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Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models

Ingénierie des systèmes et du logiciel — Exigences de qualité et évaluation des systèmes et du logiciel (SQuaRE) — Modèles de qualité du système et du logiciel

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
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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 25010 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 25010 cancels and replaces ISO/IEC 9126-1:2001, which has been technically revised.

ISO/IEC 25010 is a part of the SQuaRE series of International Standards, which consists of the following divisions:

- Quality Management Division (ISO/IEC 2500n),
- Quality Model Division (ISO/IEC 2501n),
- Quality Measurement Division (ISO/IEC 2502n),
- Quality Requirements Division (ISO/IEC 2503n),
- Quality Evaluation Division (ISO/IEC 2504n),
- SQuaRE Extension Division (ISO/IEC 25050 – ISO/IEC 25099).

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Introduction

Software products and software-intensive computer systems are increasingly used to perform a wide variety of business and personal functions. Realization of goals and objectives for personal satisfaction, business success and/or human safety relies on high-quality software and systems. High-quality software products and software-intensive computer systems are essential to provide value, and avoid potential negative consequences, for the stakeholders.

Software products and software-intensive computer systems have many stakeholders including those who develop, acquire, use, or who are customers of businesses using software-intensive computer systems. Comprehensive specification and evaluation of the quality of software and software-intensive computer systems is a key factor in ensuring value to stakeholders. This can be achieved by defining the necessary and desired quality characteristics associated with the stakeholders' goals and objectives for the system. This includes quality characteristics related to the software system and data as well as the impact the system has on its stakeholders. It is important that the quality characteristics are specified, measured, and evaluated whenever possible using validated or widely accepted measures and measurement methods. The quality models in this International Standard can be used to identify relevant quality characteristics that can be further used to establish requirements, their criteria for satisfaction and the corresponding measures.

This International Standard is derived from ISO/IEC 9126:1991, *Software engineering — Product quality*, which was developed to support these needs. It defined six quality characteristics and described a software product evaluation process model.

ISO/IEC 9126:1991 was replaced by two related multipart standards: ISO/IEC 9126, *Software engineering — Product quality* and ISO/IEC 14598, *Software engineering — Product evaluation*.

This International Standard revises ISO/IEC 9126-1:2001, and incorporates the same software quality characteristics with some amendments.

- The scope of the quality models has been extended to include computer systems, and quality in use from a system perspective.
- Context coverage has been added as a quality in use characteristic, with subcharacteristics *context completeness* and *flexibility*.
- *Security* has been added as a characteristic, rather than a subcharacteristic of functionality, with subcharacteristics *confidentiality*, *integrity*, *non-repudiation*, *accountability* and *authenticity*.
- C*ompatibility* (including *interoperability* and *co-existence)* has been added as a characteristic.
- The following subcharacteristics have been added: *functional completeness, capacity, user error protection, accessibility, availability, modularity* and *reusability*.
- The compliance subcharacteristics have been removed, as compliance with laws and regulations is part of overall system requirements, rather than specifically part of quality.
- The internal and external quality models have been combined as the product quality model.
- When appropriate, generic definitions have been adopted, rather than using software-specific definitions.
- Several characteristics and subcharacteristics have been given more accurate names.

Full details of the changes are in Annex A.

This International Standard is intended to be used in conjunction with the other parts of the SQuaRE series of International Standards (ISO/IEC 25000 to ISO/IEC 25099), and with ISO/IEC 14598 until superseded by the ISO/IEC 2504n series of International Standards.

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Figure 1 (adapted from ISO/IEC 25000) illustrates the organization of the SQuaRE series representing families of standards, further called divisions.

