine ・ Risk resolving ratio ・ Test check system by a 3rd person - 1 ・ Test check system by a 3rd person - 2 (Checking rate of pointed out matters) ・ Countermeasure rate for protective device ・ Ratio of the number of successful instances of avoiding discontinuance ・ Ratio of the number of occurrences of mis operation in a fault countermeasure ・ Ratio of execution of preventive training ・ Restoration capability ・ Restoration effectiveness ・ Operation quality ratio ・ Operation initial trouble countermeasure ratio ・ Presence of monitoring the number of handlable data cases ・ Change control check rate ・ Handling execution ratio for alarm of hardware ・ Software monitoring ratio of other company ・ Misoperation rate ・ Ratio of the number of days required for actual recovery compared to the scheduled number of days for recovery from a disaster ・ Ratio of the number of days required for actual recovery compared to the scheduled number of days for recovery from a disaster ・ Recovery	【Not internal standard】 Mean Time Between Failure ・ Missing rate ・ Slippage rate ・ Review indication density ・ Test coverage ratio ・ Trouble density of system test ・ Coding rule deviation rate ・ Failure convergence rate ・ Fault removal rate ・ Control statement mixture rate ・ Fault occurrence density ・ Specification change rate ・ Specification change convergence ratio ・ No. of vending cases ratio ・ System restart objective ・ Operation ratio ・ Protectability of data damage ・ Function cessation avoidance ・ Failure avoidance ・ Incorrect operation avoidance ・ Redundant (equipment) (for server trouble) ・ Redundant (component) (for server trouble) ・ Redundant (equipment) (for terminal trouble) ・ Redundant (component) (for terminal trouble) ・ Redundant (equipment) (for trouble with equipment composing network) ・ Redundant (component) (for trouble with equipment composing network) ・ Redundancy of line ・ Redundancy of route ・ Segment division ・ Redundancy (machine) ・ Redundancy (component) ・ Redundancy (disc) ・Backup method ・ Data recovery range ・ Data integrity ・ Recovery policy ・ Storage location distribution degree ・ Storage method ・ Disaster handling range ・ Quality evaluation value ・ Work period evaluation value ・ Requirement specification format utilization degree ・ Irregular processing implementation ratio ・ Trace function implementation ratio between sub-systems ・ Preparation state of test environment ・ Test coverage ratio ・Degree of skill proficiency in switching to backup machine ・ Risk resolving ratio ・ Test check system by a 3rd person - 1 ・ Test check system by a 3rd person - 2 (Checking rate of pointed out matters) ・ Countermeasure rate for protective device ・ Ratio of the number of successful instances of avoiding discontinuance ・ Ratio of the number of occurrences of mis operation in a fault countermeasure ・ Ratio of execution of preventive training ・ Availability ・ Average down time ・ Mean Time To Failure ・ Restart capability ・ Restoration capability ・ Effectiveness of restoration ・ Operation quality ratio ・ Operation initial trouble countermeasure ratio ・ Presence of monitoring the number of handlable data cases ・ Change control check rate ・ Handling execution ratio for alarm of hardware ・ Software monitoring ratio of other company ・ Misoperation rate ・ Ratio of the number of days required for actual recovery

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
				policy ・ Storage location distribution degree ・ Storage method ・ Disaster handling range ・ Recovery work ・ Range of agency business operation ・ Checking range	compared to the scheduled number of days for recovery from a disaster ・ Ratio of the number of days required for actual recovery compared to the scheduled number of days for recovery from a disaster ・ Recovery policy ・ Storage location distribution degree ・ Storage method ・ Disaster handling range ・ Recovery work ・ Range of agency business operation ・ Checking range
It is a matter of course that trouble recovery or degenerating operations are implemented in the financial terminal system.	Reliability	Fault tolerance	It should operate as in requirement spec.	【Internal standard】 ・ Authentication of an entity with control authority ・ Authentication of an entity that does not have control authority ・ Operation limiting degree for the countermeasure on the system ・ Acquisition of log ・ Log storage period ・ Illegal monitoring target (device) ・ Checking interval ・ Reinforcement of countermeasures by secure coding, setting web server, etc	【Internal standard】 ・ Access auditability ・ Authentication of an entity with control authority ・ Authentication of an entity that does not have control authority ・ Operation limiting degree for the countermeasure on the system ・ Acquisition of log ・ Log storage period ・ Illegal monitoring target (device) ・ Checking interval ・ Reinforcement of countermeasures by secure coding, setting web server, etc
It is a matter of course for a financial system handling money that security function is implemented.	Security	Confidentiality	It should operate as in requirement spec.	【Not internal standard】 ・ Access auditability ・ Data encryption ・ Presence of encryption of transmission data ・ Presence of encryption of accumulated data ・ Key control ・ Access controllability ・ Protectability of data damage ・ Operation limit degree by physical measures ・ Establishment of control rules ・ Illegal monitoring target（Network） ・ Illegal monitoring target (intruder・Illegal operation, etc.) ・ Communication control ・ Detection range of unauthorized communication ・ Network convergence measures ・ PRESENCE OF DEPLOYMENT OF WAP ・ Presence of usage of digital signature ・ Checking interval ・ Presence of in-company regulation, rule, law, guideline, etc. that should be observed ・ Presence of execution of network diagnosis ・ Presence of execution of Web diagnosis ・ Presence of execution of DB diagnosis	【Not internal standard】 ・ Presence of encryption of transmission data ・ Presence of encryption of accumulated data ・ Key control ・ Access controllability ・ Protectability of data damage ・ Operation limit degree by physical measures ・ Establishment of control rules ・ Illegal monitoring target（Network） ・ Illegal monitoring target (intruder ・ Illegal operation, etc.) ・ Communication control ・ Detection range of unauthorized communication ・ Network convergence measures ・ PRESENCE OF DEPLOYMENT OF WAP ・ Presence of usage of digital signature ・ Checking interval ・ Presence of in-company regulation, rule, law, guideline, etc. that should be observed ・ Presence of execution of network diagnosis ・ Presence of execution of Web diagnosis ・ Presence of execution of DB diagnosis
Reading comprehension is a necessary function from the development side, too.	Maintainability	Analyzability	Should comply with the in-company standard.	【Not internal standard】 ・ Execution of reusability ・ Execution record ・ Diagnostic function sufficiency level ・ Comment sentence mixture ratio ・ Average number of functions ・ Max. number of lines of functions ・Mean No. of file lines ・Max. number of file lines ・ Document volume ratio ・ Document balance ・ Maintenance document sufficiency ・ Trace tool usage ratio ・ Program source comment ratio ・ Change recording capability ・ Influence degree of change ・ Presence of stoppage of plan ・ Prior announcement of stoppage of plan ・ Automization range of maintenance work ・ Automization of server software updating work ・ Automization of terminal software updating ・Provision of patch release information ・	【Not internal standard】 ・ Execution of reusability ・ Track audit ability ・ Diagnostic function support ・ Failure analysis capability ・ Failure analysis efficiency ・ State monitoring capability ・ Comment sentence mixture ratio ・ Average number of functions ・ Max. number of lines of functions ・Mean No. of file lines ・ Max. number of file lines ・ Document volume ratio ・ Document balance ・ Maintenance document sufficiency ・ Trace tool usage ratio ・Program source comment ratio ・ Changed cycle efficiency ・ Change execution elapsed time ・ Correction complexity ・ Correction possibility using parameters ・ Software change control capability ・ Successful change rate ・ Correction influence localization

			④Used measures *	

Product Quality

①Important needs, risks	②Quality characteristics and sub characteristics	③Quality requirements Up to unit test	④Used measures *	
			Up to unit test	After combined test
			Patch application policy ・Patch application timing ・Presence of execution of patch validation ・ Range of hardware activity maintenance ・ Software activity maintenance range ・ Regular maintenance frequency ・ Preventive maintenance level ・ Recovery work ・ Range of agency business operation ・ Fault recovery automization range ・ Handlable time ・ Rushed arrival time ・ SE ARRIVAL AVERAGE TIME ・ Maintenance parts ensuring level ・ Presence of spare machine ・ Change history recording rate ・ Configuration control efficiency ・ Furnishing change range validation tool ・ Change productivity ・ Parameter correction success ratio ・ Structural degree of base system ・ Failure occurrence rate ・ Base quality ・ Auto recovery function sufficiency level ・ Consistency judgment time ・ Functional completeness of built-in test function ・ Autonomous testablity ・ Test progress monitoring degree ・ Maintainability standard conformance ・ Rate of conformity with software design guideline ・ Rate of conformity to creation of document ・ Rate of conformity to coding rules ・ (process specific) test execution standard, conformity ratio with the said execution procedure ・ Life cycle period	degree (trouble appearance degree after change) ・ Presence of stoppage of plan ・ Prior announcement of stoppage of plan ・ Automization range of maintenance work ・ Automization of server software updating work ・ Automization of terminal software updating ・ Provision of patch release information ・ Patch application policy ・Patch application timing ・Presence of execution of patch validation ・ Range of hardware activity maintenance ・ Software activity maintenance range ・ Regular maintenance frequency ・ Preventive maintenance level ・ Recovery work ・ Range of agency business operation ・ Fault recovery automization range ・ Handlable time ・ Rushed arrival time ・ SE ARRIVAL AVERAGE TIME ・ Maintenance parts ensuring level ・ Presence of spare machine ・ Change history recording rate ・ Configuration control efficiency ・ Furnishing change range validation tool ・ Change productivity ・ Parameter correction success ratio ・ Structural degree of base system ・ Failure occurrence rate ・ Base quality ・ Auto recovery function sufficiency level ・ Consistency judgment time ・ Availability of built-in test function ・ Retest efficiency ・ Test restartability ・ Maintainability standard conformance ・ Rate of conformity with software design guideline ・ Rate of conformity to creation of document ・ Rate of conformity to coding rules ・ (process specific) test execution standard, conformity ratio with the said execution procedure

