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Systems and software engineering — Systems and software quality requirements and evaluation (SQuaRE) — Measurement of quality in use

Ingénierie des systèmes et du logiciel — Exigences de qualité et évaluation des systèmes et du logiciel (SQuaRE) — Mesurage de la qualité lors de l'utilisation

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, SC 7, *Software and systems engineering*.

This first edition of ISO/IEC 25022, which is a part of the SQuaRE series of standards, cancels and replaces ISO/IEC 9126-4:2004, with the following changes:

— measures are given for the revised quality model for quality in use in ISO/IEC 25010;

— measures are categorized as generally applicable, could be used in a wide range of situations, or specialized for specific needs;

— annexes that were common to ISO/IEC 9126-2, ISO/IEC 9126-3, and ISO/IEC 9126-4 have been removed (and might be included in a future revision of ISO/IEC 25020).

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

— ISO/IEC 2504n — Quality Evaluation Division

— ISO/IEC 25050 — 25099 SQuaRE Extension Division

Annexes A, B, C, D, E, F and G are for information only.

Introduction

This International Standard is a part of the SQuaRE series of International Standards. It provides a set of measures for the characteristics of quality in use (defined in ISO/IEC 25010) that can be used for specifying quality in use requirements (in conjunction with ISO/IEC 25030) and measuring and evaluating quality in use (in conjunction with ISO/IEC 25040 and ISO/IEC 25041).

The quality measures included in this International Standard were selected based on their practical value. They are based on established practice (including, for example, Reference [17]). They are not intended to be exhaustive, and users of this International Standard are encouraged to refine them, if necessary.

Quality Measurement Division

This International Standard is a part of ISO/IEC 2502n Quality Measurement Division of SQuaRE series that currently consists of the following International Standards:

— ISO/IEC 25020 — Measurement reference model and guide: provides a reference model and guide for measuring the quality characteristics defined in ISO/IEC 2501n Quality Model Division;

— ISO/IEC 25021 — Quality measure elements: provides a format for specifying Quality Measure Elements and some examples of QMEs that can be used to construct software quality measures;

— ISO/IEC 25022 — Measurement of quality in use: provides measures, including associated measurement functions for the quality characteristics in the quality in use model;

— ISO/IEC 25023 — Measurement of system and software product quality: provides measures, including associated measurement functions and QMEs for the quality characteristics in the product quality model;

— ISO/IEC 25024 — Measurement of data quality: provides measures, including associated measurement functions and QMEs for the quality characteristics in the data quality model.

Figure 1 depicts the relationship between this International Standard and the other standards in the ISO/IEC 2502n division.

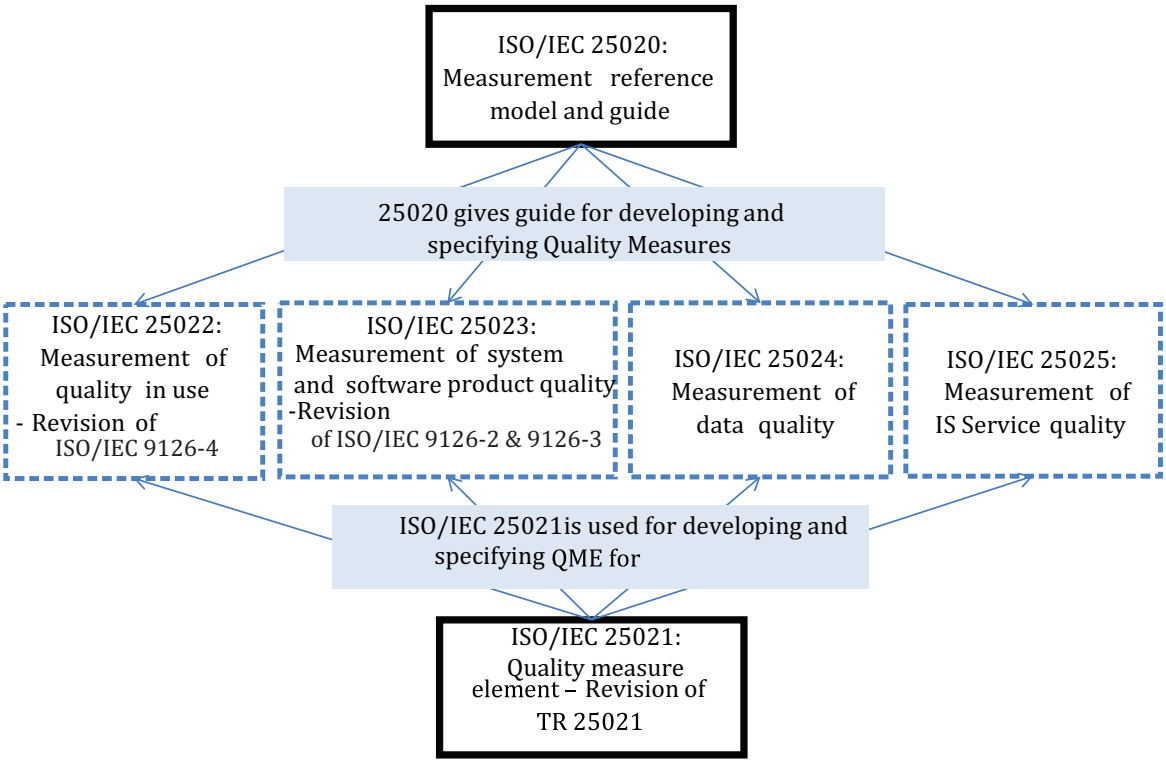


Figure 1 — Structure of the Quality Measurement Division

Outline and Organization of SQuaRE Series

The SQuaRE series consists of five main divisions and extension division. The outline of each divisions within the SQuaRE series are as follows.

— ISO/IEC 2500n — Quality Management Division. The standards that form this division define all common models, terms, and definitions referred further by all other standards from SQuaRE series. The division also provides requirements and guidance for the planning and management of a project.

— ISO/IEC 2501n — Quality Model Division. The standards that form this division provide quality models for system/software products, quality in use, and data. An IT service quality model is under development. Practical guidance on the use of the quality model is also provided.

— ISO/IEC 2502n — Quality Measurement Division. The standards that form this division include a system/software product quality measurement reference model, definitions of quality measures, and practical guidance for their application. This division presents internal measures of software quality, external measures of software quality, and quality in use measures. Quality measure elements forming foundations for the quality measures are defined and presented.

— ISO/IEC 2503n — Quality Requirements Division. The standard that forms this division helps specifying quality requirements. These quality requirements can be used in the process of quality requirements elicitation for a system/software product to be developed, designing a process for achieving necessary quality, or as inputs for an evaluation process.

— ISO/IEC 2504n — Quality Evaluation Division. The standards that form this division provide requirements, recommendations, and guidelines for system/software 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 for SQuaRE extension International Standards, which currently include ISO/IEC 25051 and the ISO/IEC 25060 to ISO/IEC 25069.

Systems and software engineering — Systems and software quality requirements and evaluation (SQuaRE) — Measurement of quality in use

1 Scope

This International Standard defines quality in use measures for the characteristics defined in ISO/IEC 25010, and is intended to be used together with ISO/IEC 25010. It can be used in conjunction with the ISO/IEC 2503n and the ISO/IEC 2504n standards or to more generally meet user needs with regard to product or system quality.

This International Standard contains the following:

— a basic set of measures for each quality in use characteristic;

— an explanation of how quality in use is measured.

This International Standard provides a suggested set of quality in use measures to be used with the quality in use model in ISO/IEC 25010. They are not intended to be an exhaustive set.

It includes as informative annexes examples of how to measure context coverage (Annex A), options for normalising quality in use measures (Annex B), use of ISO/IEC 25022 for measuring usability in ISO 9241-11 (Annex C), a quality in use evaluation process (Annex D), the relationship between different quality models (Annex E), and quality measurement concepts (Annex F).

The measures are applicable to the use of any human-computer system, including both computer systems in use and software products that form part of the system.

This International Standard does not assign ranges of values of the measures to rated levels or to grades of compliance because these values are defined for each system or product depending, on the context of use and users' needs.

