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Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Evaluation guide for developers, acquirers and independent evaluators

Ingénierie des systèmes et du logiciel — Exigences de qualité et évaluation des systèmes et du logiciel (SQuaRE) — Guide d'évaluation pour les développeurs, les acquéreurs et les évaluateurs indépendants

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 25041 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*.

This first edition of ISO/IEC 25041 cancels and replaces ISO/IEC 14598-3:2000, ISO/IEC 14598-4:1999 and ISO/IEC 14598-5:1998.

Introduction

As the use of information technology grows, the number of critical systems also grows. Such systems include, for example, security critical, life critical, economically critical and safety critical systems. The quality of systems and software product of such critical systems is particularly important because software faults may lead to serious consequences.

Evaluation is the systematic determination of the extent to which an entity meets its specified criteria. The evaluation of product quality is vital to both the acquisition and development of software. The relative importance of the various characteristics of software quality depends on the intended usage or objectives of the system of which the software is a part; products need to be evaluated to decide whether relevant quality characteristics meet the requirements of the system.

This International Standard is part of the ISO/IEC 250nn SQuaRE series of standards. ISO/IEC 25040 contains general requirements and recommendations for product quality evaluation as well as associated general concepts. This International Standard provides specific issues related to the developers, acquirers and independent evaluators based on ISO/IEC 25040.

The general goal of creating the SQuaRE set of standards is to move to a logically organized, enriched and unified series covering two main processes: software quality requirements specification and software quality evaluation, supported by a software quality measurement process. The purpose of the SQuaRE set of standards is to assist those developing and acquiring products with the specification and evaluation of quality requirements. It establishes criteria for the specification of product quality requirements, their measurement, and evaluation. It includes a quality model for aligning customer definitions of quality with properties of the development process. In addition, the series provides recommended measures of product properties that can be used by developers, acquirers, and independent evaluators.

SQuaRE provides:

- terms and definitions;
- reference models;
- general guide;
- individual division guides, and
- standards for requirements specification, planning and management, measurement and evaluation purposes.

SQuaRE includes International Standards on quality modes and measures, as well as on quality requirements and evaluation.

SQuaRE replaces the current ISO/IEC 9126 series and the ISO/IEC 14598 series.

The SQuaRE series of standards consists of the following divisions under the general title *Systems and software Quality Requirements and Evaluation*:

- ISO/IEC 2500n - *Quality Management Division*,
- ISO/IEC 2501n - *Quality Model Division*,
- ISO/IEC 2502n - *Quality Measurement Division*,

- ISO/IEC 2503n - *Quality Requirements Division*, and
- ISO/IEC 2504n - *Quality Evaluation Division*.

This International Standard is intended to be used in conjunction with the other parts of the SQuaRE series of standards, and with the ISO/IEC 14598 series and ISO/IEC 9126 series until superseded by the ISO/IEC 250nn series of standards.

The descriptions in this International Standard are mainly based on the descriptions in ISO/IEC 14598-3, ISO/IEC 14598-4, and ISO/IEC 14598-5, which will be replaced by this International Standard.

Figure 1 illustrates the organization of the SQuaRE series representing families of standards, further called Divisions.