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics of product that should be considered	
Functional suitability	Functional completeness, Functional appropriateness
Performance efficiency	Time behavior, Resource utilization
Compatibility	Co-existence, Interoperability
Usability	Operability, User error protection, User interface aesthetics, Accessibility
Reliability	Availability, Recoverability
Security	Integrity, Non-repudiation, Accountability, Authenticity
Maintainability	Modularity, Reusability, Modifiability, Testability

<<Case Study # 4>>

Outline of example	
Case # : System	4 : Auto fare collection system using contactless IC card
System outline	Auto fare collection system using contactless IC card
Field	Transport
Usage stage of system (business type)	Transportation business (Transport (ITS)), Finance/insurance business (Electronic settlement (e-money))
Utilization stage of system	＜N/A＞
Related built-in system	Facility equipment system
Architecture	Autonomous distribution
System processing form	Batch processing, Online transaction processing

Usage Scenario		
Stakeholder	Usage scene (Use case, Usage method)	Required main functions
Station staff	Issuing/selling IC cards	Issuing a new IC card (information registration) and selling it to a customer.
Station staff	Registering for re-issuance of IC card in the event of loss	Registration of re-issuance of lost or broken IC card (registration of new card, invalidation of old card)
Passenger	Passing the ticket gate by presenting an IC card	Reading/writing of an IC card, controlling ticket gate door, processing usage information
Passenger	Charging money to the IC card	Writing the amount paid in the IC card on the ticketing device
Customer	Shopping using an IC card	Device or network for reading and writing IC card is required at a shop.

Quality in use				
①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements	④Used measures *
Data on media (card) and system needs to be consistent.	Effectiveness	Effectiveness	Functional completeness of data	【Internal standard】・ Work effectiveness ・ Work completion degree ・ Mistake frequency ・ Handling time ・ Operation time ・ Reception time ・ Handling time of job usage ・ Handling time for media usage ・ Handling time for outputting slips ・ Service time ・ Operation service time ・ Ensuring seismic resistancet/seismic isolation capability ・ Operation time (management time) ・ Mean operation ratio ・ Max. stop time 【Not internal standard】・ Operation ratio ・ Mean operation ratio ・ Max. stop time ・ Operation ratio control
Possible to pass the ticket gate smoothly with simple action even at busy times.	Satisfaction	Usefulness	Accurate and high speed processing of reading, writing and fare calculation	【Internal standard】・ Service provision time zone (handling trouble) ・ Service provision time zone (general inquiry) 【Not internal standard】・ Satisfaction scale (there is customer research including factors other than the system) ・ Usage of discretion (it is sometimes researched in general society)
Operation can be continued even at malfunction or disaster.	Freedom from risk	Economic risk mitigation	Autonomous distribution system configuration	【Internal standard】・ No. of claims from customer ・Balance Score・Card (BSC) 【Not internal standard】・ Return on investment (ROI)(Check using a systematized evaluation sheet) ・ Auto measurement of qualitative effect (check using a systematized evaluation sheet) ・ Percentage of revenue from new customers ・ Ratio of revenue from existing customers ・ Comparison with other company (benchmark)(comparing the state of own company with other top companies in the industry or same business) ・ Opportunity loss (check with a systemization evaluation sheet) ・ IT ASSET INVESTMENT

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics in use that should be considered	
Efficiency	Efficiency
Satisfaction	Trust
Context coverage	Context completeness

	Product Quality				

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
Correct fare collection and high speed processing are requisite conditions for passing the ticket gate.	Functional suitability	Functional completeness	Accurate and high speed processing of reading, writing and fare calculation	＜N/A＞	＜N/A＞
Consistency of data of media (card) and system is necessary.	Functional suitability	Functional correctness	Functional completeness of data	＜N/A＞	＜N/A＞
Mutual usage with other vendors is possible.	Compatibility	Interoperability	Compatibility	＜N/A＞	＜N/A＞
System operates stably.	Reliability	Maturity	Redundant type, Autonomous distribution	＜N/A＞	＜N/A＞
There are many everyday transactions, so impact of operation shutdown is extremely large.	Reliability	Fault tolerance	Redundant type, Autonomous distribution	＜N/A＞	＜N/A＞
Preventing leakage of personal information.	Security	Confidentiality	Encryption technology, operation control	＜N/A＞	＜N/A＞
Preventing data falsification.	Security	Functional completeness	Encryption technology, operation control	＜N/A＞	＜N/A＞

Other quality characteristics and sub characteristics of product that should be considered	
Performance efficiency	Time behavior
Compatibility	Co-existence
Usability	Appropriateness recognizability, Learnability, Operability, User error protection
Reliability	Availability, Recoverability
Security	Authenticity
Maintainability	Reusability, Analyzability, Modifiability
Portability	Adaptability

<<Case Study # 5>>

Outline of example	
Case # : System	5 : Power supply, customer information control system
System outline	System used for meter reading and settlement that are necessary in the sales business of a power company based on information obtained from a voltmeter with communication functions.
Field	Electricity
Usage stage of system (business type)	Electricity, gas, heat supply, water utility business
Utilization stage of system	Sales/Retail
Related built-in system	Business use terminal equipment system, system of communication facility equipment, etc.
Architecture	Mainframe, Client/server
System processing form	Batch processing, Online transaction processing

Usage Scenario		
Stakeholder	Usage scenario (Use case, Usage method)	Required main functions
Meter reader	Reading the figure indicated on the voltmeter and informing amount of electricity used to a customer.	・Extracting the indicated value from electricity meter to the business use terminal using communication function. ・Calculating the amount used and electricity rate based on the indicated value and issuing the slip.
Receptionist	Researching the usage result and providing consultation for inquiries made by a customer about the usage method of electricity,	・Indicating a record of figures indicated on a meter and electricity amount used for each time zone. ・Indicating parameters and analysis result for consulting.
Operator	Starting or stopping supplying electricity upon customer's application on moving in or out.	・Turning on or off the electric power meter from business use terminal using communication function. ・Calculating amount of electricity used at moving out on the business use terminal using communication function.

Quality in use			
①Important needs, risks	②Quality characteristics and sub characteristics	③Quality requirements	④Used measures *
Lack of correctness to usage objective directly leads to loss of appropriateness in carrying out business operation.	Effectiveness / Effectiveness	Consistency of overall flow of business and spec.	【Internal standard】・ Handling time ・ Operation time ・ Reception time ・ Handling time of job usage ・ Handling time for media usage ・ Handling time for outputting slips ・ Handling time of job usage ・ Handling time for media usage ・ Handling time for outputting slips ・ Service time ・ Operation ratio ・ Mean operation ratio ・ Max. stop time ・ Operation ratio control ・ Operation service time ・ Ensuring seismic resistancet/seismic isolation capability ・ Operation time (management time) ・ Mean operation ratio ・ Max. stop time 【Not internal standard】・ Work effectiveness ・ Work completion degree ・ Mistake frequency ・ Online system operation ratio ・Batch processing normal finish ratio
The main section carries out the interface design, so it is sensitive to the usage status after starting operation.	Satisfaction / Usefulness	Incorporation of improvement request from main section to the actual site	【Internal standard】・ Service provision time zone (handling trouble) ・ Service provision time zone (general inquiry) 【Not internal standard】・ Satisfaction scale ・ Satisfaction questionnaire slip ・ Usage of discretion ・ User satisfaction
Sales are handled as business with higher priority inside the company.	Satisfaction / Trust	Operation state monitoring after starting operation	【Internal standard】・ ・Fault recovery time ・ Recovery time ・ Aggregation report interval ・ Aggregation report interval ・ Failure rate ・ Aggregation report interval ・ Fault recovery time ・ Aggregation report interval ・ Network trouble recovery time observation ratio

				【Not internal standard】・ Check cycle of asset control

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics in use that should be considered	
Efficiency	Efficiency
Freedom from risk	Economic risk mitigation
Context coverage	Context completeness