Some attributes could have a desirable range of values, which does not depend on specific user needs but depends on generic factors, for example, human cognitive factors.

The proposed quality in use measures are primarily intended to be used for quality assurance and management of systems and software products based on their effects when actually used. The main users of the measurement results are people managing development, acquisition, evaluation, or maintenance of software and systems.

The main users of this International Standard are people carrying out specification and evaluation activities as part of the following:

— development: including requirements analysis, design, and testing through acceptance during the life cycle process;

— quality management: systematic examination of the product or computer system, for example, when evaluating quality in use as part of quality assurance and quality control;

— supply: a contract with the acquirer for the supply of a system, software product, or software service under the terms of a contract, for example, when validating quality at qualification test;

— acquisition: including product selection and acceptance testing, when acquiring or procuring a system, software product, or software service from a supplier;

— maintenance: improvement of the product based on quality in use measures.

2 Conformance

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

a) select the quality in use characteristics and/or subcharacteristics to be specified or evaluated as defined in ISO/IEC 25010;

b) for each selected characteristic or subcharacteristic, all the General (G) quality measures defined in Clause 8 should be used. If any are excluded, then provide a rationale;

c) select any Special (S) quality measures that are relevant;

d) if any quality measure is modified, provide the rationale for any changes;

e) define any additional quality measures to be used that are not included in this International Standard;

f) define precisely how each quality measure is operationalized (for example details of the measurement method or questionnaire used).

NOTE It is important to use the same measurement method when making comparisons.

3 Normative references

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

ISO/IEC 25010, *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 25000 and ISO/IEC 25010 and the following apply.

NOTE The essential definitions from ISO/IEC 25000 SQuaRE series and the other ISO standards are reproduced here.

4.1
context completeness
degree to which a product or system can be used with the required levels of effectiveness, efficiency, satisfaction, and freedom from risk in each of the specified contexts of use

Note 1 to entry: Context completeness is a subcharacteristic of context coverage.

[SOURCE: ISO/IEC 25010:2011, modified — Added “the required levels of” and changed “all” to “each of” for clarification.]

4.2
context coverage
degree to which a product or system can be used with effectiveness, efficiency, satisfaction, and freedom from risk in both specified contexts of use and in contexts beyond those initially explicitly identified

Note 1 to entry: Context of use is relevant to both quality in use and some product quality (sub)characteristics (where it is referred to as “specified conditions”).

[SOURCE: ISO/IEC 25010:2011, 4.1.5]

4.3
customer
relationship with the supplier of an organization or person that receives or uses a product or service

Note 1 to entry: The relationship can include a warranty or agreeing to the terms and conditions of a service.

4.4
effectiveness
accuracy and completeness with which users achieve specified goals

[SOURCE: ISO 9241-11:1998]

4.5
efficiency
resources expended in relation to the accuracy and completeness with which users achieve goals

Note 1 to entry: Relevant resources can include time to complete the task (human resources), materials, or the financial cost of usage.

[SOURCE: ISO 9241-11:1998, modified — note 1 to entry added]

4.6
context of use
users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a system, product or service is used

[SOURCE: ISO 9241-11:1998, 3.5, modified — With "product" replaced by "system, product or service".]

4.7
flexibility
degree to which a product or system can be used with acceptable levels of effectiveness, efficiency, freedom from risk, and satisfaction in contexts beyond those initially specified in the requirements

Note 1 to entry: Flexibility is a subcharacteristic of context coverage.

[SOURCE: ISO/IEC 25010:2011, modified — Added "acceptable levels of" for clarification.]

4.8
formative evaluation
evaluation designed and used to improve the object of evaluation, especially when it is still being developed

[SOURCE: ISO/TS 18152:2010, 4.6]

4.9
freedom from risk
degree to which the quality of a product or system mitigates or avoids potential risks to economic status, human life, health, or the environment

Note 1 to entry: Risk is a function of the probability of occurrence of a given threat and the potential adverse consequences of that threat's occurrence.

Note 2 to entry: The risks considered by the SQuaRE series are those arising from insufficient product quality.

Note 3 to entry: Freedom from risk includes reduction of potential risks to the user, organisation or project.

[SOURCE: ISO/IEC 25010:2011, modified — Added "quality of" and "or avoids" for clarification.]

4.10
goal
intended outcome

[SOURCE: ISO 9241-11:1998]

4.11
measure (noun)
variable to which a value is assigned as the result of measurement

Note 1 to entry: The term "measures" is used to refer collectively to base measures, derived measures, and indicators.

Note 2 to entry: In this International Standard, when the word "measure" is used qualified by a characteristic or subcharacteristic, it refers to a quality measure.

[SOURCE: ISO/IEC 15939:2007, modified — note 2 to entry added]

4.12
measurement
set of operations having the object of determining a value of a measure

Note 1 to entry: Measurement can include assigning a qualitative category such as the language of a source program (ADA, C, COBOL, etc.).

[SOURCE: ISO/IEC 15939:2007, modified — note 1 to entry modified from original]

4.13
measurement function
algorithm or calculation performed to combine two or more quality measurement elements

[SOURCE: ISO/IEC 25021:2012]

4.14
psychometrics
field of study concerned with the theory and technique for developing valid and reliable psychological measures

4.15
quality in use
degree to which a product or system can be used by specific users to meet their needs to achieve specific goals with effectiveness, efficiency, satisfaction, and freedom from risk in specific contexts of use

Note 1 to entry: The quality in use of a software product or system can be measured and evaluated by the effect of the target system or software products when used by users of the implemented system or during field testing or prototype testing.

Note 2 to entry: When quality in use is specified, it relates to specified users meeting their needs to achieve specified goals with effectiveness, efficiency, satisfaction, and freedom from risk in specified contexts of use.

[SOURCE: ISO/IEC 25010:2011, modified — notes 1 and 2 to entry added]

4.16
quality measure
measure that is defined as a measurement function of two or more values of quality measure elements

[SOURCE: ISO/IEC 25021:2012]

4.17
quality measure element
measure defined in terms of a property and the measurement method for quantifying it, including optionally the transformation by a mathematical function

[SOURCE: ISO/IEC 25021:2012]

4.18
quality model
defined set of characteristics, and of relationships between them, which provides a framework for specifying quality requirements and evaluating quality

[SOURCE: ISO/IEC 25000:2014]

4.19
satisfaction
degree to which user needs are satisfied when a product or system is used in a specified context of use

Note 1 to entry: For a user who does not directly interact with the product or system, only purpose accomplishment and trust are relevant.

Note 2 to entry: Satisfaction is the user's response to interaction with the product or system, and includes attitudes towards use of the product.

Note 3 to entry: Users include: primary users who interact with the system to achieve the primary goals, secondary users who provide support, and indirect users who receive output, but do not interact with the system.

Note 4 to entry: In this International Standard, user's needs include their desires and expectations associated with use of a product, system, or service. Exceeding desires and expectations is a means of significantly increasing satisfaction and improving the user experience.

[SOURCE: ISO/IEC 25010:2011, modified — notes 3 and 4 to entry added]

4.20
stakeholder satisfaction
degree to which stakeholder needs are satisfied when a product or system is used in a specified context of use

Note 1 to entry: Users of a product or system are one type of stakeholder, so user satisfaction is one type of stakeholder satisfaction.

[SOURCE: ISO/IEC 25010:2011, modified — Definition for the term "satisfaction" modified to refer to stakeholders.]

4.21
summative evaluation
evaluation designed to present conclusions about the merit or worth of the object of evaluation

Note 1 to entry: The results can be used to produce recommendations about whether it should be retained, altered, or eliminated.

Note 2 to entry: It is possible to design a method to provide a combined formative and summative evaluation.

Note 3 to entry: A summative test method is used to perform a summative evaluation.

[SOURCE: ISO/TS 20282-2:2013, 4.17]

4.22
system
combination of interacting elements organised to achieve one or more stated purposes

Note 1 to entry: A system may be considered as a product or as the services it provides.