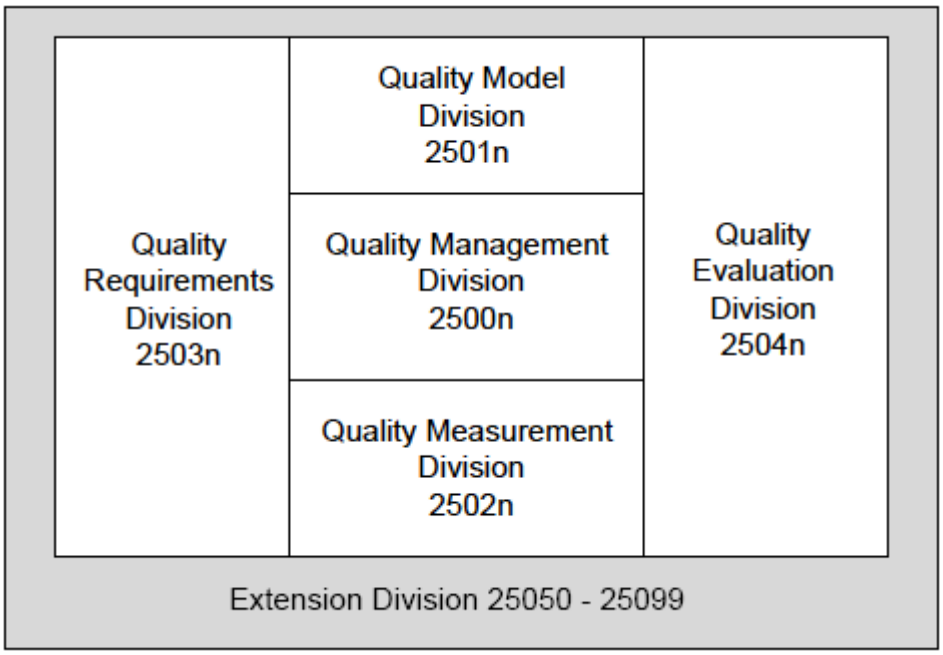

Figure 1 — Organization of SQuaRE series of International Standards

The divisions within the SQuaRE series are:

- **ISO/IEC 2500n - Quality Management Division**. The International Standards that form this division define all common models, terms and definitions further referred to by all other International Standards from the SQuaRE series. The division also provides requirements and guidance for a supporting function that is responsible for the management of the requirements, specification and evaluation of software product quality.

- **ISO/IEC 2501n - Quality Model Division**. The International Standards that form this division present detailed quality models for computer systems and software products, quality in use, and data. Practical guidance on the use of the quality models is also provided.

- **ISO/IEC 2502n - Quality Measurement Division**. The International Standards that form this division include a software product quality measurement reference model, mathematical definitions of quality measures, and practical guidance for their application. Examples are given of internal and external measures for software quality, and measures for quality in use. Quality Measure Elements (QME) forming foundations for these measures are defined and presented.

- **ISO/IEC 2503n - Quality Requirements Division**. The International Standards that form this division help specify quality requirements, based on quality models and quality measures. These quality requirements can be used in the process of quality requirements elicitation for a software product to be developed or as input for an evaluation process.

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

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- **ISO/IEC 25050 – 25099 SQuaRE Extension Division**. These International Standards currently include requirements for quality of Commercial Off-The-Shelf software and Common Industry Formats for usability reports.

The quality models in this International Standard can be used in conjunction with ISO/IEC 12207 and ISO/IEC 15288, particularly the processes associated with requirements definition, verification and validation with a specific focus on the specification and evaluation of quality requirements. ISO/IEC 25030 describes how the quality models can be used for software quality requirements, and ISO/IEC 25040 describes how the quality models can be used for the software quality evaluation process.

This International Standard can also be used in conjunction with ISO/IEC 15504 (which is concerned with software process assessment) to provide:

- a framework for software product quality definition in the customer-supplier process;
- support for review, verification and validation, and a framework for quantitative quality evaluation, in the support process;
- support for setting organizational quality goals in the management process.

This International Standard can be used in conjunction with ISO 9001 (which is concerned with quality assurance processes) to provide:

- support for setting quality goals;
- support for design review, verification and validation.