Product Quality

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
Handling important parameters related to claiming action.	Functional suitability	Functional correctness	Adjusting fare based on the auto detected meter value.	【 Not internal standard 】Correctness of calculation ・ Accuracy	【Not internal standard】Correctness to expectations ・ Correctness of calculation ・ Accuracy ・ Correctness of manual description ・ Density of inspection
There are a huge number of end users, so the impact is enormous if the system does not suit the objective.	functional suitability	Functional appropriateness	All specifications defined by the main section are complied with.	【Not internal standard】 Functional appropriateness ・ Completeness of function implementation ・ Coverage of function implementation ・ Stability of functional specification (variable system) ・ Number of users ・ No. of clients ・ No. of bases ・ Regional expansion ・ Presence of usage of specific product ・ System usage range ・ No. of languages	【 Not internal standard 】Functional appropriateness ・ Completeness of function implementation ・ Coverage of function implementation ・ Stability of functional specification ・ Number of users ・ No. of clients ・ No. of bases ・ Regional expansion ・ Presence of usage of specific product ・ System usage range ・ No. of languages
It's used for very demanding business such as in call centers, so high performance is required.	Performance efficiency	Time behavior	Response in a server per transaction should be within 3sec.	【Internal standard】Response time ・ Turn around time 【Not internal standard】 Throughput	【Internal standard】・ Response time ・ Response time (mean time till response) ・ Response time (response time ratio in the worst case) ・ Turn around time ・ Turn around time (turn around average time) ・ Turn around time (turn around time ratio in the worst case) ・ Response observance ratio at normal times (when online system is used) ・ Response observance ratio at peak (when online system is used) ・ Response observance ratio at degeneration (when online system is used) ・ Response observance degree at normal times (when batch system is used) ・ Response observance degree at peak (when batch system is used) ・ Response observance degree at degeneration (when batch system is used) 【Not internal standard】・ Throughput ・ Mean throughput ・ Throughput at max. load ・ Stand-by time ・ Processing margin ratio at normal times (when online system is used) ・ Processing margin ratio at peak (when online system is used) ・ Processing margin ratio at degeneration (when online system is used) ・ Processing margin ratio at normal times (when batch system is used) ・ Processing margin ratio at peak (when batch system is used) ・ Processing margin ratio at degenerating (when batch system is used) ・ Printing

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
					margin rate at normal times ・Printing margin ratio at peak ・ Printing margin rate at degeneration ・ Throughput ・ Provision business
Even if the business use terminal is lost, no customer information is decoded.	Security	Confidentiality	Data containing personal information located in the business use terminal should be encrypted in a manner that it cannot be decoded by humans.	【Not internal standard】Access auditability ・ Data encryption	【Internal standard】・ Presence of encryption of transmission data 【Not internal standard】・ Access auditability
Because it handles customer information, authority should be controlled strictly for each business operation.	Security	Integrity	Limiting access to screens other than those used for business taken charge of.	【Not internal standard】Access controllability ・ Protectability of data damage	【Internal standard】・ Authentication of an entity with control authority ・ Authentication of an entity that does not have control authority ・ Operation limiting degree for the countermeasure on the system ・ Operation limit degree by physical measures ・ Establishment of control rules ・ Acquisition of log ・ Log storage period ・ Illegal monitoring target (device) ・ Illegal monitoring target（Network） ・ Illegal monitoring target (intruder・Illegal operation, etc.) ・ Checking interval ・ Communication control ・ Detection range of unauthorized communication ・ Network convergence measures ・ Reinforcement of countermeasures by secure coding, setting web server, etc 【Not internal standard】・ Access controllability ・ Protectability of data damage

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics of products that should be considered	
Performance efficiency	Time behavior
Compatibility	Co-existence
Usability	Appropriateness recognizability, Learnability, Operability, User error protection
Reliability	Availability, Recoverability
Security	Authenticity
Maintainability	Reusability, Analyzability, Modifiability
Portability	Adaptability

<<Case Study # 6>>

Outline of example	
Case # : System	6 : Information system providing customer information
System outline	Information system providing customer information
Field	Electricity : Contents
Usage stage of system (business type)	Electricity, Gas, Heat supply, Water supply business
Utilization stage of system	Sales/Retail
Related built-in system	Information device system for individuals
Architecture	Intranet/Internet
System processing form	Dialogue processing/Real time processing

Usage Scenario		
Stakeholder	Usage scene (Use case, Usage method)	Required main functions
Contractant	Referring to customer information	Specifying a customer
Contractant	Referring to customer information	Providing latest information.
Contractant	Checking notices	Sending e-mail.
Employee	Handling inquiries	Accumulating history

Quality in use				
①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements	④Used measures *
Drawing the interest of a customer.	Satisfaction	Usefulness	Specifying a customer	【Internal standard】・Satisfaction scale ・User satisfaction、, recognizability to users ・Fault recovery time 【Want to use】・Revised version/time interval of patch application ・ Check cycle of asset control ・ Fault recovery time
Transmitting the effective usage of resources (electricity) and contributing to environmental protection.	Freedom from risk	Environmental risk mitigation	Providing update information	【Want to use】・Return on investment (ROI) ・ Auto measurement of qualitative effect ・ Comparison with other company (benchmark)
Transmitting the effective usage of resources (electricity) and contributing to reduction of customer's cost.	Context coverage	Context completeness	Providing update information	＜N/A＞

*[Internal standard]: Measures used as in-company standard *[Not internal standard]: Measures used at the site as other than in-company standard [Desired to use]: Measures that are not currently used but desired to use in the future

Other quality characteristics and sub characteristics in use that should be considered	
Satisfaction	Pleasure
Freedom from risk	Economic risk mitigation

Product Quality					

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
Providing update information	Functional suitability	Functional correctness	Specifying a customer and providing unique information.	【Want to use】Density of inspection	【Want to use】・Correctness of manual description
Providing update information	Performance efficiency	Time behavior	Searching target information at high speed.	【Internal standard】・Response time ・ Throughput ・ Turn around time ・ Throughput 【Want to use】・Response observance ratio at normal times (when online system is used) ・ Response observance degree at normal times (when batch system is used) ・ Processing margin ratio at normal times (when online system is used) ・ Processing margin ratio at peak (when online system is used) ・ Processing margin ratio at peak (when batch system is used)	【Internal standard】・Response time ・ Response time (mean time till response) ・ Throughput ・ Turn around time ・ Throughput
Linking with various systems in the company.	Compatibility	Interoperability	Unifying the communication method/technique.	【Internal standard】・Interface consistency (protocol) ・ Ease of connection with other system 【Want to use】・Data exchangeability based on data format	＜N/A＞
Conveying information to be provided effectively	Usability	User Interface aesthetics	Using standard technology.	＜N/A＞	【Want to use】・Attractive mutual effect
Providing customer information.	Security	Functional completeness	Specifying a customer	【Internal standard】・Acquisition of log ・ Log storage period	【Internal standard】・Access controllability ・ Operation limiting degree for the countermeasure on the system ・ Operation limit degree by physical measures ・ Establishment of control rules ・ Acquisition of log ・ Reinforcement of countermeasures by secure coding, setting web server, etc 【Want to use】Access controllability

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard [Desired to use]: Measures that are not currently used but it is desired to use them in the future

Other quality characteristics and sub characteristics of product that should be considered	
Compatibility	Co-existence
Usability	Appropriateness recognizability, Operability, User error protection
Reliability	Availability, Fault tolerance, Recoverability
Security	Reliability
Maintainability	Modularity, Reusability
Portability	Adaptability

<<Case Study # 7>>

Outline of example	
Case # : System	7 : Agricultural information system
System outline	Product outline: Associating agricultural field information/soil information for each field and controlling the agricultural field status. Realizing harvesting at the appropriate time by determining the harvest order according to the growth analysis of wheat using satellite images. Product characteristics: ①creating agricultural field drawing based on the satellite image, ②supporting website and mobiles ③disclosing information of agricultural products to customers through the Internet.
Field	Agriculture
Usage stage of system (business type)	Agriculture, forestry and fisheries
Utilization stage of system	Production/logistics, master control, customer control, information analysis,　Others: Planting plan/control
Related built-in system	Agricultural information control system
Architecture	Stand alone, Client/server, Intranet/Internet
System processing form	Dialogue processing/Real time processing

Usage Scenario		
Stakeholder	Usage scene (Use case, Usage method)	Required main functions
Japan Agriculture staff, agricultural worker	Monitoring the growth status of crops	Indication on maps of agricultural fields, indication of growth status of crops (coloring)
Buyer including a retailer	Checking the production place of crops	Outputting production history information of crops

Quality in use			
①Important needs, risks	②Quality characteristics and sub characteristics	③Quality requirements	④Used measures *
Users have a need to harvest at the best time.	Effectiveness / Effectiveness	Monitoring the difference of dryness level of crops of each farmland using satellite images.	＜N/A＞
Users have a need to reduce the trouble with drying crops after harvesting.	Efficiency / Efficiency	Possible to monitor dryness of wide area using the satellite image, without checking at the site.	＜N/A＞
The contents displayed on the system should match the actual status.	Satisfaction / Trust	Relative dryness degree of crops and dryness degree assumed from the satellite image should match.	＜N/A＞

*[Internal standard]: Measures used as in-company standard　*[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics in use that should be considered	
Satisfaction	Usefulness
Freedom from risk	Health and safety risk mitigation, Environmental risk mitigation