Note 2 to entry: In practice, the interpretation of its meaning is frequently clarified by the use of an associative noun, e.g. aircraft system. Alternatively, the word system may be substituted simply by a context dependent synonym, e.g. aircraft, though this may then obscure a system principles perspective.

[SOURCE: ISO/IEC 15288:2015, modified — note 3 to entry deleted.]

4.23
task
activities required to achieve a goal

Note 1 to entry: These activities can be physical or cognitive.

Note 2 to entry: Job responsibilities can determine goals and tasks.

[SOURCE: ISO 9241-11:1998]

4.24
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

Note 1 to entry: Adapted from ISO 9241-210.

Note 2 to entry: Usability can either be specified or measured as a product quality characteristic in terms of its subcharacteristics, or specified or measured directly by measures that are a subset of quality in use.

[SOURCE: ISO/IEC 25010:2011]

4.25
use error
act or omission of an act that results in a different system response than intended by the manufacturer or expected by the user

[SOURCE: IEC 62366:2007, modified — With “medical device” replaced by “system”.]

4.26
user
individual or group that benefits from a system during its utilization

[SOURCE: ISO/IEC 15939:2007]

5 Abbreviated terms

The following abbreviation is used in this International Standard.

QME Quality Measure Element

6 Use of quality in use measures

6.1 Applications of quality in use

This International Standard provides suggested measures for the characteristics and subcharacteristics in the ISO/IEC 25010 quality in use model.

— Effectiveness

— Efficiency

— Satisfaction

  — Usefulness

  — Trust

  — Pleasure (user experience)

  - Comfort (ergonomic)
- Freedom from risk
  - Economic risk mitigation
  - Health and safety risk mitigation
  - Environmental risk mitigation
- Context coverage
  - Context completeness
  - Flexibility

Quality in use is the degree to which a product or system can be used by specific users to meet their needs to achieve specific goals with effectiveness, efficiency, and satisfaction and freedom from risk in specific contexts of use.

In the quality in use model, the term usability refers to the subset of quality in use composed of effectiveness, efficiency, satisfaction, and context coverage. Measures of the usability and functional suitability of the user interface and interaction are contained in ISO/IEC 25023.

Unacceptable levels of freedom from risk can result from poor levels of usability, which can be caused by poor levels of product usability. Unacceptable levels of freedom from risk can also be caused by poor levels of other product quality characteristics.

Measures of quality in use measure the outcomes of interaction between a user and a system. The final quality in use of an implemented system or software product can be measured when the system or software product is used in the user's environment for its intended purpose. Quality in use measures can also be used at conceptual design and development stages as follows.

- Requirements: quality in use requirements can be specified early in the design and development process, to give a high level goal for the intended quality to be experienced by users and other stakeholders.
- Formative evaluation of prototypes: specific problems with quality in use can be identified by testing prototypes with small numbers of representative users during development using product usability measures and unnormalized quality in use measures in order to identify problems and improve the product.
- Summative evaluation of prototypes: estimates of the final quality in use of different design solutions can be obtained by testing prototypes with larger numbers of representative users during development using normalized quality in use measures, and estimating how the resulting effectiveness, efficiency, and satisfaction adequately mitigate the potential risks.
- Quality assurance and control process: the quality in use of the implemented system can be tested against requirements.

NOTE 2 Annex E explains the relationship between different SQuaRE quality models.

NOTE 3 In this International Standard, the word "measure" (used as a noun) refers to a quality measure.

6.2 Measurement of quality in use

Quality in use depends not only on the product quality of the software or computer system, but also on the particular context in which the product is being used (see ISO/IEC 25063). The context of use includes user factors, task factors, and physical and social environmental factors that can affect quality in use. Therefore, comparisons of the quality in use of a software product or system are only valid when the measures are made in the same context of use.

This makes it particularly difficult to predict or interpret levels of freedom from risk, as it is usually not possible to control other factors in the context of use that could influence freedom from risk. However, it is often possible to provide evidence for the potential risks that could result from poor usability or poor product quality, and to suggest target values for usability or product quality that would mitigate these risks (see Figure 2). If any measures of usability or product quality do not reach these target values, the potential impact of the measured values on freedom from risk can be assessed.

EXAMPLE When designing an airline reservation system, a high target level is set for the effectiveness (success rate) of users booking a flight to the intended destination at the intended time on the intended date to minimize the likelihood of the potential economic consequences that could arise from any errors.

Many of the measures are defined in a way that allows them to be customized to meet specific needs. Therefore, meaningful comparisons between measures or with target values can only be made for measures that have been operationalized in the same way and used in the same or a sufficiently similar context of use (i.e. with similar types of users carrying out similar tasks in similar environments).

Effectiveness, efficiency, and satisfaction can be assessed by observing representative users carrying out representative tasks in a realistic context of use (for example, see the methods in Annexes B and C and ISO/TS 20282-2). The measures can be obtained by simulating a realistic usage environment (for instance, in a usability laboratory) or by observing operational use of the product. In order to specify or measure quality in use, it is first necessary to identify each component of the intended context of use: the users, their goals, and the environment of use. The evaluation needs to be designed to match this context of use as closely as possible. It is also important that users are only given the type of help and assistance that would be available to them in the operational environment. These measures can be used for assurance processes when applying a method such as that specified in ISO/TS 20282-2.

Some external usability measures (ISO/IEC 25023) are tested in a similar way, but evaluate the use of particular product features during more general use of the product to achieve a typical task as part of a test of the quality in use.

NOTE 1 Annex B and ISO/TS 20282-2 provide examples of how to measure effectiveness, efficiency, and satisfaction. Annex A provides examples of how to measure context coverage. See also Reference [19].

NOTE 2 Annex F provides more information on SQuaRE quality measurement concepts.

6.3 Interpretation of quality in use measures

Some quality in use measures (such as the time to complete a task) can be difficult to interpret in isolation. There are several ways that quality in use measures can be compared so that they are easier to interpret, namely:

a) conformance: comparing measures with a specific business or usage requirements (e.g. it must be possible to complete the task in 10 minutes);

b) benchmarks: comparing measures with a benchmark for the same or a similar product or system used for the same purpose (e.g. it must be possible to complete the tasks with the new system in no more time than it took with the old system);

c) time series: comparing trends over time (e.g. the reduced number of errors made by users with each new prototype version of a system);

d) proficiency: comparison with the values obtained when used by a trained or expert user (e.g. how much longer does it take a new user compared with an experienced user);

e) population norms for satisfaction: when there is a database of previous values, measures can be expressed as the percentage of users who have previously given a rating of at least this value.

The quality in use measures in Clause 8 include examples that have been normalized in one of these ways, but for most measures, several forms of normalization are possible, as shown in Annex B.

Unnormalized measures (such as errors made or task time) can be used to identify specific problems encountered by individual users, or small groups of users.

To obtain reliable measures for effectiveness, efficiency, or satisfaction, data needs to be obtained from sufficient users performing tasks to obtain the desired level of statistical confidence that the target values have been achieved.

NOTE ISO/TS 20282-2 provides an example of a method for summative testing of the effectiveness, efficiency, and satisfaction of products for use by the general public.

6.4 Selecting appropriate quality in use measures

Factors that can influence the selection of specific quality in use measures include the following:

— the relative importance of effectiveness, efficiency, satisfaction, and freedom from risk;

— specific aspects of effectiveness, efficiency, or satisfaction that could create risks to economic status, human life, health, or the environment;

— the skills and knowledge required to apply particular measures.

For more information on the process to be used for evaluation of quality in use, see Annex D.

6.5 Aspects of quality in use described in other International Standards

The following International Standards provide further information about specific aspects of quality in use:

— ISO 9241-11: the definitions of effectiveness, efficiency, and satisfaction in ISO 9241-11 are similar to those in ISO/IEC 25010, so the quality in use measures for effectiveness, efficiency, and satisfaction in ISO/IEC 25022 can also be as measures of usability as defined in ISO 9241-11 (see Annex C);

— ISO/IEC 25062 specifies how the results of a summative usability test should be documented;

— ISO/IEC 25063 explains the elements of the context of use that need to be identified when measuring usability;

— ISO/IEC 25064 explains how user needs (that could include needs for quality in use) should be documented;

— ISO/TS 20282-2 provides a rigorous methodology for measuring effectiveness, efficiency, and satisfaction of a consumer product.