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Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models

1 Scope

This International Standard defines:

a) A quality in use model composed of five characteristics (some of which are further subdivided into subcharacteristics) that relate to the outcome of interaction when a product is used in a particular context of use. This system model is applicable to the complete human-computer system, including both computer systems in use and software products in use.

b) A product quality model composed of eight characteristics (which are further subdivided into subcharacteristics) that relate to static properties of software and dynamic properties of the computer system. The model is applicable to both computer systems and software products.

The characteristics defined by both models are relevant to all software products and computer systems. The characteristics and subcharacteristics provide consistent terminology for specifying, measuring and evaluating system and software product quality. They also provide a set of quality characteristics against which stated quality requirements can be compared for completeness.

NOTE Although the scope of the product quality model is intended to be software and computer systems, many of the characteristics are also relevant to wider systems and services.

ISO/IEC 25012 contains a model for data quality that is complementary to this model.

The scope of the models excludes purely functional properties (see C.6), but it does include functional suitability (see 4.2.1).

The scope of application of the quality models includes supporting specification and evaluation of software and software-intensive computer systems from different perspectives by those associated with their acquisition, requirements, development, use, evaluation, support, maintenance, quality assurance and control, and audit. The models can, for example, be used by developers, acquirers, quality assurance and control staff and independent evaluators, particularly those responsible for specifying and evaluating software product quality. Activities during product development that can benefit from the use of the quality models include:

- identifying software and system requirements;
- validating the comprehensiveness of a requirements definition;
- identifying software and system design objectives;
- identifying software and system testing objectives;
- identifying quality control criteria as part of quality assurance;
- identifying acceptance criteria for a software product and/or software-intensive computer system;
- establishing measures of quality characteristics in support of these activities.

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2 Conformance

Any quality requirement, quality specification, or evaluation of quality that conforms to this International Standard shall either:

a) use the quality models defined in 4.1 and 4.2; or

b) tailor the quality model giving the rationale for any changes and provide a mapping between the tailored model and the *standard* model.

3 Quality model framework

3.1 Quality models

The quality of a system is the degree to which the system satisfies the stated and implied needs of its various stakeholders, and thus provides value. These stated and implied needs are represented in the SQuaRE series of International Standards by quality models that categorize product quality into characteristics, which in some cases are further subdivided into subcharacteristics. (Some subcharacteristics are divided into sub-subcharacteristics.) This hierarchical decomposition provides a convenient breakdown of product quality. However, the set of subcharacteristics associated with a characteristic have been selected to be representative of typical concerns without necessarily being exhaustive.

The measurable quality-related properties of a system are called quality properties, with associated quality measures. To arrive at measures of the quality characteristic or subcharacteristic, unless the characteristic or subcharacteristic can be directly measured, it will be necessary to identify a collection of properties that together cover the characteristic or subcharacteristic, obtain quality measures for each, and combine them computationally to arrive at a derived quality measure corresponding to the quality characteristic or subcharacteristic (see Annex C). Figure 2 shows the relationship between quality characteristics and subcharacteristics, and quality properties.