Product Quality				

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
Providing correct information to the user.	Functional suitability	Functional correctness	Relative dryness degree of crops and dryness degree assumed from the satellite image should match.	【Internal standard】・Accuracy	【Internal standard】・Correctness to expectations ・Correctness of calculation ・Correctness of manual description ・Density of inspection
Users have needed to reduce trouble with drying crops after harvesting.	Performance efficiency	Time behavior	Indication of relative dryness degree for each agricultural area	【Internal standard】・Response time	【Internal standard】・Response time ・Response time (response time ratio in the worst case) ・Turn around time ・Turn around time (turn around time ratio in the worst case)
Output result of the system is effective/appropriate to a user.	Usability	Appropriateness recognizability	Relative dryness degree of crops and dryness degree assumed from the satellite image should match.	【Internal standard】・Description completeness ・Functional clarity	＜N/A＞
Supporting business operation of a user.	Usability	Operability	Function to output the analysis result according to usage objective (in units of union, product type, etc.)	【Internal standard】・Operation consistency ・Message clarity ・Interface factor clarity	【Internal standard】・Presence of setting of service disc ・Presence of execution of change control ・Presence of execution of release control
Output information of a system is easy for a user to discriminate.	Usability	User interface mitigation	Coloring indication of analysis result (with legend)	【Internal standard】・Attractive mutual effect	【Internal standard】・Attractive mutual effect
Operating stably with no troubles	Reliability	Maturity	Operating for 24 hours	【Internal standard】・Fault detection ・No. of fault removal ・Test plan appropriateness	【Internal standard】・No. of fault removal ・Test completeness ・Test maturity ・Missing rate ・Review indication density ・Number of review indication cases ・Bug density ・Test coverage ratio ・Test case density ・Trouble density of system test ・Coding rule deviation rate ・Failure convergence rate ・Fault removal rate ・Test density ・Fault occurrence density
Operating appropriately at harvest time of crops.	Reliability	Availability	Operating for 24 hours	＜N/A＞	【Internal standard】・Operation time (normal) ・Presence of stoppage of plan

Other quality characteristics and sub characteristics of product that should be considered	
None in particular	

<<Case Study # 8>>

Outline of example	
Case # : System	8 : Earthquake early warning service
System outline	Earthquake early warning service
Field	Disaster prevention
Usage stage of system (business type)	Others: Disaster prevention control
Utilization stage of system	Information analysis, Disaster prevention control
Related built-in system	Analysis equipment/measuring equipment system
Architecture	Client/server
System processing form	Dialogue processing/Real time processing

Usage Scenario		
Stakeholder	Usage scene (Use case, Usage method)	Required main functions
Various media, factories, hospitals, municipalities, etc.	When the occurrence of a strong quake is detected, receiving the alert automatically before it comes	Sounding alarm, flashing a lamp, stopping machinery automatically and calling associated people for emergency assembly (automatically) based on the received alert

Quality in use				
①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements	④Used measures *
Because this is extremely important social information directly related to human life and property, no stoppage or incorrect information is permissible.	Effectiveness	Effectiveness	Reliability　(no stoppage is permissible) Functional correctness　(no false report is permissible) Processing speed (delay in unit of sec. affects life)	【Internal standard】· Handling time · Operation time · Reception time · Handling time of job usage · Service time · Operation ratio · Mean operation ratio · Max. stop time · Operation ratio control · Operation service time · Operation time (management time) · Mean operation ratio · Max. stop time
	Efficiency	Efficiency	Duplication of system and distribution of data centers Monitoring system for 24 hours 365 days including terminals	【Internal standard】· Trouble notification time of job usage · Transmission delay time (domestic) · Fault notification time · Transmission delay time (domestic)
	Satisfaction	Trust	Preparation of the monitoring system of entire system including terminals for 24 hours 365 days	【Internal standard】· Service provision time zone (handling trouble) ·Service provision time zone (general inquiry)
	Freedom from risk	Health and safety risk mitigation	Reliability (no stoppage is permissible) Functional correctness (false report is not permissible) Processing speed (delay in unit of sec. affects life)	＜N/A＞

*[Internal standard]: Measures used as in-company standard　*[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics in use that should be considered
None in particular

Product Quality				

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
It is socially important information, so social impact is large, therefore false report is not permissible.	Functional suitability	Functional correctness	When a server receives a warning from Meteorological Office, it transfers the warning to all terminals with no delay after processing it for a terminal.	【Internal standard】・ Number of users ・ No. of clients ・ No. of bases ・ Regional expansion	Same as on the left
It is important information involving human lives and assets, so no delay is permitted even for a second.	Performance efficiency	Time behavior	When a server receives a warning from Meteorological Office, it transfers the warning to all terminals with no delay after processing it for a terminal.	【Internal standard】 ・ Turn around time ・ Provision business ・ Number of users ・ Data volume ・ No. of business functions ・ Data volume increase ratio ・ Network equipment setting range ・ Scale up ・ Setting of band guarantee ・ Transaction protection	Same as on the left
It is important information associated with human lives and assets, so it is not acceptable to stop the service.	Reliability	Maturity	Duplication of system, duplication of data center, duplication of lines and constant monitoring of terminals	【Internal standard】・ Operation time (normal) ・ Presence of stoppage of plan ・ Service changeover time ・ RPO (Recovery Point Objective) ・ RTO (Recovery Time Objective) ・ RLO (Recovery Level Objective) ・ System restart objective ・ Operation ratio ・ Redundant (equipment) (for server trouble) ・ Redundant (equipment) (for terminal trouble) ・ Redundant (equipment) (for trouble with equipment composing network) ・ Redundancy of line ・ Redundancy of route ・ Redundancy (disc) ・ Recovery policy ・ Preparation state of test environment ・Degree of skill proficiency in switching to backup machine ・ Ratio of the number of days required for actual recovery compared to the scheduled number of days for recovery from a disaster ・ Ratio of the number of days required for actual recovery compared to the scheduled number of days for recovery from a disaster ・ Recovery policy	Same as on the left

[In-company standard] : Measures used as in-company standard

Other quality characteristics and sub characteristics of product that should be considered	
None in particular	

<<Case Study # 9>>

Outline of example	
Case # : System	9 : EC SITE, Cyber mall
System outline	EC SITE, Cyber mall, Main functions are shopping and searching functions for a customer, customer control, product control and ad function for branch shops
Field	Content/information provision
Usage stage of system (business type)	Wholesale/retailing, Finance/insurance business
Utilization stage of system	Sales/retailing, order receiving/order placing/inventory, physical distribution, customer control, information analysis
Related built-in system	＜N/A＞
Architecture	Intranet/Internet, Others (mobile)
System processing form	Batch processing, Dialogue processing/Real time processing, Online transaction processing

Usage Scenario		
Stakeholder	Usage scene (Use case, Usage method)	Required main functions
Consumer	Shopping	Searching products, authorizing individuals and making settlement
Shop	Displaying products	Registering products, writing ad statements and controlling inventory
Shop	Selling products	Making settlement, controlling inventory, controlling customers and carrying out distribution delivery
Management	Placing an ad	Making recommendations, personalization
Management	Recovering from errors	Notifying with mail when an error occurs

Quality in use			
①Important needs, risks	②Quality characteristics and sub characteristics	③Quality requirements	④Used measures *
Products that the customer wants are displayed and they are purchased properly.	Satisfaction / Usefulness	Matching contents, search result display performance	【Not internal standard】・ Satisfaction scale ・ Satisfaction questionnaire slip ・ Usage of discretion ・ User satisfaction ・ Service provision time zone (handling trouble) ・ Service provision time zone (general inquiry)
There is a sense of bargain and individuality.	Satisfaction / Pleasure	Point service, personalized recommendation	＜N/A＞
Safe settlement is possible.	Freedom from risk / Economical risk mitigation	Personal information protection, electronic settlement	【Not internal standard】・ Economic damage ・ Software damage ・ Return on investment (ROI) ・ Discount cash flow (DCF) ・ Auto measurement of qualitative effect ・ Ratio of overall manufacturing lead time ・ Ratio of lead time for each process ・ No. of delayed delivery cases ・ No. of claims from customer ・ No. of missing items ・ Percentage of revenue from new customers ・ Ratio of revenue from existing customers ・Balance Score Card (BSC) ・ Comparison with other company (benchmark) ・ Opportunity loss ・ Real option ・ IT ASSET INVESTMENT
PC, mobile phone or smart phone can be used anytime anywhere.	Context coverage / Context completeness	Display performance, screen configuration	【Internal standard】・ Review frequency of security risk ・ Review range of security risk ・ Risk handling range after starting operation ・ Risk measure policy ・ Security patch application range ・ Security patch application policy ・ Security patch application timing ・ Malware countermeasure execution range ・ Execution of real time scanning ・Full scan regular check timing ・ Seismic withstand intensity ・ Handling degree to Act on promoting Green Purchasing ・ Life cycle period of equipment ・ TARGET VALUE FOR CO2 EMISSION 【Not internal standard】・ Setting space limitation (machine room)) ・ Setting space limitation (office setting) ・ Parallel operation space (at transition) ・ Expansion margin of setting space ・ Floor load ・ Setting countermeasures ・ Supplied power suitability ・ Restriction of power supply capacity ・ Parallel operation electricity (at transition) ・ Power failure

			countermeasure ・ Voltage variation of assumed setting location ・ Frequency variation of assumed setting location ・ Grounding ・ Temperature (band) ・ Humidity (band) ・ Air conditioning performance ・ Restriction of air conditioning facilities ・ Same equipment available expansion capacity ・ Target value of energy consumption ・ Noise value