7 Format used for documenting the quality measures

The following information is given for each measure in the tables in Clause 8.

a) ID: Identification code of quality measure. Each ID consists of the following three parts:

   — code representing the quality characteristics and subcharacteristics. For Effectiveness and Efficiency use the format “Ef” and “Ey”, and for Satisfaction, Freedom from risk, and Context coverage, use the format “ABc”, where ”A” represents the characteristic and “Bc” represents the subcharacteristic;

   — serial number of sequential order within quality subcharacteristic;

   — G: Generally applicable, could be used in a wide range of situations; S: Specialised for specific needs;

b) Name: Quality measure name;

c) Description: The information provided by the quality measure;

d) Measurement function: Formula showing how the quality measure elements are combined to produce the quality measure;

e) Method: The type of method that can be used to obtain the measure.

- measure user performance: measures of effectiveness and efficiency (see D.3.3.2 and D.3.3.3);
- measure customer behaviour: data collected on actions taken by customers;
- automated data collection: data collected by instrumenting the software to collect user actions;
- questionnaire: measures of satisfaction (see D.3.3.5);
- business analytics: analysis of business activities and results;
- software and usability analysis: analysis of potential risks arising from human or system errors;
- usage statistics: analysis of the consequences arising from previous human or system errors;
- analysis of context description: analysis of the context of use to assess the expected quality in use;
- inspection: inspection of the system to identify potential problems.

8 Quality in use measures

8.1 General

The quality measures in this Clause are listed by quality characteristics and subcharacteristics, in the order used in ISO/IEC 25010: effectiveness, efficiency, satisfaction, freedom from risk, and context coverage.

The values obtained for measures of effectiveness, efficiency, and satisfaction depend on the context of use (see 6.2), so the types of users, tasks, and the environments for which measures are made (or are to be made) has to be stated in combination with any measurement results.

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.

NOTE This list of quality measures is not finalized and might be revised in future versions of this International Standard. Readers of this International Standard are invited to provide feedback.

8.2 Effectiveness measures

Effectiveness measures assess the accuracy and completeness with which users achieve specified goals.

NOTE 1 Effectiveness measures do not take account of how the goals were achieved, only the extent to which they were achieved (see D.3.1.2).

NOTE 2 The phrase “errors made by the user” refers to the user not performing the intended actions. These errors are sometimes called “use errors” to emphasise that the main cause of the error can be bad system design.

Table 1 — Effectiveness measures

ID	Name	Description	Measurement function	Method
Ef-1-G	**Tasks completed**	The proportion of the tasks that are completed correctly without assistance	X = A/B A = Number of unique tasks completed B = Total number of unique tasks attempted	Measure user performance
NOTE 1 This measure can be measured for one user or a group of users. NOTE 2 If tasks can be partially completed the Objectives achieved measure is more appropriate. NOTE 3 If the tasks are of different complexity, weighted tasks could be used in the formula: X = Σ (i=1..n) Wi × Ai/B where i is the number of the task and Wi represents the difficulty of that task where total sum of Wi = 1.0. NOTE 4 This could be applied either to the tasks identified in the requirements or to the tasks attempted by the user.				
Ef-2-S	**Objectives achieved**	The proportion of the objectives of the task that are achieved correctly without assistance	{X = 1-ΣA$_i$ | X≥0} A$_i$ = Proportional value of each missing or incorrect objective in the task output (maximum value = 1)	Measure user performance
NOTE Each potential missing or incomplete component is given a weight Ai based on the extent to which it detracts from the value of the output to the business or user. (If the sum of the weights exceeds 1, the quality measure is normally set to 0, although this can indicate negative outcomes and excessive risks.) The scoring scheme is refined iteratively by applying it to a series of task outputs and adjusting the weights until the results obtained are repeatable, reproducible and meaningful. EXAMPLE: The business impact of potential diary and contact information errors was discussed with several potential customers, leading to the following scoring scheme for calculating the mean objectives achieved (expressed as a percentage): — installation: all components successfully installed: 100 %; for each necessary subcomponent omitted from the installation deduct 20 %; — new contact: all details entered correctly: 100 %; for each missing item of information, deduct 50 %; for each item of information in the wrong field, deduct 20 %; for each typo deduct 5 %; — new meeting: all details entered correctly: 100 %, incorrect time or date: 0 %; for each item of information in the wrong field, deduct 20 %; for each typo deduct 5 %. Combined deductions equalling or exceeding 100 % would be as scored 0 % objectives achieved.				
Ef-3-G	**Errors in a task**	The number of errors made by the user during a task	X = A A = Number of errors made by the user during a task	Measure user performance
NOTE 1 The number of errors made by the user can include all errors, or only uncorrected errors, or only errors that result in the task not being completed correctly. NOTE 2 Measures of counts of errors can be used to make comparisons between the same task carried out in different circumstances, for example when comparing different versions of a system under development. NOTE 3 To compare errors made in different tasks, the number of errors could be related to the number of actions in each task. NOTE 4 It is only appropriate to make comparisons if errors have equal importance, or are weighted. NOTE 5 Errors can be analyzed using a user by problem matrix indicating how many users had which problem, in which combination.				
Ef-4-G	**Tasks with errors**	Proportion of tasks where errors were made by the user	X = A/B A = Number of tasks with errors B = Total number of tasks	Measure user performance

Table 1 *(continued)*

ID	Name	Description	Measurement function	Method
NOTE The notes to Ef-3-G apply.				
Ef-5-G	**Task error intensity**	Proportion of users making an error	X = A/B A = Number of users making an error B= Total number of users performing the task	Measure user performance
NOTE The notes to Ef-3-G apply.				

8.3 Efficiency measures

Efficiency measures assess the resources expended in relation to the accuracy and completeness with which users achieve goals.

NOTE 1 The most common resource is time to complete the task, although other relevant resources could include the user's effort, materials, or the financial cost of usage.

NOTE 2 Efficiency measures are typically compared with the efficiency when using a different product or version, or the efficiency in the absence of the product. Efficiency can also be compared with the efficiency of an expert.

Table 2 — Efficiency measures

ID	Name	Description	Measurement function	Method
Ey-1-G	**Task time**	The time taken to successfully complete a task	X = T T = Task time	Measure user performance
NOTE Learnability (see ISO/IEC 25023) can be measured by the time taken by a normal user to complete a task in comparison with the time taken by an expert, and how this changes with repeated usage.				
Ey-2-S	**Time efficiency**	The efficiency with which users achieve their objectives over time when using the system	X = A/T A = Number of objectives achieved T = Time	Measure user performance
NOTE 1 Time efficiency is a measure of productivity: the number of the objectives achieved for every unit of time. Efficiency increases with increasing effectiveness and reducing task time. It enables comparisons to be made, for example between fast error-prone interfaces and slow easy interfaces. NOTE 2 If Ef-1-G tasks completed has been measured, time efficiency can be measured as tasks completed/time. This measures the proportion of tasks completed successfully for every unit of time. A high value indicates a high proportion of successful tasks in a small amount of time. NOTE 3 The time efficiency could be compared with that of an expert, or with time efficiency for a different product or version, or with completing the task manually. NOTE 4 If the objectives achieved have different value, they could be weighted.				
Ey-3-S	**Cost-effectiveness**	The cost-effectiveness of the user	X = A/B A = Total cost of carrying out the task B = Number of objectives achieved	Measure user performance
NOTE 1 Examples of objectives achieved could include defined business goals, required information retrieved or system outputs. NOTE 2 If the objectives achieved have different value, they could be weighted. NOTE 3 Costs could for example include the user's time, the time of others giving assistance, and the cost of computing resources, telephone calls, and materials. NOTE 4 The measure could be normalised against the cost of not using the system.				