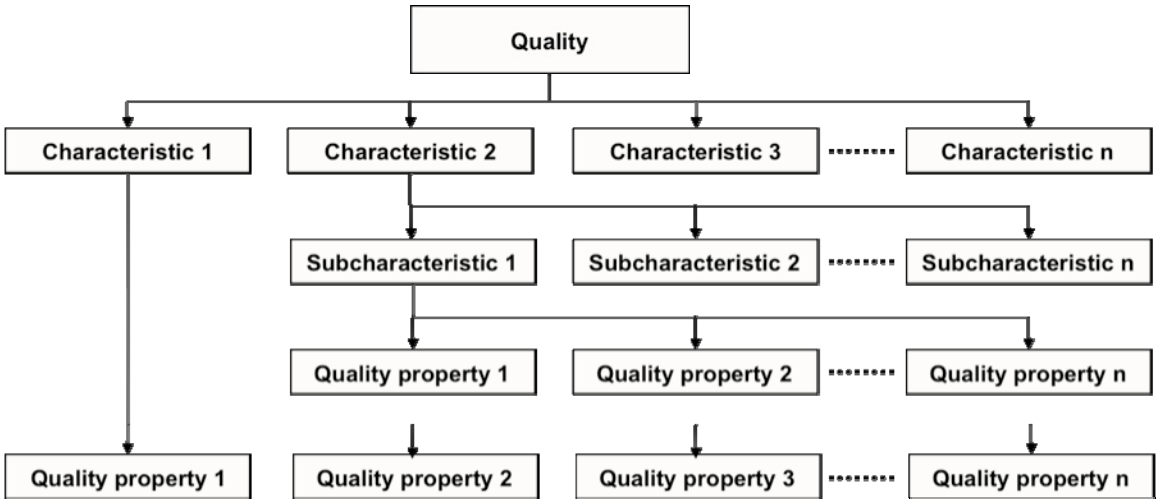

Figure 2 — Structure used for the quality models

Currently there are three quality models in the SQuaRE series: the quality in use model and the product quality model in this International Standard, and the data quality model in ISO/IEC 25012. The quality models together serve as a framework to ensure that all characteristics of quality are considered. These models provide a set of quality characteristics relevant to a wide range of stakeholders, such as: software developers, system integrators, acquirers, owners, maintainers, contractors, quality assurance and control professionals, and users.

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The full set of quality characteristics across these models will not be relevant to every stakeholder. Nonetheless, each category of stakeholder should be represented in reviewing and considering the relevance of the quality characteristics in each model before finalizing the set of quality characteristics that will be used, for example to establish product and system performance requirements or evaluation criteria.

3.2 Quality in use model

The quality in use model in 4.1 defines five characteristics related to outcomes of interaction with a system: effectiveness, efficiency, satisfaction, freedom from risk, and context coverage (Figure 3 and Table 3). Each characteristic can be assigned to different activities of stakeholders, for example, the interaction of an operator or the maintenance of a developer.

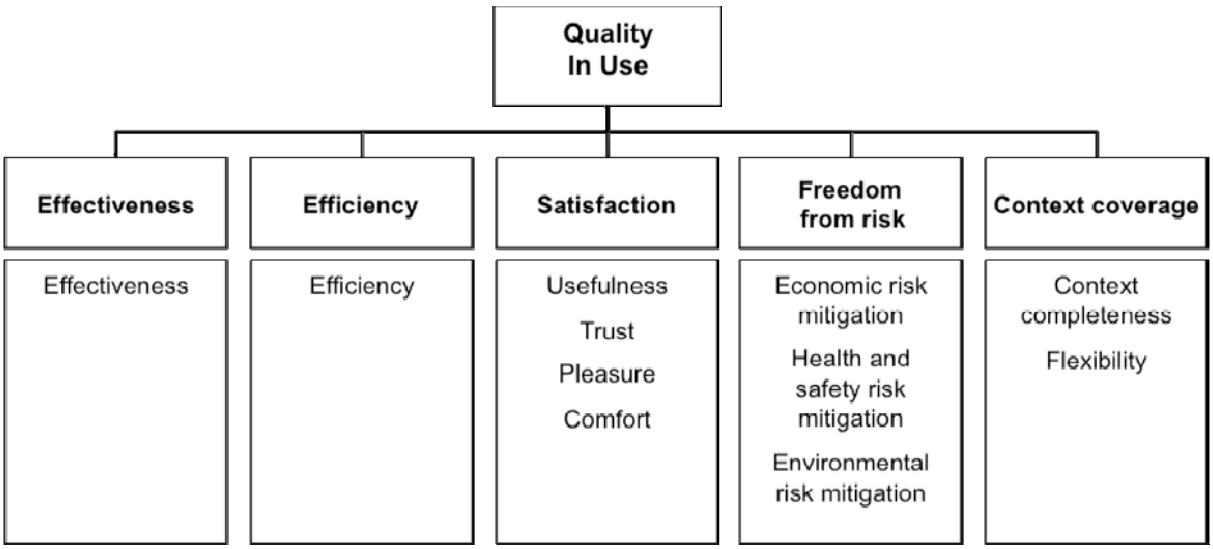

Figure 3 — Quality in use model

The quality in use of a system characterizes the impact that the product (system or software product) has on stakeholders. It is determined by the quality of the software, hardware and operating environment, and the characteristics of the users, tasks and social environment. All these factors contribute to the quality in use of the system.