*[Internal standard]: Measures used as in-company standard　*[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics in use that should be considered	
Effectiveness	Effectiveness
Satisfaction	Trust, Comfort
Freedom from risk	Health and safety risk mitigation

Product Quality

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
Realizing specification of individual correctly and safe settlement.	Functional suitability	Functional correctness	Account settlement, Authentication	【Not internal standard】・ Correctness of calculation ・ Accuracy ・ Correctness of manual description	【Internal standard】・ Correctness to expectations ・ Correctness of calculation ・ Accuracy ・ Density of inspection 【Not internal standard】・ Correctness of manual description
Realizing comfortable shopping.	Performance efficiency	Time behavior	Performance	【Not internal standard】・ Response time ・ Throughput ・ Turn around time ・ Response observance ratio at normal times (when online system is used) ・ Response observance ratio at peak (when online system is used) ・ Response observance ratio at degeneration (when online system is used) ・ Response observance degree at normal times (when batch system is used) ・ Response observance degree at peak (when batch system is used) ・ Response observance degree at degeneration (when batch system is used) ・ Processing margin ratio at normal times (when online system is used) ・Processing margin ratio at peak (when online system is used) ・ Processing margin ratio at degeneration (when online system is used) ・ Processing margin ratio at normal times (when batch system is used) ・ Processing margin ratio at peak (when batch system is used) ・ Processing margin ratio at degenerating (when batch system is used) ・ Throughput processing time result check・Correction time recovery time	【Internal standard】・ Response time ・ Response time (mean time till response) ・ Response time (response time ratio in the worst case) ・ Throughput ・ Mean throughput ・ Response observance ratio at normal times (when online system is used) ・ Response observance ratio at peak (when online system is used) ・ Response observance ratio at degeneration (when online system is used) ・ Response observance degree at normal times (when batch system is used) ・ Response observance degree at peak (when batch system is used) ・ Response observance degree at degeneration (when batch system is used) ・ Processing margin ratio at normal times (when online system is used) ・ Processing margin ratio at peak (when online system is used) ・ Processing margin ratio at degeneration (when online system is used) ・ Processing margin ratio at normal times (when batch system is used) ・ Processing margin ratio at peak (when batch system is used) ・ Processing margin ratio at degenerating (when batch system is used) ・ Throughput processing time result check・Correction time recovery time
Increasing mutual usage of services.	Compatibility	Interoperability	Purchase history control, point granting service, authentication	【Not internal standard】・ Data exchangeability based on data formatInterface consistency (protocol)Ease of connection with other system	【Not internal standard】・ Data exchangeability based on data format ・ Data exchangeability based on frequency of successful attempts by a user ・ Ease of connection with other system
Possible to search desired product easily.	Usability	Appropriateness recognizability	Search, matching	【Internal standard】・ Restriction condition at construction 【Not internal standard】・ Description completeness ・ Demonstration explanation ability ・ Functional clarity ・	【Internal standard】・ Restriction condition at construction 【Not internal standard】・ Description completeness ・ Demonstration explanation accessibility ・Demonstration

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
				Function understanding level ・Functional completeness of user documentation and/or help function	explanation accessibility in use ・ Demonstration explanation effectiveness ・ Functional definiteness ・ Function understanding level ・Understandable I/O
Maintaining the sales of a shop and continuing placing ads.	Reliability	Fault tolerance	Fail Over	【Internal standard】・ ・Backup method ・ Data recovery range ・ Data integrity ・ Recovery policy ・ Storage location distribution degree ・ Storage method ・ Disaster handling range 【Not internal standard】・ Protectability of data damage ・ Failure avoidance ・ Incorrect operation avoidance ・ Redundant (equipment) (for server trouble) ・ Redundant (equipment) (for terminal trouble) ・ Redundant (equipment) (for trouble with equipment composing network) ・ Redundancy of line ・ Redundancy of route ・ Segment division ・ Redundancy (machine) ・ Quality evaluation value ・ Work period evaluation value ・ Requirement specification format utilization degree ・ Irregular processing implementation ratio ・ Trace function implementation ratio between sub-systems ・ Preparation state of test environment ・ Test coverage ratio ・Degree of skill proficiency in switching to backup machine ・ Risk resolving ratio ・ Test check system by a 3rd person - 1 ・ Test check system by a 3rd person - 2 (Checking rate of pointed out matters) ・ Countermeasure rate for protective device ・ Ratio of the number of successful instances of avoiding discontinuance ・ Ratio of the number of occurrences of mis operation in a fault countermeasure ・ Ratio of execution of preventive training	【Internal standard】・ ・Backup method ・ Data recovery range ・ Data integrity ・ Recovery policy ・ Storage location distribution degree ・ Storage method ・ Disaster handling range 【Not internal standard】・ Protectability of data damage ・ Function cessation avoidance ・ Failure avoidance ・ Incorrect operation avoidance ・ Redundant (equipment) (for server trouble) ・ Redundant (equipment) (for terminal trouble) ・ Redundant (equipment) (for trouble with equipment composing network) ・ Redundancy of line ・ Redundancy of route ・ Segment division ・ Redundancy (machine) ・ Quality evaluation value ・ Work period evaluation value ・ Requirement specification format utilization degree ・ Irregular processing implementation ratio ・ Trace function implementation ratio between sub-systems ・ Preparation state of test environment ・ Test coverage ratio ・Degree of skill proficiency in switching to backup machine ・ Risk resolving ratio ・ Test check system by a 3rd person - 1 ・ Test check system by a 3rd person - 2 (Checking rate of pointed out matters) ・ Countermeasure rate for protective device ・ Ratio of the number of successful instances of avoiding discontinuance ・ Ratio of the number of occurrences of mis operation in a fault countermeasure ・ Ratio of execution of preventive training
Protecting customer's personal information	Reliability	Recoverability	Backup	【Internal standard】・ Operation quality ratio ・ Operation initial trouble countermeasure ratio ・ Ratio of the number of days required for actual recovery compared to the scheduled number of days for recovery from a disaster ・ Ratio of the number of days required for actual recovery compared to the scheduled number of days for recovery from a disaster ・ Recovery policy ・ Storage location distribution degree ・ Storage method ・ Disaster handling range ・ Recovery work ・ Range of agency business operation ・ Checking range 【Not internal standard】・ Restoration capability ・ Restoration effectiveness ・ Presence of monitoring the number of handlable data cases ・ Change control check rate ・ Handling execution ratio for alarm of hardware ・ Software monitoring ratio of other company ・ Misoperation	【Internal standard】・ Operation quality ratio ・ Operation initial trouble countermeasure ratio ・ Ratio of the number of days required for actual recovery compared to the scheduled number of days for recovery from a disaster ・ Ratio of the number of days required for actual recovery compared to the scheduled number of days for recovery from a disaster ・ Recovery policy ・ Storage location distribution degree ・ Storage method ・ Disaster handling range ・ Recovery work ・ Range of agency business operation ・ Checking range 【Not internal standard】・ Availability ・ Average down time ・ Mean Time To Failure ・ Restart capability ・ Restoration capability ・ Effectiveness of restoration ・ Presence of monitoring the number of handlable data cases ・ Change control check rate ・ Handling execution ratio for alarm of

Product Quality					

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
				rate	hardware ・ Software monitoring ratio of other company ・ Misoperation rate
Realizing correct individual authentication.	Security	Authenticity	Authentication	Security in general 【Internal standard】・ Access auditability ・ Data encryption ・ Presence of encryption of transmission data ・ Presence of encryption of accumulated data ・ Key control ・ Access controllability ・ Protectability of data damage ・ Authentication of an entity with control authority ・ Authentication of an entity that does not have control authority ・ Operation limiting degree for the countermeasure on the system ・ Operation limit degree by physical measures ・ Establishment of control rules ・ Acquisition of log ・ Log storage period ・ Illegal monitoring target (device) ・ Illegal monitoring target（Network）・ Illegal monitoring target (intruder・Illegal operation, etc.) ・Checking interval ・ Communication control ・Detection range of unauthorized communication ・ Network convergence measures ・ Reinforcement of countermeasures by secure coding, setting web server, etc ・ PRESENCE OF DEPLOYMENT OF WAP ・ Presence of usage of digital signature ・ Checking interval ・ Presence of in-company regulation, rule, law, guideline, etc. that should be observed ・ Presence of execution of network diagnosis ・ Presence of execution of Web diagnosis ・ Presence of execution of DB diagnosis ・ Risk analysis range	Security in general 【Internal standard】・ Access controllability ・ Protectability of data damage ・ Presence of encryption of transmission data ・ Presence of encryption of accumulated data ・ Key control ・(at inspection)Access controllability ・ Protectability of data damage (at inspection) ・ Authentication of an entity with control authority ・ Authentication of an entity that does not have control authority ・ Operation limiting degree for the countermeasure on the system ・ Operation limit degree by physical measures ・ Establishment of control rules ・ Acquisition of log ・ Log storage period ・ Illegal monitoring target (device) ・ Illegal monitoring target（Network）・ Illegal monitoring target (intruder・Illegal operation, etc.) ・ Checking interval ・ Communication control ・ Detection range of unauthorized communication ・ Network convergence measures ・ Reinforcement of countermeasures by secure coding, setting web server, etc ・ PRESENCE OF DEPLOYMENT OF WAP ・ Presence of usage of digital signature ・ Checking interval ・ Presence of in-company regulation, rule, law, guideline, etc. that should be observed ・ Presence of execution of network diagnosis ・ Presence of execution of Web diagnosis ・ Presence of execution of DB diagnosis ・ Risk analysis range