Table 2 *(continued)*

ID	Name	Description	Measurement function	Method
Ey-4-S	**Productive time ratio**	The proportion of the time that the user is performing productive actions	X = Ta/Tb Ta = Productive time = time taken to complete the task - time spent getting help or assistance - time taken recovering from errors - time taken searching ineffectually Tb = Task time	Measure user performance
NOTE Unproductive time spent looking at help, recovering from errors and searching ineffectually can be identified by analysing a video of the interaction.				
Ey-5-S	**Unnecessary actions**	The proportion of the actions performed by the user that were not necessary to achieve the task	X = A/B A = Number of actions actually that were not necessary to achieve the task B = Number of actions performed by the user	Measure user performance or automated data collection
NOTE 1 This measure is most useful when the task is completed by making selections (for example using the mouse, touch or voice commands). For more complex tasks, actions could be defined to include data entry. NOTE 2 The purpose of the measure is similar to productive time ratio, but unnecessary actions are easier to measure.				
Ey-6-S	**Consequences of fatigue**	The decrease in human performance after continuous use	X = 1 – A/B A = Current performance B = Initial performance	Measure user performance or automated data collection
NOTE 1 Applies to continuous use by an experienced user. NOTE 2 Performance refers to any appropriate measure of effectiveness or efficiency (if necessary normalized so that a larger number is better). NOTE 3 Physiological measures can be used to assess the effects of fatigue. NOTE 4 Personal assessment of fatigue can be measured using a questionnaire. NOTE 5 Measures of fatigue are only appropriate for experienced users carrying out repetitive tasks. NOTE 6 Computer systems and working practices can be designed to reduce fatigue. NOTE 7 Closer to 0 is better.				

8.4 Satisfaction measures

8.4.1 General

Satisfaction measures assess the degree to which user needs are satisfied when a product or system is used in a specified context of use.

The scope of a satisfaction measure can be

a) an overall generic measure of satisfaction (SUs-1-G),

b) a measure of a specific satisfaction subcharacteristics (8.4.2, 8.4.3, 8.4.4, 8.4.5), or

c) an overall measure of satisfaction produced by combining measures of individual subcharacteristics.

NOTE Combined measures of individual subcharacteristics could be weighted for their relative importance and contribution to overall satisfaction.

Users respond to questions in a satisfaction questionnaire by selecting a value on a scale that could have two points (e.g. agree, disagree) or several points on a scale (e.g. ranging from strongly agree to strongly disagree).

The summed scores obtained from satisfaction questionnaires are often scaled into a range from 0 to 100. For some questionnaires (such as SUS, see Reference [21]), there is a database of previous results which enables the score to be transformed into a value for the percentage of users who have previously given a similar product or system the same score or better.

This subclause provides examples of methods that can be used to obtain quality measures for different aspects of satisfaction. The specific measures can be obtained by using existing published questionnaires.

NOTE 1 Users include secondary users who provide support and indirect users who receive output, but do not interact with the system.

NOTE 2 Satisfaction is the user's response to interaction with the product or system, and includes attitudes towards use of the product.

NOTE 3 User satisfaction is influenced by the user's perception of properties of the software or computer system (such as those measured by external measures) and by the user's perception of the effectiveness, efficiency, and freedom from risk in use.

NOTE 4 User satisfaction can be measured during development as part of usability testing to understand how the design could be improved. User satisfaction can be measured by surveying users after release to help understand whether the product is meeting their requirements.

NOTE 5 Psychometric scales have known reliability and validity. The benefits of using questionnaires that have standardised psychometric scales are explained in Reference [22].

Table 3 — General satisfaction measures

ID	Name	Description	Measurement function	Method
SUs-1-G	**Overall satisfaction**	The overall satisfaction of the user	$X = \sum A_i$ A_i = Response to a question	Questionnaire
NOTE Examples of overall measures of satisfaction are the Net Promoter Score [18] and Single Ease Question [20].				

8.4.2 Usefulness measures

Usefulness measures assess the degree to which a user is satisfied with their perceived achievement of pragmatic goals, including the results of use and the consequences of use.

Table 4 — Usefulness measures

ID	Name	Description	Measurement function	Method
SUs-2-G	**Satisfaction with features**	The satisfaction of the user with specific system features	$X = \sum A_i$ A_i = Response to a question related to a specific feature	Questionnaire
NOTE This is typically an unvalidated questionnaire using a Likert scale[a]. If the questionnaire items are combined to give an overall score, they can be weighted, as different questions can have different importance.				
SUs-3-G	**Discretionary usage**	The proportion of potential users choosing to use a system or function	$X = A/B$ A = Number of users using a specific function, application or system B = Number of potential users who could have used the specific function, application, or system	Measure user behaviour or automated data collection
NOTE This measure can be used when it is possible to identify situations when usage of a function, application or system would be appropriate, for example by monitoring of sampling the user's behaviour.				
[a] A response range for a type of survey question in which a person is asked to rate their reaction to a statement along a scale. The scale typically runs from a positive rating to a negative rating with a neutral score in between.				

Table 4 *(continued)*

ID	Name	Description	Measurement function	Method
SUs-4-G	**Feature utilisation**	The proportion of an identified set of users of the system who use a particular feature	X = A/B A = Number of users using a particular feature B = Number of users in an identified set of users of the system	Measure user behaviour or automated data collection
NOTE 1 Features can be defined at different levels of granularity from an individual function to a subset of a system. NOTE 2 A low value could indicate that the feature is not useful, or is only useful to a subset of users, or that users do not understand how to use it, or that they do not know that it exists.				
SUs-5-G	**Proportion of users complaining**	The proportion of users making complaints	X = A/B A = Number of users complaining B = Number of users using the system	Measure user behaviour
SUs-6-G	**Proportion of user complaints about a particular feature**	The proportion of user complaints about a particular feature	X = A/B A = Number of user complaints for a particular feature B = Total number of user complaints about features	Measure user behaviour
[a] A response range for a type of survey question in which a person is asked to rate their reaction to a statement along a scale. The scale typically runs from a positive rating to a negative rating with a neutral score in between.				

8.4.3 Trust measures

Trust measures assess the degree to which a user or other stakeholder has confidence that a product or system will behave as intended.

Table 5 — Trust measures

ID	Name	Description	Measurement function	Method
STr-1-G	**User trust**	The extent to which the user trusts the system	X = A A = Psychometric scale value from a trust questionnaire	Questionnaire
NOTE Reference [16] has an example of a trust questionnaire.				

8.4.4 (User experience) pleasure measures

Pleasure measures assess the degree to which user needs for pleasure are satisfied.

NOTE 1 Modified from the definition in ISO/IEC 25010: “degree to which a user obtains pleasure from fulfilling their personal needs”.

NOTE 2 User needs can include needs to acquire new knowledge and skills, to communicate personal identity, to provoke pleasant memories and to be engaged with the interaction.

Table 6 — (User experience) pleasure measures

ID	Name	Description	Measurement function	Method
SPl-1-G	**User pleasure**	The extent to which the user obtains pleasure compared to the average for this type of system	X = A A = Psychometric scale value from a pleasure questionnaire	Questionnaire
NOTE Examples of psychometric pleasure questionnaires are in References [14] and [23].				

8.4.5 (Ergonomic) comfort measures

Comfort measures assess the degree to which user needs for physical comfort are satisfied.

NOTE Modified from the definition in ISO/IEC 25010: "degree to which the user is satisfied with physical comfort".

Table 7 — (Ergonomic) comfort measures

ID	Name	Description	Measurement function	Method
SCo-1-G	**Physical comfort**	The extent to which the user is comfortable compared to the average for this type of system	X = A A = Psychometric scale value from a comfort questionnaire	Questionnaire
NOTE 1 Physical comfort can be influenced by position or actions that the user has to make to use the computer system and by the environment in which the system is used. NOTE 2 Reference [15] has an example of a psychometric comfort questionnaire.				

8.5 Freedom from risk measures

8.5.1 General

Freedom from risk measures assess the degree to which the quality of a product or system mitigates or avoids potential risk to the user, organisation or project, including risks to economic status, human life, health, or the environment.

NOTE 1 This is a corrected version of the definition in ISO/IEC 25010: "degree to which a product or system mitigates the potential risk to economic status, human life, health, or the environment".