Definitions and explanations of each quality characteristic for quality in use are given in 4.1.

Examples of quality in use measures are given in ISO/IEC TR 9126-4 (to be replaced by ISO/IEC 25024).

3.3 Product quality model

The product quality model in 4.2 categorizes system/software product quality properties into eight characteristics: functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability. Each characteristic is composed of a set of related subcharacteristics (Figure 4 and Table 4).

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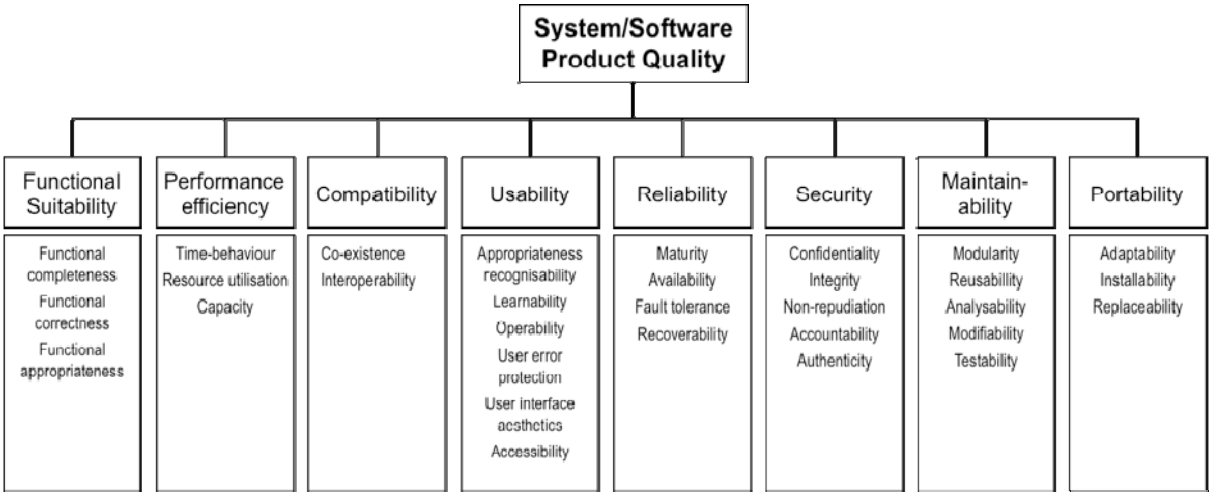

Figure 4 — Product quality model

NOTE The need for compliance with standards or regulations can be identified as part of requirements for a system, but these are outside the scope of the quality model.

The product quality model can be applied to just a software product, or to a computer system that includes software, as most of the subcharacteristics are relevant to both software and systems.

Definitions and explanations of each quality characteristic for product quality are given in 4.2.

3.4 Targets of the quality models

Figure 5 illustrates the targets of the quality models and the related entities.

The product quality model focuses on the target computer system that includes the target software product, and the quality in use model focuses on the whole human-computer system that includes the target computer system and target software product. The target computer system also includes computer hardware, non-target software products, non-target data, and target data, which is the subject of the data quality model (see C.8). The target computer system is included in an information system that can also include one or more computer systems and communication systems, such as a local area network and the Internet. The information system is within a wider human-computer system (such as an enterprise system, embedded system or large-scale control system) and can include users and the technical and physical usage environment. Where the boundary of the system is judged to be, depends upon the scope of the requirements or evaluation, and upon who the users are.