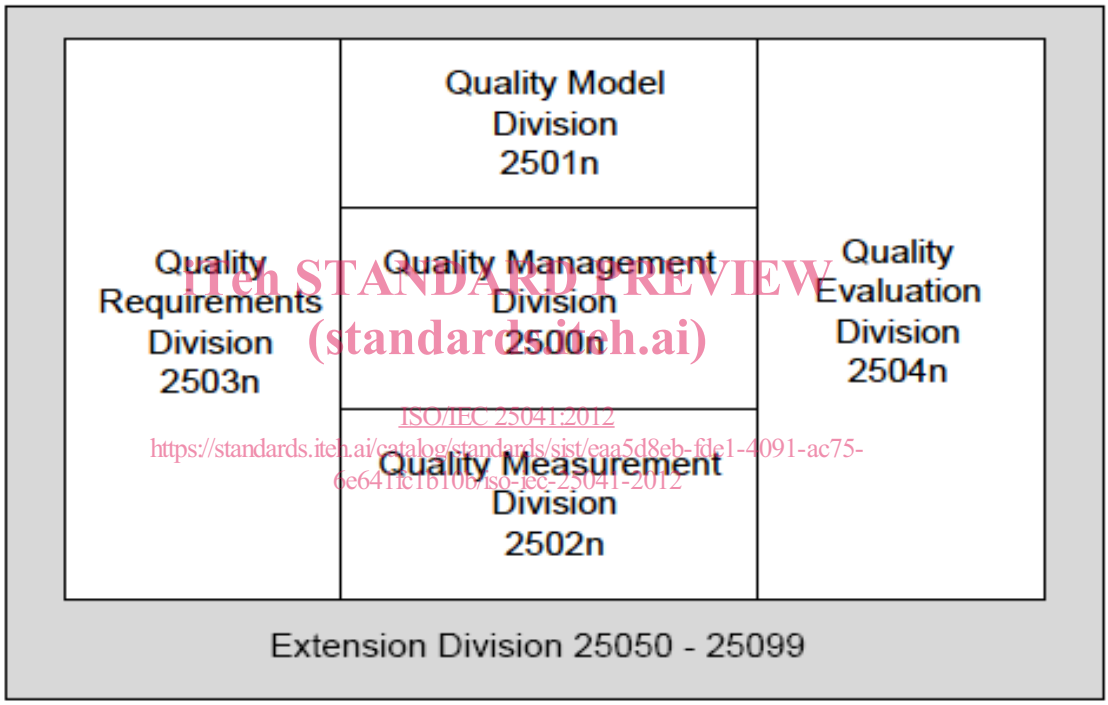

Figure 1—Organization of SQuaRE series of International Standards

The Divisions within the SQuaRE model are:

·**ISO/IEC 2500n - Quality Management Division**. The International Standards that form this division define all common models, terms and definitions referred to by all other standards from the SQuaRE series. Referring paths (guidance through SQuaRE documents) and high level practical suggestions in applying proper standards to specific application cases offer help to all types of users. The division also provides requirements and guidance for a supporting function which is responsible for the management of product requirements specification and evaluation.

·**ISO/IEC 2501n - Quality Model Division**. The International Standard that forms this division presents detailed quality models for software, quality in use and data. Practical guidance on the use of the quality model is also provided.

·**ISO/IEC 2502n - Quality Measurement Division**. The International Standards that form this division include a product quality measurement reference model, mathematical definitions of quality measures, and practical

guidance for their application. This division presents internal measures of software quality, external measures of software product quality and quality in use measures. Measurement primitives forming foundations for the latter measures are defined and presented.

· **ISO/IEC 2503n - Quality Requirements Division**. The International Standard that forms this division helps specifying quality requirements. These quality requirements can be used in the process of quality requirements elicitation for a product to be developed or as inputs for an evaluation process. The requirements definition process is mapped to technical processes defined in ISO/IEC 15288:2008.

· **ISO/IEC 2504n - Quality Evaluation Division**. The International Standards that form this division provide requirements, recommendations and guidelines for product evaluation, whether performed by independent evaluators, acquirers or developers. The support for documenting a measure as an Evaluation Module is also presented.

ISO/IEC 25050 to ISO/IEC 25099 are reserved to be used for SQuaRE extension International Standards and/or Technical Reports.

This International Standard is part of the 2504n - Quality Evaluation Division that currently consists of the following International Standards:

· **ISO/IEC 25040 - Evaluation process**: contains general requirements for specification and evaluation of software quality and clarifies the general concepts. It provides a process description for evaluating quality of product and states the requirements for the application of this process. The evaluation process is the basis for product quality evaluation for different purposes and approaches. Therefore the process can be used for the evaluation of quality in use, the external measure of software product quality and the internal measure of software product quality, as well as for the evaluation of the quality of pre-developed software product or custom software product during its development process.