Risks of undesirable consequences can originate from the inadequacy of any product quality characteristic (ISO/IEC 25063) or from inadequate levels of effectiveness, efficiency, satisfaction, or context coverage.

Risks of undesirable consequences can impact the following types of stakeholders:

a) User of a product or system:

   — health and safety while using the product or system;

   — adverse consequences of failing to achieve the intended outcome.

b) Organisation using a product or system:

   — damage to an organisation's reputation or finances from errors made by the organization as a consequence of poor usability;

   — risks arising from inadequate operational safety or protection of security or privacy.

c) Organisation developing a product or system:

   — risks of the economic consequences if design and development of the system, product, or service does not produce a system with the intended targets for quality;

   — risks of economic or reputational consequences that result in a product or system not being purchased or a service not being used as a result of quality defects.

d) Wider community:

   — risk of health and safety consequences or negative environmental impact.

Table 8 shows which stakeholders can be impacted by the consequences of different types of risks.

Table 8 — Types of adverse consequences for different types of stakeholders

Type of consequence: Stakeholder	Health and safety	Economic status	Environment
User of a product or system	Health and safety risk mitigation measures Stress resulting from poor usability	Consequences of failing to achieve the intended outcome	
Organisation using a product or system		Economic risk mitigation measures	
Organisation developing or acquiring a product or system		Economic risk mitigation measures	
Wider community	Risk of health and safety consequences		Environmental risk mitigation measures

The quality measures defined in 8.5 can be operationalized in different ways tailored to the needs of the stakeholder using them. For the measures expressed in terms of positive or negative outcomes, risk mitigation refers to avoiding unacceptable values.

NOTE 2 Risks of adverse consequences can be controlled by specifying the minimum acceptable levels of quality and using these as criteria for evaluation. Specifying higher levels of quality could require investment of additional resources but can provide opportunities for improved economic, health, or environmental outcomes. See Figure 2.

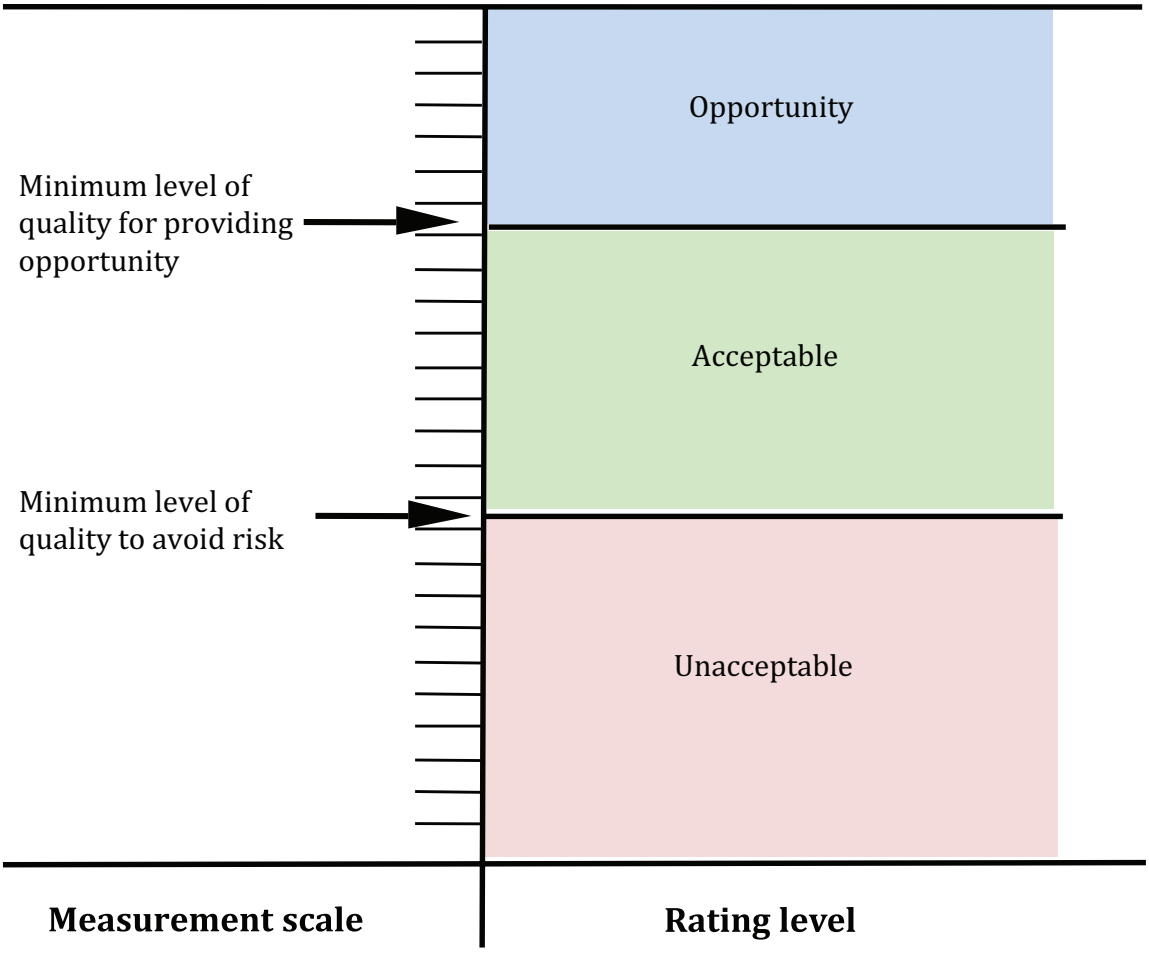


Figure 2 — Risks and opportunities associated with the level of quality

NOTE 3 Risk is a function of the probability of occurrence of a given threat and the potential adverse consequences of that threat's occurrence.

NOTE 4 Potential risks arising from the impact of quality on outcomes is typically based on assessing the level of risk to economic status, human life, health, or the environment created by (predicted or) measured quality of the product (functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, or portability).

For information on risk assessment, see ISO/IEC 31010.

8.5.2 Economic risk mitigation measures

Economic risk mitigation measures assess the impact of quality on economic objectives related to financial status, efficient operation, commercial property, reputation, or other resources that could be at risk or provide opportunities.

NOTE 1 Risk mitigation can be used to mitigate the risk of unacceptable economic outcomes that could result from poor product quality.

NOTE 2 Expected values of the measures can be estimated, based on actual values from historical data.

NOTE 3 The results of measurement can be difficult to interpret, as isolating the contribution that product or system quality makes to actual measures of each of the economic outcomes can be difficult as many other factors contribute to these measures. The main value of the measures can be to estimate the impact of quality on economic objectives based on previous experience of how quality influenced the economic outcomes. Financial measures that are closely related to system/software product behaviour (such as REc-5-S, REc-6-S, REc-7-S, REc-8-G) will be easier to interpret.

Table 9 — Economic risk mitigation measures

ID	Name	Description	Measurement function	Method
REc-1-G	**Return on investment (ROI)**	The return on investment	X = (A – B)/B A = Additional benefits obtained B = Invested amount	Business analytics
NOTE Examples of benefits obtained can include reduction in personnel expenses, shrinkage of inventory assets, reduction of stock, or reduction of material cost through concentrated purchase.				
REc-2-G	**Time to achieve return on investment**	The time taken to achieve the expected return on investment	X = T T = Time to achieve ROI	Business analytics
NOTE This can be compared with an acceptable time to achieve ROI.				
REc-3-G	**Business performance**	Profitability or sales compared to a target	X = Aa/At A = Profitability or sales of the company (a = actual, t = target)	Business analytics
NOTE This can be compared with the IT investment amount or sales of another company for comparison.				
REc-4-G	**Benefits of IT Investment**	Measure of the benefits of IT investment (for example using the Balanced Score Card) compared to a target	X = Aa/At A = Measure of the benefits of IT investment (a = actual, t = target)	Business analytics
NOTE The balanced scorecard evaluates the benefits of IT investment from viewpoints such as financial, customer, business operation processes and HR development. Any of these benefits could be the basis of a measure.				
REc-5-S	**Service to customers**	The extent to which the intended level of service to customers is achieved	X = A/B A = Actual level of service B = Intended level of service	Business analytics
NOTE The value can exceed 1 if the level of service exceeds intentions. EXAMPLES The extent to which deliveries are delayed, the average waiting time to obtain customer service.				