EXAMPLE If the users of an aircraft with a computer-based flight control system are taken to be the passengers, then the system upon which they depend includes the flight crew, the airframe, and the hardware and software in the flight control system, whereas if the flight crew are taken to be the users, then the system upon which they depend consists only of the airframe and the flight control system.

Other stakeholders, such as software developers, system integrators, acquirers, owners, maintainers, contractors, quality assurance and control professionals, will also be concerned with the quality.

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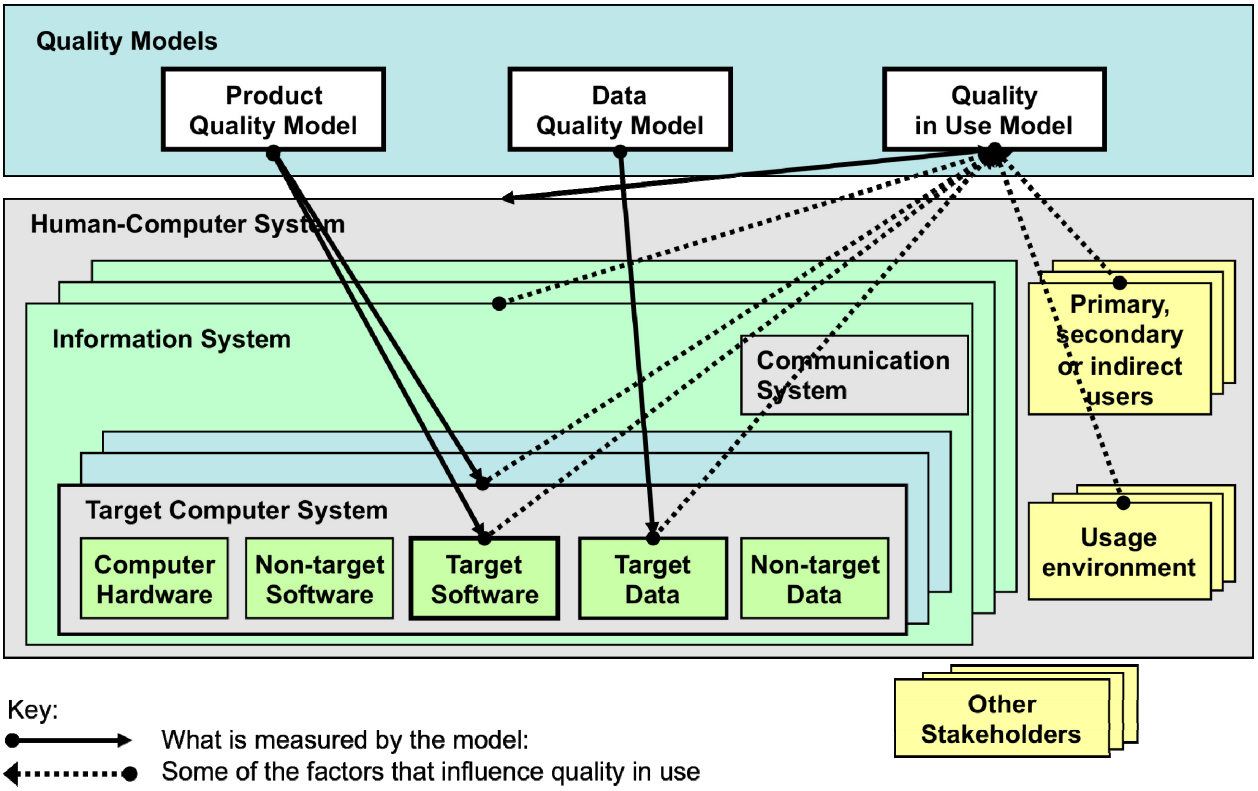

NOTE This is conceptually the same as Figure 2 in ISO/IEC 25012 and Figure 5 in ISO/IEC 25030, but a different version that focuses on quality models.