· **ISO/IEC 25041 - Evaluation guide for developers, acquirers and independent evaluators**: contains specific requirements and recommendations for developers, acquirers and independent evaluators.

· **ISO/IEC 25045 - Evaluation module for recoverability:** provides the specification to evaluate the subcharacteristics of recoverability defined under the characteristic of reliability of the quality model. It determines the external measures of software product quality of resiliency and autonomic recovery index when the information system composed of one or more software products' execution transactions is subjected to a series of disturbances. A disturbance could be an operational fault (e.g. an abrupt shutdown of an OS process that brings down a system) or an event (e.g. a significant increase of users to the system).

ISO/IEC 25040 is a revised version and replaces ISO/IEC 14598-1.

ISO/IEC 25041 is a revised version and replaces ISO/IEC 14598-3, ISO/IEC 14598-4 and ISO/IEC 14598-5.

The term "product" is used as a simplified term for "systems and software product" throughout this International Standard.

The term "evaluation process" is used as a simplified term for "product quality evaluation process" throughout this International Standard.

The term "evaluation report" is used as a simplified term for "product quality evaluation report" and the term "evaluation plan" is used as a simplified term for "product quality evaluation plan" throughout this International Standard.

Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Evaluation guide for developers, acquirers and independent evaluators

1 Scope

This International Standard provides requirements, recommendations and guidelines for product quality evaluation specifically for developers, acquirers and independent evaluators. It is not restricted to any specific application area and can be used for quality evaluation of any type of products.

This International Standard provides a process description for evaluating product quality and states the specific requirements for the application of the evaluation process from the viewpoint of developers, acquirers and independent evaluators. The evaluation process can be used for different purposes and approaches. The process can be used for the evaluation of the quality of pre-developed software, commercial-off-the-shelf software or custom software and can be used during or after the development process.

This International Standard is intended for those who are responsible for product quality evaluation and is appropriate for developers, acquirers and independent evaluators of products.

This International Standard is not intended for evaluation of other aspects of products (functional requirements, process requirements, business requirements, etc.).

2 Conformance

Evaluation of product quality conforms to this International Standard if developers conform to requirements of Clauses 6 and 7, if acquirers conform to requirements of Clauses 6 and 8, and if independent evaluators conform to requirements of Clauses 6 and 9.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 25000, *Software Engineering — Software product Quality Requirements and Evaluation (SQuaRE) — Guide to SQuaRE*

ISO/IEC 25001, *Software engineering — Software product Quality Requirements and Evaluation (SQuaRE) — Planning and management*

ISO/IEC 25030, *Software engineering — Software product Quality Requirements and Evaluation (SQuaRE) — Quality requirements*

ISO/IEC 25040, *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Evaluation process*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 25000 and the following apply.

4.1
deliverable product
any unique and verifiable system or software product to perform a service, that is subject to approval by the project sponsor or customer

4.2
dynamic product
system or software product that is measurable during execution in testing and/or operational environment

4.3
evaluation
systematic determination of the extent to which an entity meets its specified criteria

[ISO/IEC 12207:2008]

4.4
evaluation level
rigour to be applied during the evaluation that defines the depth or thoroughness of the evaluation in terms of evaluation techniques to be applied and evaluation results to be achieved

4.5
evaluation records
documented objective evidence of all activities performed and of all results achieved within the evaluation process

4.6
evaluation requester
person or organization that requests an evaluation

4.7
evaluation tool
instrument that can be used during evaluation to collect data, to perform interpretation of data or to automate part of the evaluation

NOTE Examples of such tools are source code analysers to compute code metrics, CASE tools to produce formalized models, test environment to run the executable programs, checklists to collect inspection data or spreadsheets to produce syntheses of measures.

4.8
evaluation stringency
degree required for the product quality characteristics and subcharacteristics to fulfil the expected use criticality of the product

4.9
independent evaluator
individual or organization that performs an evaluation independently from developers and acquirers

NOTE The individual or organization who performs as developer or acquirer for the target system to be evaluated may not become the independent evaluator for the system. The independent evaluator may be an organization. The independent evaluator may belong to the same organization as the developer as long as they are independent from developers and acquirers.