Table 9 *(continued)*

ID	Name	Description	Measurement function	Method
REc-6-S	**Website visitors converted to customers**	The proportion of visitors to a particular web page(s) who become customers	X = A/B A = Number of visitors who become customers B = Number of unique visitors to a particular web page(s)	Business analytics
NOTE The measure could be based on specific web pages or the whole website.				
REc-7-S	**Revenue from each customer**	The revenue from each customer	X = A A = Revenue from a customer	Business analytics
NOTE There are several attributes of customers such as existing and new. They can be used to evaluate the status of opportunity loss for provision of new functionality.				
REc-8-G	**Errors with economic consequences**	Proportion of usage situations where there are human or system errors with economic consequences	X = A/B A = Number of errors with economic consequences B = Total number of usage situations	Business, software and usability analytics
NOTE 1 The errors can be weighted by economic magnitude. Usage situations can be defined by transactions or by time. Errors can include data corruption. NOTE 2 The economic consequences can be for an organization or for an individual user. EXAMPLE The economic consequences for an individual of failing to achieve their goal(s) of purchasing an intended transport ticket effectively and efficiently could result in inability to travel as intended or the need to purchase a new ticket.				

8.5.3 Health and safety risk mitigation measures

Health and safety risk mitigation measures assess the impact of quality on health and safety objectives (such as avoidance of repetitive strain injury).

NOTE 1 The specific measurement of quality characteristics such as safety or security can be found in IEC 62366 for medical devices and in International Standards provided by IEC 65 and ISO/IEC JTC 1/SC 27.

NOTE 2 Risk mitigation can be used to mitigate the risk of unacceptable health and safety measures that could result from poor product quality.

Table 10 — Health and safety risk mitigation measures

ID	Name	Description	Measurement function	Method
RHe-1-G	**User health reporting frequency**	The proportion of users of the product who report health problems arising from usage	X = A/B A = Number of users reporting health problems B = Total number of users	Usage statistics
NOTE 1 Health problems can include Repetitive Strain Injury, fatigue, headaches, etc. NOTE 2 The measure could be weighted by length of use.				
RHe-2-G	**User health and safety impact**	The health and safety impact on users of the product	$X = \frac{1}{Tb}\sum_{i=1}^{n}(Ta_i \times S_i)$ n = Number of affected people Ta_i = Length of time for which the i-th person is affected S_i = Degree of significance of the impact on the i-th person Tb = Length of time from start of system in operation	Usage statistics
NOTE The impact can include mental as well as physical health and safety, for example the stress caused by the difficulty of using a system with a poor user interface.				
RHe-3-G	**Safety of people affected by use of the system**	The incidence of hazard to people affected by use of the system.	X = A/B A = Number of people put at hazard B = Total number of people who could be affected by use of the system	Usage statistics
NOTE 1 An example of this measure is Patient Safety, where A = number of patients with incorrectly prescribed treatment and B = total number of patients. NOTE 2 For some purposes, the number of people affected could be a more relevant measure than the ratio.				

8.5.4 Environmental risk mitigation measures

Environmental risk mitigation measures assess the impact of quality on environmental objectives.

NOTE Risk mitigation can be used to mitigate the risk of unacceptable environmental consequences that could result from poor product quality.

Table 11 — Environmental risk mitigation measures

ID	Name	Description	Measurement function	Method
REn-1-G	**Environmental impact**	The environmental impact of the manufacture and use of the product or system compared to a target	X = Aa/At A = Environmental impact (a = actual, t = target)	Usage statistics
NOTE 1 Environmental impact could include consequences such pollution, noise or global warming, depending on the type of system. NOTE 2 The environmental risk could result from software defects or from the risk of user errors with a badly designed user interface.				

8.6 Context coverage measures

8.6.1 General

Context coverage measures assess the degree to which a product or system can be used with effectiveness, efficiency, satisfaction, and freedom from risk in both specified contexts of use and in contexts beyond those initially explicitly identified.

NOTE 1 Annex A provides examples of measures of context coverage.

NOTE 2 Distinct contexts refers to contexts in which differences between users, tasks and/or environments result in significant differences in usability (see ISO/TS 20282-2).

8.6.2 Context completeness measures

Context completeness measures are used to assess the degree to which a product or system can be used with the required levels of effectiveness, efficiency, satisfaction, and freedom from risk in each of the specified contexts of use.

NOTE 1 This is a corrected version of the definition in ISO/IEC 25010: "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".

NOTE 2 Context completeness can be specified or measured either in terms of actual use by specified users to achieve specified goals with effectiveness, efficiency, satisfaction, and freedom from risk in all the intended contexts of use, or by the presence of product properties that support use in all the intended contexts of use.

Table 12 — Context completeness measures

ID	Name	Description	Measurement function	Method
CCm-1-G	**Context completeness**	The proportion of the intended contexts of use in which a product or system can be used with acceptable usability and risk	X = A/B A = Number of contexts with acceptable usability and risk B = Total number of required distinct contexts of use	Analysis of user performance or context description
NOTE 1 Analysis or user testing can be used to assess whether a product or system has acceptable usability for all the intended combinations of types of users, tasks, and environments. EXAMPLE 1 The requirement is for the system to have adequate quality in use in all the intended context of use. EXAMPLE 2 The system only has adequate quality in use in three of the four intended contexts of use. NOTE 2 Different contexts of use could be weighted by their importance.				

8.6.3 Flexibility measures

Flexibility measures are used to assess the degree to which a product or system can be used with acceptable levels of effectiveness, efficiency, satisfaction, and freedom from risk in contexts beyond those initially specified in the requirements.

NOTE 1 Flexibility enables products to take account of circumstances, opportunities, and individual preferences that might not have been anticipated in advance.

NOTE 2 Flexibility can be measured by analysing the characteristics of the product and the context of use to assess the extent to which a product can be used by additional types of users to achieve additional types of goals with effectiveness, efficiency, satisfaction, and freedom from risk in additional types of contexts of use, or by testing the product with users in these additional contexts of use, or by the capability of the product to be modified to support adaptation for new types of users, tasks and environments, and suitability for individualization as defined in ISO 9241-110.

Table 13 — Flexibility measures

ID	Name	Description	Measurement function	Method
CFl-1-S	**Flexible context of use**	Extent to which the product can be used in additional contexts of use (different types of users, tasks, and environments) with no modifications or only simple modifications.	X = A/B A = Number of additional contexts in which the product can be used with acceptable quality in use B = Total number of additional contexts in which the product might be used	Analysis of user performance or context description
NOTE 1 Simple modifications means that the product can be customized by the user or only modifications to text and/or data are needed. NOTE 2 The closer to 1, the better. EXAMPLE A product designed primarily for use in a particular market could potentially be used in a range of other situations (B) but with the current design would only be usable in a subset (A).				
CFl-2-S	**Product flexibility**	Ease with which a product can be modified to meet additional user requirements.	$X = \frac{1}{B}\sum_{i=1}^{B} A_i$ A_i = Modifiability (as specified in ISO/IEC 25023) for the i-th requirement B = Total number of new requirements from specified users	Analysis of user performance or inspection
CFl-3-S	**Proficiency independence**	Extent to which the product can be used by people without specific knowledge, skills or experience	X = A/B A = Number of additional user groups without specific knowledge, skills or experience who can use the product B = Total number of potential user groups without specific knowledge, skills, or experience	Analysis of user performance or inspection
NOTE 1 The product could be primarily intended for a user group with specific knowledge, skills, or experience, but potentially usable by a wider range of types of user. NOTE 2 If the product can only be used by the intended user group, the value is 0. If the product can be used by anyone, the value is 1.				

Annex A
(informative)

Examples of how to measure context coverage

A.1 General

This Annex provides examples of how to measure context coverage.