Figure 5 — Targets of quality models

3.5 Using a quality model

The product quality and quality in use models are useful for specifying requirements, establishing measures, and performing quality evaluations (see Annex C). The defined quality characteristics can be used as a checklist for ensuring a comprehensive treatment of quality requirements, thus providing a basis for estimating the consequent effort and activities that will be needed during systems development. The characteristics in the quality in use model and product quality model are intended to be used as a set when specifying or evaluating computer system or software product quality.

It is not practically possible to specify or measure all subcharacteristics for all parts of a large computer system or software product. Similarly it is not usually practical to specify or measure quality in use for all possible user-task scenarios. The relative importance of quality characteristics will depend on the high-level goals and objectives for the project. Therefore the model should be tailored before use as part of the decomposition of requirements to identify those characteristics and subcharacteristics that are most important, and resources allocated between the different types of measure depending on the stakeholder goals and objectives for the product.

3.6 Quality from different stakeholder perspectives

The quality models provide a framework for collecting stakeholder needs. Stakeholders include the following types of user:

1. Primary user: person who interacts with the system to achieve the primary goals.

2. Secondary users who provide support, for example

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a) content provider, system manager/administrator, security manager;

b) maintainer, analyzer, porter, installer.

3. Indirect user: person who receives output, but does not interact with the system.

Table 1 — Examples of user needs for quality in use and product quality

User needs	Primary user	Secondary users		Indirect user
		Content provider	Maintainer	
	Interacting	Interacting	Maintaining or porting	Using output
Effectiveness	How effective does the user need to be when using the system to perform their task?	How effective does the content provider need to be when updating the system?	How effective does the person maintaining or porting the system need to be?	How effective does the person using output from the system need to be?
Efficiency	How efficient does the user need to be when using the system to perform their task?	How efficient does the content provider need to be when updating the system?	How efficient does the person maintaining or porting the system need to be?	How efficient does the person using the output from the system need to be?
Satisfaction	How satisfied does the user need to be when using the system to perform their task?	How satisfied does the content provider need to be when updating the system?	How satisfied does the person maintaining or porting the system need to be?	How satisfied does the person using the output from the system need to be?
Freedom from risk	How risk free does using the system to perform their task need to be for the user?	How risk free does updating the content of the system need to be?	How risk free does making maintenance changes to the system or porting the system need to be?	How risk free does using the output from the system need to be?
Reliability	How reliable does the system need to be when the user uses it to perform their task?	How reliable does updating the system with new content need to be?	How reliable does maintaining or porting the system need to be?	How reliable does the output from the system need to be?
Security	How secure does the system need to be when the user uses it to perform their task?	How secure does the system need to be after the content provider updates it?	How secure does the system need to be after maintenance changes are made or when it is ported?	How secure does the output from the system need to be?
Context coverage	To what extent does the system need to be effective, efficient, risk free and satisfying in all the intended and potential contexts of use?	To what extent does providing content need to be effective, efficient, risk free and satisfying in all the intended and potential contexts of use?	To what extent does maintaining or porting the system need to be effective, efficient, risk free and satisfying in all the intended and potential contexts of use?	To what extent does using the output of the system need to be effective, efficient, risk free and satisfying in all the intended and potential contexts of use?
Learnability	To what extent does learning to use the system need to be effective, efficient, risk free and satisfying?	To what extent does learning to provide content need to be effective, efficient, risk free and satisfying?	To what extent does learning to maintain or port the system need to be effective, efficient, risk free and satisfying?	To what extent does learning to use the output from the system need to be effective, efficient, risk free and satisfying?
Accessibility	To what extent does the system need to be effective, efficient, risk free and satisfying to use for people with disabilities?	To what extent does providing content for the system need to be effective, efficient, risk free and satisfying for people with disabilities?	To what extent does maintaining or porting the system need to be effective, efficient, risk free and satisfying for people with disabilities?	To what extent does using the output of the system need be effective, efficient, risk free and satisfying for people with disabilities?

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