4.10
intermediate product
system or software product of the development process that is used as inputs to other stages of the development process

4.11
product quality
degree to which the product satisfies stated and implied needs when used under specified conditions

NOTE This definition differs from the ISO 9000:2005 quality definition because the software quality definition refers to the satisfaction of stated and implied needs, while the ISO 9000 quality definition refers to the satisfaction of requirements.

[ISO/IEC 25000:2005 definition, rephrased as “degree to which”]

4.12
static product
non-executable system or software product for reviewing

5 Concept of evaluation from the viewpoint of each role

5.1 Framework of the product quality evaluation from the perspective of each role

Developers, acquirers and independent evaluators perform different activities during system product quality evaluation according to each specific role and the category of the evaluation target entity.

Basically, product quality evaluation process of each role is the same, but the target entity of evaluation is different according to purposes of the evaluation depending on the requester’s needs.

Figure 2 is the general framework of the product quality evaluation process.

Product quality evaluation is regarded as a system, which is composed of inputs for, outcomes of, constraints and resources of the evaluation process. They are different for each role and evaluations purpose.

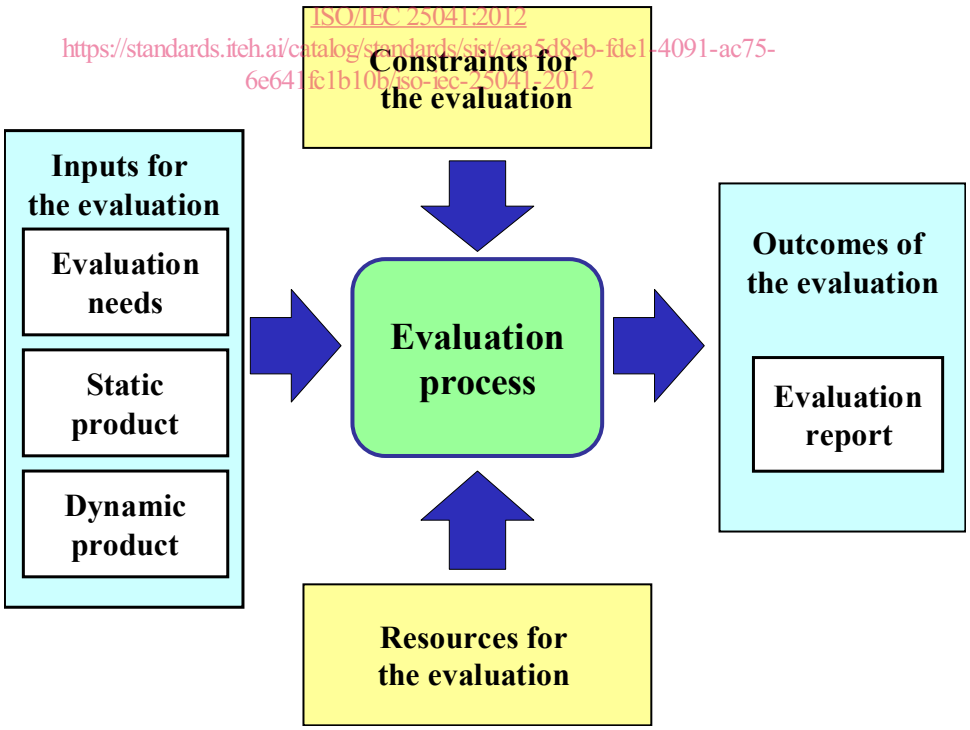

Figure 2 — General framework of the product quality evaluation process

The following are the examples of inputs for and outcomes of an evaluation process.

Inputs for the evaluation process:
-evaluation needs for developers, acquirers and independent evaluators;
-target entities of evaluation such as static products and dynamic products.

NOTE Product quality evaluation needs of each stakeholder, such as developers, acquirers and independent evaluators, are decided from the viewpoint of each role.