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics of product that should be considered	
Functionality	Functional completeness, Functional appropriateness
Performance efficiency	Resource utilization
Compatibility	Co-existence
Usability	Learnability, Operability, User error protection, User interface aesthetics, Accessibility
Reliability	Maturity, Availability
Security	Confidentiality, Integrity, Non-repudiation, Accountability
Maintainability	Modularity, Reusability, Analyzability, Modifiability, Testability
Portability	Adaptability, Installability, Replaceability

<<Case Study # 10>>

Outline of example	
Case # : System	10 : Multi player online game system used from mobile/PC
System outline	For carrying out RPG simultaneously in one world by multiple players on mobile or PC using a network (Internet)
Field	Content/information provision (game/anime distribution)
Usage stage of system (business type)	Service business (game/anime distribution)
Utilization stage of system	Entertainment/Game
Related built-in system	Information equipment system for individual, communication terminal equipment system for civilian use
Architecture	Intranet/Internet
System processing form	Batch processing, Dialogue processing/Real time processing, Online transaction processing

Usage Scenario		
Stakeholder	Usage scenario (Use case, Usage method)	Required main functions
Player	Purchasing items used for a game	Purchasing items using e-money (updating e-money balance granting items)
Player	Playing a game	Functions in general that configure each game
Game operator	Determining cause and recovering the error if a problem occurs in a game	Displaying action history of player Recording operation log of system

Quality in use				
①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements	④Used measures *
If satisfaction cannot be provided, the system itself is not used.	Satisfaction	Usefulness	Requirements in general	＜N/A＞
Causing users to use a system continuously.	Satisfaction	Pleasure	Requirements in general	＜N/A＞
Preventing flaming due to negative information against the game in order to eliminate illegal usage of the game.	Freedom from risk	Economic risk mitigation	Requirements in general　(functions related to strength/progress degree of a player, requirements for communication functions in a game in particular)	＜N/A＞

*[Internal standard]: Measures used as in-company standard　*[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics in use that should be considered	
Effectiveness	Effectiveness
Efficiency	Efficiency
Satisfaction	Trust, Comfort
Freedom from risk	Health and safety risk mitigation, Environmental risk mitigation

Product Quality				

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
It occurs frequently that many players simultaneously access functions that need to carry out real time processing.	Performance efficiency	Time behavior	Requirement related to functions in general (functions with high cost such as data updating and data reference in particular).	＜N/A＞	＜N/A＞
Many users use.	Performance efficiency	Resource utilization	Requirements in general	＜N/A＞	＜N/A＞
It will not be used in the first place if it does not suit the needs whether overt or potential.	Usability	Appropriateness recognizability	Requirements in general	＜N/A＞	＜N/A＞
If it is not satisfactory, continuous usage rate drops.	Usability	Learnability	Requirements in general (Requirements related to functions used at start of the game in particular)	＜N/A＞	＜N/A＞
User's needs relate to their interests, so it should be comfortable as a feeling.	Usability	User Interface aesthetics	Requirements in general	＜N/A＞	＜N/A＞

Other quality characteristics and sub characteristics of product that should be considered	
Functional suitability	Functional completeness, Functional correctness, Functional appropriateness
Compatibility	Co-existence, Interoperability
Usability	Operability, User error protection, Accessibility
Reliability	Maturity, Availability, Fault tolerance, Recoverability
Security	Confidentiality, Integrity, Accountability, Authenticity
Maintainability	Modularity, Reusability, Analyzability, Modifiability, Testability

<<Case Study # 11>>

Outline of example	
Case # : System	11 : Various information provision, Registration system
System outline	System for providing various information to a user, requesting to send brochures or entering an event to participate through the Internet
Field	Contents/information provision
Usage stage of system (business type)	General release, Contents
Utilization stage of system	Information provision
Related built-in system	＜N/A＞
Architecture	Intranet/Internet
System processing form	Dialogue processing/Real time processing

Usage Scenario		
Stakeholder	Usage scenario (Use case, Usage method)	Required main functions
User	Searching or referring to desired information by specifying various conditions。	Searching target information accurately and speedily, and returning a quick response (no stress for usage)
User	Storing information of each individual in a system, including search results (bookmark) and booking for participation in an event.	A system should be created firmly so that no personal information leaks
User	Possible to use for 24 hours 365 days except during regular maintenance time zone.	Necessary to form HA composition[15] in order to minimize the risk of inability to provide service

Quality in use				
①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements	④Used measures *
Providing information required by a user (meeting their needs)	Effectiveness	Effectiveness	Displaying the search function, list → detailed data, updating data in a short cycle (provision of latest information, etc.)	【Not internal standard】・ Operation time ・ Reception time ・ Service time ・ Operation ratio
Providing information that sufficiently satisfies a user	Satisfaction	Usefulness	Storage of default search conditions and search results for each usage objective	【Not internal standard】・ User satisfaction
Service (system) is easy to use and convenient for the user.	Satisfaction	Trust	Provision of usability in the regular web system range (manual is not necessary, usable intuitively)	【Not internal standard】・ , recognizability to users ・ Fault notification time
Possible to enjoy using a service (system) (there is a new discovery)	Satisfaction	Pleasure	Provision of information using image or animation, provision of recommended information	＜N/A＞

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics in use that should be considered	
None in particular	

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[15] HA composition: System composition that realizes high availability

Product Quality				

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
It should work properly with no bugs.	Functional suitability	Functional correctness	Trouble occurrence rate n cases/scale or less	＜N/A＞	【Not internal standard】・ Correctness to expectations
Necessary to ensure a response does not make stress in usage.	Performance efficiency	Time behavior	Online response within 3sec.	【Not internal standard】・ Response time	【Not internal standard】・ Response time ・ Response time (mean time till response) ・ Response time (response time ratio in the worst case) ・ Throughput ・ Mean throughput
It should be a service (system) that satisfies the requirements of the user.	Usability	Appropriateness recognizability	Collection and analysis of access log	＜N/A＞	【Want to use; With regard to this, user monitoring is carried out, but quite rarely.　It's better to do it on a regular basis, but it is not easy to do so.】・ Functional definiteness ・ Function understanding level
Possible to use intuitively without referring to a manual or FAQ	Usability	Learnability	Tool chip, operation comment, etc.	＜N/A＞	＜N/A＞
Design and sense of unity of a screen need to be accepted by the user.	Usability	User Interface aesthetics	Design (devising size or type of font, consistency of contents arrangement, etc.), unifying color, etc.	＜N/A＞	【Want to use; With regard to this, user monitoring is carried out, but quite rarely.　It's better to do it on a regular basis, but it is not easy to do so.】・ Attractive mutual effect
Target operation rate of the system is 99.7%.	Reliability	Maturity	System operation rate 99.7%	【Not internal standard】・ Test plan appropriateness	【Not internal standard】・ No. of fault removal ・ Test completeness ・ Fault removal rate 【Want to use】・ Bug density (planned to carry out in the future) ・ Test case density (due to variation in grain size of test case) ・ Trouble density of system test (planned to carry out in the future)
High trouble resistance is required.	Reliability	Fault tolerance	Hardware redundancy (clustering)	＜N/A＞	【Internal standard】・ Redundant (equipment) (for server trouble) ・ Redundant (component) (for server trouble) ・ Redundant (equipment) (for trouble with equipment composing network) ・ Redundant (component) (for trouble with equipment composing network) ・ Redundancy of line ・ Redundancy of route ・ Segment division ・ Redundancy (machine) ・ Redundancy (component) ・ Redundancy (disc) ・Backup method ・ Data recovery range 【Want to use, plan to carry out in the future】・ Recovery policy ・ Disaster handling range
When trouble occurs, it should be recovered within a short time.	Reliability	Recoverability	Trouble recovery within 2 hours	＜N/A＞	【Want to use, plan to carry out in the future】・ Recovery policy ・ Range of agency business operation
Personal information needs to be controlled.	Security	Confidentiality	Controlling access authority, individual authentication	＜N/A＞	＜N/A＞
Unauthorized external access should be blocked and data should be ensured.	Security	Integrity	Monitoring/reporting unauthorized access	＜N/A＞	【Internal standard】・ Illegal monitoring target (device) ・ Illegal monitoring target（Network） ・ Illegal monitoring target (intruder・Illegal operation, etc.) ・ Communication control ・ Detection range of unauthorized communication ・ Network convergence measures ・ Reinforcement of countermeasures by secure coding, setting web server, etc ・ PRESENCE OF DEPLOYMENT OF WAP 【Not internal standard】・ Establishment of control rules ・