Outcomes of the evaluation are the evaluation report, results of improvement of the evaluation process and profit.

In this figure, SQuaRE (ISO/IEC 25010, ISO/IEC 25020, ISO/IEC 2502n, ISO/IEC 25030, ISO/IEC 2504n) are included as resources for the evaluation.

Constraints for the product quality evaluation process can include the following:

a) specific user needs for the evaluation;

b) the evaluation project schedule;

c) the evaluation project budget;

d) the environment used for the evaluation project;

e) the tools and the methods used for the evaluation project;

f) specific requirements for reporting of the evaluation.

Resources for the product quality evaluation process can include the following:

a) applicable measurement tools and method;

b) applicable SQuaRE series of international standard;

c) human resources used for the evaluation;

d) financial resources used for the evaluation;

e) information systems used for the evaluation;

f) knowledge data base used for the quality evaluation.

The software product quality evaluation reference model can be applicable to those responsible for product quality evaluation. It is intended and appropriate for such organizations, in their role, but not limited to, developers, acquirers and independent evaluators.

Product quality evaluation can be performed during or after the development process or acquisition process.

5.2 Target entity of software product quality evaluation

The evaluation purpose is different depending on the role of developers, acquirers and independent evaluators.

The target entity of the evaluation is defined depending on the evaluation purpose.

The target entity of the evaluation is categorized as static products and dynamic products.

Static products, which are either intermediate products or deliverable products, can include the following:
-specification of quality requirements;
-software design specifications;
-program source codes;

-specification of the test planning;
-specification of result of the testing report;
-explanation of the product;
-operation manuals.

Dynamic products can include the following:
-executable intermediate products, which are being executed during dynamic testing in a testing environment;
-deliverable products, which are being executed during operation by an operational environment.

Developers review static products at each development stage of the software life cycle, such as design stage, implementation stage and testing stage in order to evaluate quality of the intermediate product to achieve its role.

Developers test intermediate dynamic products during unit testing stage and deliverable dynamic products during system integration testing stage.

NOTE 1 The target entities of the evaluation according to the developer's viewpoint are static and dynamic intermediate and/or deliverable products.

Acquirers review the static products at the design stage and testing stage for the purpose of product acquisition in order to achieve their role.

Acquirers test the dynamic product at the acceptance or operational testing stage.

Acquirers evaluate both the static and dynamic products in order to compare the quality of some candidate products and to select the higher quality product based on their role.

NOTE 2 The target entities of the evaluation according to the acquirer's viewpoint are static and dynamic intermediate and/or deliverable products.

Independent evaluators may review the static products and test the dynamic products in order to evaluate the quality of the product and make an evaluation report based on their contract with the quality evaluation requesters.

NOTE 3 The target entities of the evaluation according to the independent evaluator's viewpoint are static and dynamic intermediate and/or deliverable products based on the contract with requesters.

Table 1 — Example of target entity of each role

Role	Target entity of the evaluation	
	Static product	Dynamic product
Developers	Intermediate and deliverable products for reviewing	Intermediate and deliverable products for testing
Acquirers	Quality requirements and design documents for reviewing deliverable product	Deliverable products for selection and acceptance
Independent Evaluators	Intermediate or deliverable products for reviewing	Intermediate or deliverable products for testing

Every kind of evaluation activities can be performed from the viewpoint of both static and dynamic product quality evaluation based on the role of developers, acquirers and independent evaluators according to their purpose of evaluation.

5.3 Roles and responsibilities

5.3.1 Roles and responsibilities of developers

.Responsibility of developers concerning product quality evaluation can include the following:

-to assure the quality of developed deliverable product;
-to accept the custom-made software product with a required quality from subcontractors;
-to select suitable off-the-shelf software product with a required quality from vendors;
-to improve the productivity of testing process;
-to train the personnel for product quality evaluation.

When implementing a custom-made software product, developers evaluate the intermediate and deliverable products in order to ensure the quality of the developed software product including the following:
-quality requirements documents in the early stages of development;
-intermediate products, such as design documents and program source codes during implementation;
-deliverable software products that are included in the target system during testing.