Product Quality

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
					Acquisition of log ・ Log storage period

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard

[Want to use]: Measures that are not currently used but desired to be used in the future

Other quality characteristics and sub characteristics of product that should be considered	
Compatibility	Co-existence
Usability	Appropriateness recognizability, Operability, User error protection
Reliability	Availability, Fault tolerance, Recoverability
Security	Authenticity
Maintainability	Modularity, Reusability
Portability	Adaptability

<<Case Study # 12>>

Outline of example	
Case # : System	12 : Educational learning system, Contents control system
System outline	Educational learning system LMS (Learning Management System) and Contents control system CMS (Contents Management System) on the WEB
Field	School/education
Usage stage of system (business type)	Education/Learning supporting b business
Utilization stage of system	Others: Education history control
Related built-in system	Educational equipment, Entertainment equipment system
Architecture	Intranet/Internet
System processing form	Batch processing, Online transaction processing

Usage Scenario		
Stakeholder	Usage scenario (Use case, Usage method)	Required main functions
User	Learning on web	Recording usage status, learning history and true/false result, and indicating the grade report
Controller	Registration of teaching material contents and registration of master data	Adding/changing/deleting teaching material content control function (CMS) and master data
Tutor	Dispatching information to users	Sending mail, adding/changing bulletin board

Quality in use			
①Important needs, risks	②Quality characteristics and sub characteristics	③Quality requirements	④Used measures *
Presenting the progress status of learning and the result correctly to the user. Even if they are used simultaneously, there is a need to give an appropriate response.	Effectiveness / Effectiveness	Learning history function Result aggregation function	【Not internal standard】・ Work effectiveness ・ Work completion degree ・ Mistake frequency ・ Handling time ・ Operation time ・ Reception time ・ Handling time of job usage ・ Operation service time ・ Online system operation ratio
Making a user improve his/her academic ability and maintain continuous will to learn	Satisfaction / Pleasure	Grade display function Bulletin board function	＜N/A＞
Providing service continuously in a manner that the user does not have to discontinue learning and he/she can use it with no stress.	Freedom from risk / Economic risk mitigation	Response requirements Simultaneous connection requirements	【Executed by the customer】・ Return on investment (ROI) ・ Discount cash flow (DCF) ・ Auto measurement of qualitative effect ・ Ratio of overall manufacturing lead time ・ Ratio of lead time for each process ・ No. of delayed delivery cases ・ No. of claims from customer ・ No. of missing items ・ Percentage of revenue from new customers ・ Ratio of revenue from existing customers ・Balance Score Card (BSC) ・ Comparison with other company (benchmark) ・ Opportunity loss ・ Real option ・ IT ASSET INVESTMENT 【Want to use】・ Economic damage、 Software damage
Providing accurate true/false results and grades. Providing an appropriate curriculum.	Context coverage / Context completeness	Teaching material distribution function	【Not internal standard】・ Risk handling range after starting operation ・ Risk measure policy ・ Security patch application range ・ Security patch application policy ・ Security patch application timing 【Want to use】・ Review frequency of security risk ・ Review range of security risk

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard

[Want to use] Measures that are not currently used but desired to be used in the future

Other quality characteristics and sub characteristics in use that should be considered	
Efficiency	Efficiency
Satisfaction	Usefulness, Trust

Product Quality

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
Indicating correct true/false results in order to store the academic results. Distributing and displaying teaching material selected by a user correctly.	Functional suitability	Functional correctness	Result aggregation function Learning history storage function Teaching material distribution function	【Internal standard】・ Correctness of calculation ・ Accuracy ・ Correctness of manual description ・ Density of inspection	【 Internal standard 】 ・ Correctness to expectationsCorrectness of manual descriptionDensity of inspection

【Want to use】・ Correctness of calculation ・ Accuracy |
| A large number of accesses occur in a burst fashion according to the season or time zone, so appropriate response needs be made. | performance efficiency | Time behavior | Time from receiving a request from a terminal to returning the service processing result should be within 5sec. | 【Not internal standard】・ Response time ・ Throughput ・ Turn around time ・ Response observance ratio at normal times (when online system is used) ・ Response observance ratio at peak (when online system is used) ・ Response observance degree at normal times (when batch system is used) ・ Response observance degree at peak (when batch system is used) ・ Provision business | 【Internal standard】・ Throughput ・ Processing method monitoring・Preparation time (average)

【Not internal standard】・ Response time ・ Response time (mean time till response) ・ Throughput at max. load ・ Response observance ratio at normal times (when online system is used) ・ Response observance ratio at peak (when online system is used) ・ Response observance degree at normal times (when batch system is used) ・ Response observance degree at peak (when batch system is used) ・ Provision business |
| Distributing an appropriate teaching material according to information from CRM. | Compatibility | Interoperability | Data link function Mail transmission function Point exchange function User information linking function | 【Not internal standard】・ Data exchangeability based on data formatInterface consistency (protocol) | 【Not internal standard】・ Data exchangeability based on data format ・Data exchangeability based on frequency of successful attempts by a user ・ Ease of connection with other system |
| A user can use a server whenever he/she wants. | Reliability | Maturity | System is operated 24 hours 365 days.   However, the time when maintenance is performed is excluded from the target. | 【Internal standard】・ ・Fault detection ・ No. of fault removal ・ Test plan appropriateness ・ Missing rate ・ Review indication density ・ Number of review indication cases ・ Bug density ・ Test case density ・ Test density ・ Fault discovery rate ・ Fault occurrence density

【Not internal standard】・ Test coverage ratio | 【Internal standard】・ No. of fault removal ・ Mean Time Between Failure ・ Test completeness ・ Test maturity ・ Missing rate ・ Review indication density ・ Number of review indication cases ・ Bug density ・ Test case density ・ Test density ・ Fault discovery rate ・ Fault occurrence density |
| Disabling the use of teaching materials for E learning if not a proper user. Only users themselves are | Security | Confidentiality | Personal information protection should be considered. Teaching material distribution | 【Not internal standard】・ Access auditability ・ Data encryption ・ Presence of encryption of accumulated data ・ Key control | 【Not internal standard】・ Access auditability ・ Presence of encryption of transmission data ・ Presence of encryption of accumulated data ・ Key control |

Product Quality				
①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
allowed to inquire about grades and refer to learning history.			function Member authentication function Contents control function		

*[Internal standard]: Measures used as in-company standard   *[Not internal standard]: Measures used at the site as other than in-company standard   [Want to use] Measures that are not currently used but desired to be

used in the future

Other quality characteristics and sub characteristics of product that should be considered	
Functional suitability	Functional completeness
Performance efficiency	Resource utilization
Usability	Learnability, Operability, User Interface aesthetics
Reliability	Recoverability
Maintainability	Reusability
Portability	Adaptability

<<Case Study # 13>>

Outline of example

Case # : System	13 : Built-in design supporting tool
System outline	Assistant tool for designing/implementing built-in software
Field	Development tool: Built-in software development
Usage stage of system (business type)	Manufacturing business
Utilization stage of system	Technology/control
Related built-in system	Business use terminal equipment system
Architecture	Stand alone
System processing form	Dialogue processing/Real time processing

Usage Scenario

Stakeholder	Usage scenario (Use case, Usage method)	Required main functions
Built in developer	Analyzing based on software requirements and extracting software component	Allocating software component Associating data and timing flow between software components
Built in developer	Registering reusable software component with DB	Selecting software component Registering with DB Deleting from DB as necessary
Built in developer	Designing using software component registered with DB	Searching for software components in DB Taking out software components and reallocating them

Quality in use

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements	④Used measures *
If design information is not recorded or restored correctly, the target software for development cannot be designed properly.	Effectiveness	Functional completeness	All drawing information is restored properly.	＜N/A＞
Because a new design technique is used, the advantage of using the technique itself can be understood.	Satisfaction	Pleasure	Improvement of reusability of target software for development	＜N/A＞
Even in a situation where PC environment cannot be specified completely, it works with satisfactory performance.	Context coverage	Context completeness	Not limiting action of other applications. Not locking OSs.	＜N/A＞

*[Internal standard]: Measures used as in-company standard *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics in use that should be considered

Efficiency	Efficiency
Satisfaction	Usefulness, Trust
Freedom from risk	Environmental risk mitigation

Context coverage	Flexibility

Product Quality

①Important needs, risks	②Quality characteristics and sub characteristics		③Quality requirements Up to unit test	④Used measures *	
				Up to unit test	After combined test
Design result can be saved and reproduced.	Functional suitability	Functional correctness	Displaying previous data correctly at finish→starting application	＜N/A＞	【Internal standard】・ Correctness to expectations ・ Correctness of manual description
It is a drawing tool, so it displays drawing with no stress without disturbing the human thought process.	Performance efficiency	Time behavior	Drawing should be within 0.3s.	＜N/A＞	【Internal standard】・ Response time ・ Throughput at max. load ・ Turn around time 【Not internal standard】・ Response time (response time ratio in the worst case) ・ Turn around time (turn around time ratio in the worst case) ・ Processing time
Action of other applications is not disturbed because other Windows applications are operated at the same time in most cases.	Compatibility	Co-existence	OS should not be locked. No apparent stoppage of other applications	＜N/A＞	【Not internal standard】・ Usable co-existence
Avoid making operation or appearance complicated as a design tool.	Usability	User Interface aesthetics	Making as simple as possible and menu should be up to 2 hierarchies.	＜N/A＞	【Not internal standard】・ Attractive mutual effect
Facilitate change of tool	Maintainability	Modularity	Module combining degree	＜N/A＞	＜N/A＞