When buying an off-the-shelf software product in order to adapt it to the deliverable system, developers evaluate and compare the candidate products, then select a product that satisfies the required quality.

Developers can use the results of product quality evaluation to ensure that products meet required quality criteria, which can be set by the acquirers, or by comparison with other products.

5.3.2 Roles and responsibilities of acquirers

Responsibility of acquirers in charge of quality evaluation includes the following:

-to accept the custom-made software products that satisfy quality requirements;
-to select an off-the-shelf software product of acceptable quality;
-to improve the effectiveness of dynamic products included in the operational target system;
-to improve the productivity of the acquisition process;
-to train the personnel for quality evaluation.

When acquiring a custom-made software product, acquirers evaluate the intermediate or deliverable products in order to ensure the quality of the acquired product.

When acquiring a custom-made software product, acquirers establish quality in use requirements, product quality requirements, specify the requirements to the supplier, and evaluate potential suppliers against these requirements before acquisition.

When acquiring a custom-made software product, the objective of specifying the quality requirements is to ensure that the product meets the stated and implied needs of the users. Possible activities include:

-to review the design documents before requesting a software development;
-to review and test the deliverable products before accepting a custom-made software product.

When acquiring an off-the-shelf software product, acquirers evaluate the candidate deliverable products in order to compare and select the product.

When acquiring an off-the-shelf software product, evaluation can be used to compare the alternative products and to ensure that the selected product meets the quality requirements. Possible activities include the following:

-to review the documents of deliverable products before selecting the product to be acquired;
-to test the deliverable products in order to select the product to be acquired that best fit the quality requirements.

In the acceptance testing stage, acquirers test the products in order to accept a high quality product.

When improving an operational product included in a target system, acquirers evaluate the dynamic product in order to improve the quality of the product. Possible activities include:

-to review the quality of static deliverable product during operation stage;
-to test the quality of dynamic deliverable product during operation stage.

When evaluating an operational product included in a target system, the product is tested and measured by using quality in use measures.

NOTE 1 The operator can be a part of acquirers. The individual or organization, which operates a target system of which the product is a part, can perform software product quality evaluation to validate that the product meets the quality requirements under variable operating conditions, and to specify needs for changes to those responsible for maintenance.

NOTE 2 The maintainer can be a part of acquirers. An individual or an organization, who maintains a target system of which the product is a part, can perform software evaluation to validate whether the product quality still meet quality requirements, and especially requirements for maintainability and portability.

5.3.3 Roles and responsibilities of independent evaluators

Responsibilities of independent evaluators are defined by the contract with the requesters.

The evaluation process can be performed from the viewpoint of either developers or acquirers.

Responsibility of independent evaluators concerning quality evaluation can include the following:

-to evaluate the target product based on the contract with requesters;
-to assure the quality of the product quality evaluation report;
-to improve the quality of the evaluation result;
-to improve the productivity of the evaluation process;
-to improve information systems, which support the quality evaluation process;
-to train the personnel for evaluation.

The independent evaluators review the scope of evaluation based on the contract before performing the evaluation and provide the suitable solution and environment for evaluation.

When evaluating a target product, the independent evaluators evaluate the intermediate or deliverable products in order to ensure the product quality.

This evaluation can be performed by the request from developers, acquirers or some other parties.

6 Organization level requirements and recommendations for software product quality evaluation

6.1 General requirements and recommendations

The software product quality evaluation process reference model describes the process and details the activities and tasks providing their purposes and complementary information that can be used to guide a product quality evaluation (see ISO/IEC 25040).

It is appropriate for organizations in their role as developers, acquirers and independent evaluators.

It is intended but not limited to, developers, acquirers and independent evaluators of products.

The software product quality evaluation process reference model intends that the evaluation should be based on a product quality requirements specification by using ISO/IEC 25030 before the evaluation and making clear the objectives and criteria for evaluations. Product quality requirements express the user's needs for the product under consideration, and are defined prior to the development (see ISO/IEC 25030).