*[Internal standard]: Measures used as in-company standard *[Not internal standard]: Measures used at the site as other than in-company standard

Other quality characteristics and sub characteristics of product that should be considered	
Functional suitability	Functional completeness, Functional appropriateness
Usability	Learnability, Operability, User error protection
Reliability	Maturity, Availability, Recoverability
Security	Confidentiality, Authenticity
Maintainability	Reusability, Analyzability, Modifiability, Testability
Portability	Adaptability

AppendixC : Creation Process of Measures Set

Investigation was made into the measure set for each quality sub characteristics based on the candidates specified through the case studies and the candidates specified by WG members. The following is the concrete procedure.
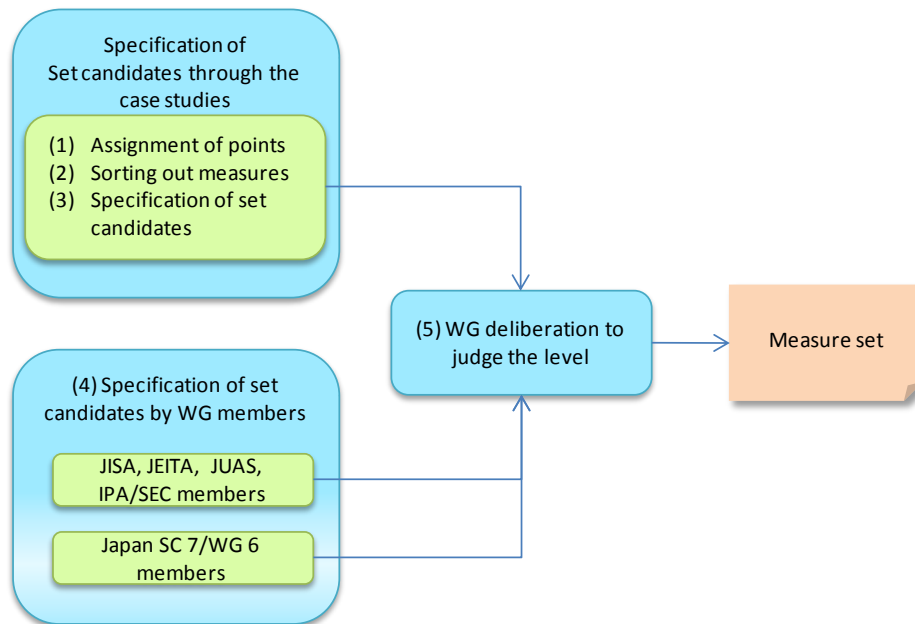

Fig. C-1 Creation flow of measure set

(1) Assignment of points

As a usage status of each metric, we calculated the points as weighted average considering a reply of "in-company standard use" as 3 points, a reply of "use out of in-company standard" as 2 points and a reply of "desire to use" as 1 point. For measures related to quality characteristics of product, we calculated weighted average up to a unit test (equivalent to internal measure) and after combined test (equivalent to external measure) and calculated the total of both figures.

(E.g.)

When a reply is given for functional completeness of function implementation after combined test as "using in the in-company standard" (3 replies), "using in other than in-company standard" (2 replies) and "not using but desiring to use in the future" (1 reply);

Calculation of points: ((3 cases x 3 points)＋ (2 cases x 2 points)＋ (1 case x 1 point))/6＝2.33 (points)

Table C-1 Example of assignment of points

Measure	Up to unit test				After combined test				Total points
	Use in in-company standard	Independent use	Desired to use	Point	Use in in-company standard	Independent use	Desired to use	point	
Functional completeness of function implementation	0	0	0	0	3	2	1	2.33	**2.33**

(2) Sorting of measures for each quality sub characteristic

We sorted measures in descending order of total points, and gathered measures for which measuring targets are similar in descending order from the measures at higher position in order to group them.

(3) Specification of set candidates through research on examples

We determined the parts with high points as the measure set candidates through research on examples for each quality characteristic using the values with large point differences as thresholds.

(4) Specification of set candidates by WG members

WG members were separated into those associated with ISO/IEC JTC1 SC 7/WG 6 and other members, they determined target quality characteristics for investigation respectively and collected opinions whether each measure of quality characteristics should be candidates for measure set or not. The following table shows the areas of responsibility

Table C-2 Responsibility for investigation targets

In charge		Investigation target		
IPA/SEC	WG6 (1)	Reliability	Security	—
JEITA	WG6 (2)	Compatibility	Usability	Maintainability
JISA	WG6 (3)	Functional suitability	Performance efficiency	Portability
JUAS	WG6 (4)	Quality in use	—	—

(5) Level judgment

The levels for each metric were determined as follows according to knowledge of members and result of research on examples.

Table C-3 Level judgment

Level	Member (IPA/SEC, JEITA, JISA, JUAS)	Member (WG6)	Example research	Meaning
1	X	X	X	Can be specified as a candidate in all cases
2	X	X		Can be specified as a candidate except as a result of example research
3	(X)	(X)	X	Can be specified as a candidate by example research and either of members in charge
4	(X)	(X)	(X)	Only 1 case can be specified as a candidate

X: Specify as a candidate, (X): Specify as a candidate by one of sections in charge shown in (　)

We created a measure set plan considering level 1 and 2 as the measures recommended in particular for use and level 3 and 4 are the measures recommended for use, and completed the final measure set through discussion inside the WG.

AppendixD : Bibliography

[1]   JIS X 25000: 2010 Quality requirements and evaluation of software product (SQuaRE) －SQuaRE guideline

      Note) Supporting international standard   ISO/IEC 25000:2005 Software engineering – Software product Quality Requirements and Evaluation (SQuaRE) –Guide to SQuaRE

[2]   ISO/IEC 25010:2011 Systems and software engineering – Systems and software product Quality Requirements and Evaluation   (SQuaRE) – System and software quality models

      Note) It is a succession standard of [3].

[3]   ISO/IEC 9126-1:2001 Software engineering -- Product quality -- Part 1: Quality model

[4]   ISO/IEC 25040:2011 Systems and software engineering -- Systems and software Quality Requirements and Evaluation   (SQuaRE) -- Evaluation process

      Note) it is a succession standard of a supporting international standard of [5]

[5]   JIS X 0133-1 : 1999   Evaluation of software product – Part 1: General overview, Japanese Standards Association

      Note) Supporting international standard ISO/IEC 14598-1:1998 Information technology -- Software product evaluation -- Part 1: General overview

[6]   JIS X 0141 : 2009   System and software technology – Measuring process, Japanese Standards Association

      Note) Supporting international standard ISO/IEC 15939:2007 Systems and software engineering -- Measurement process

[7]   TS X 0111-2 : 2009 Quality of software product – Part 2: External metrics by JIS X 0129-1 Software engineering-Product quality-Part 2: External metrics, Japanese Standards Association
      Note) Supporting international standard ISO/IEC TR 9126-2:2003 Software engineering -- Product quality -- Part 2: External metrics

[8]   TS X 0111-3 : 2009 Quality of software product – Part 3: Internal metrics by JIS X 0129-1 Software engineering-Product quality-Part 3: Internal metrics, Japanese Standards Association
      Note) Supporting international standard ISO/IEC TR 9126-3:2003 Software engineering -- Product quality -- Part 3: Internal metrics

[9]   TS X 0111-4 : 2009 Quality of software product – Part 4: Quality measurement method in use by JIS X 0129-1   Software engineering-Product quality-Part 4: Quality in use metrics, Japanese Standards Association

      Note) Supporting international standard ISO/IEC TR 9126-4:2004 Software engineering -- Product quality -- Part 4: Quality in use metrics

[10] Guide for visualization, ensuring and improvement of system and software product, Ministry of Economy, Industry and Trade   Software Metrics Advanced Project   Product Quality Metrics WG,

2010

[11] Nonfunctional requirement grade　List of items related to nonfunctional requirement of system infrastructure, Information-Technology Promotion Agency, Japan　Software Engineering Center, 2010

[12] Important Infrastructure Information System Reliability Council Report,　Information-Technology Promotion Agency, Japan　Software Engineering Center, 2009

[13] User Vender Collaboration Research Project II Report "Nonfunctional Requirement Specification Definition Guideline", Ministry Economy, Trade and Industry - Information Service Industry Div., NTT Data Institute of Management Consulting, Inc., Japan Users Association of Information Systems, 2008

[14] SLA Guideline of IT system for private sectors 3rd edition,　Japan Electronics and Information Technology Industries Association,　Solution Service Business Committee, 2006

[15] Quality Manufacturing Guide for built-in system development: ESQR, Information-Technology Promotion Agency, Japan　Software Engineering Center, 2008