Context coverage is defined as the degree to which a product or system can be used with effectiveness, efficiency, satisfaction, and freedom from risk in both specified contexts of use and in contexts beyond those initially explicitly identified. Context coverage is composed on the subcharacteristics context completeness and flexibility.

Context completeness is defined as the degree to which a product or system can be used with the required levels of effectiveness, efficiency, satisfaction and freedom from risk in each of the specified contexts of use.

A.2 Example of context completeness for an airline web site

The specified contexts of use for an airline-booking site might include that the system must be usable for all the following combinations of types of users (U), tasks (T), and web browsers (B):

— specified types of users: U1: frequent flyers and U2: occasional flyers (with experience of using the web);

— specified tasks: T1: selecting flights, T2: payment, … (etc.);

— specified environments: Web browsers: B1: Internet Explorer, B2: Firefox, etc.;

— each combination of user type, task, and environment defines a specific context of use in which specified levels of quality in use (effectiveness, efficiency, satisfaction, and freedom from risk) are needed

  — U1 T1 B1,

  — U1 T1 B2,

  — U1 T2 B1, etc.

Different levels of quality in use could be specified for each context of use, but the design objective might be to have the same quality in use for all specified browsers, and for both types of users.

The purpose of specifying requirements for context completeness would be to ensure that quality requirements are achieved in all the specified contexts of use.

A.3 Evaluating context completeness for an airline web site

It would be expensive to carry out user testing of every permutation of context of use for an existing system. An alternative could be that inspection of the system reveals no identifiable issues that would be expected to create a difference in quality in use between the different browsers, or between the two user types for the payment task. So the only permutations that need to be tested would then be

— U1 T1,

— U2 T1, and

— U1 + U2 (combined) T2.

A.4 Flexibility measures for an airline web site

Flexibility is defined as degree to which a product or system can be used with acceptable levels of effectiveness, efficiency, satisfaction, and freedom from risk in contexts beyond those initially specified in the requirements.

A flexibility design objective could be to implement the web site using technologies that are known to be compatible with the widest range of other browsers.

Measurement of flexibility could be based on an assessment of the compatibility of the implementation technologies with different browsers, or by testing the web site using a range of alternative browsers.

The purpose of specifying requirements for flexibility would be to make it more likely that acceptable levels of effectiveness, efficiency, and satisfaction would be achieved when the web site is used with wide range of existing and forthcoming web browsers.

Annex B
(informative)

Normalization of quality in use measures

Table B.1 shows which of the options for normalisation explained in 6.3 are applicable to each quality measure.

Table B.1 — Normalisation options

			Normalisation options				
ID	Name	Measurement function	Conformance	Benchmark	Time Series	Proficiency	Population norm
Ef-1-G	**Tasks completed**	X = A/B A = Number of unique tasks completed B = Total number of unique tasks attempted	✓	✓	✓	✓	
Ef-2-S	**Objectives achieved**	$\{X = 1 - \Sigma A_i \mid X \geq 0\}$ A_i = Proportional value of each missing or incorrect *objective* in the task output (maximum value = 1)	✓	✓	✓	✓	
Ef-3-G	**Errors in a task**	X = A A = Number of errors made by the user during a task	✓	✓	✓	✓	
Ef-4-G	**Tasks with errors**	X = A/B A = Number of tasks with errors B = Total number of tasks	✓	✓	✓	✓	
Ef-5-G	**Task error intensity**	X = A/B A = Number of users making an error B= Total number of users performing the task	✓	✓	✓	✓	
Ey-1-G	**Task time**	X = T T = Task time	✓	✓	✓	✓	
Ey-2-S	**Time efficiency**	X = A/T A = Number of objectives achieved T = Time	✓	✓	✓	✓	
Ey-3-S	**Cost-effectiveness**	X = A/B A = Total cost of carrying out the task B = Number of objectives achieved	✓	✓	✓	✓	

Table B.1 *(continued)*

			Normalisation options				
Ey-4-S	**Productive time ratio**	X = Ta/Tb Ta = Productive time = time taken to complete the task - time spent getting help or assistance - time taken recovering from errors - time taken searching ineffectually Tb = Task time	✓	✓	✓	✓	
Ey-5-S	**Unnecessary actions**	X = A/B A = Number of actions actually that were not necessary to achieve the task B = Number of actions performed by the user	✓	✓	✓	✓	
Ey-6-S	**Fatigue**	X = 1 – A/B A = Current performance B = Initial performance	✓	✓	✓	✓	
SUs-1-G	**Overall satisfaction**	X = $\sum(A_i)$ A_i = Response to a question	✓	✓	✓	✓	✓
SUs-2-G	**Satisfaction with features**	X = $\sum(A_i)$ A_i = Response to a question related to a specific feature	✓	✓	✓	✓	
SUs-3-G	**Discretionary usage**	X = A/B A = Number of users using a specific function, application or system B = Number of potential users who could have used the specific function, application, or system	✓	✓	✓	✓	
SUs-4-G	**Feature utilisation**	X = A/B A = Number of users using a particular feature B = Number of users in an identified set of users of the system	✓	✓	✓	✓	
SUs-5-G	**Proportion of users complaining**	X = A/B A = Number of users complaining B = Number of users using the system	✓	✓	✓		
SUs-6-G	**Proportion of user complaints about a particular feature**	X = A/B A = Number of user complaints for a particular feature B = Total number of user complaints about features	✓	✓	✓		

Table B.1 *(continued)*

			Normalisation options				
STr-1-G	**User trust**	X = A A = Psychometric scale value from a trust questionnaire	✓	✓	✓	✓	✓
SPl-1-G	**User pleasure**	X = A A = Psychometric scale value from a pleasure questionnaire	✓	✓	✓	✓	✓
SCo-1-G	**Physical comfort**	X = A A = Psychometric scale value from a comfort questionnaire	✓	✓	✓	✓	✓
REc-1-G	**Return on investment (ROI)**	X = (A – B) / B A = Additional benefits obtained B = Invested amount	✓	✓	✓		
REc-2-G	**Time to achieve return on investment**	X = T T = Time to achieve ROI	✓	✓	✓		
REc-3-G	**Business performance**	X = Aa/At A = Profitability or sales of the company (a = actual, t = target)	✓	✓	✓		
REc-4-G	**Benefits of IT Investment**	X = Aa/At A = Measure of the benefits of IT investment (a = actual, t = target)	✓	✓	✓		
REc-5-S	**Service to customers**	X = A/B A = Actual level of service B = Intended level of service	✓	✓	✓		
REc-6-S	**Website visitors converted to customers**	X = A/B A = Number of visitors who become customers B = Number of unique visitors to a particular web page(s)	✓	✓	✓		
REc-7-S	**Revenue from each customer**	X = A A = Revenue from a customer	✓	✓	✓		
REc-8-G	**Errors with economic consequences**	X = A/B A = Number of errors with economic consequences B = Total number of usage situations	✓	✓	✓		
RHe-1-G	**User health reporting frequency**	X = A/B A = Number of users reporting health problems B = Total number of users	✓	✓	✓		

Table B.1 *(continued)*

			Normalisation options				
RHe-2-G	**User health and safety impact**	$X = \sum(Ta_i * S_i)/Tb$ $i = 1$ to n n = Number of affected people Ta_i = Time that i-th individual of people is affected S_i = Degree of significance that i-th individual is affected Tb = Time from start of system in operation	✓	✓	✓		
RHe-3-G	**Safety of people affected by use of the system**	X = A/B A = Number of people put at hazard B = Total number of people who could be affected by use of the system	✓	✓	✓		
REn-1-G	**Environmental impact**	X = Aa/At A = Environmental impact (a = actual, t = target)	✓	✓	✓		
CCm-1-G	**Context completeness**	X = A/B A = Number of contexts with acceptable usability and risk B = Total number of required distinct contexts of use	✓	✓	✓		

Table B.1 *(continued)*

			Normalisation options				
CFl-1-S	**Flexible context of use**	X = A/B A = Number of additional contexts in which the product can be used with acceptable quality in use B = Total number of additional contexts in which the product might be used	✓	✓	✓		
CFl-2-S	**Product flexibility**	$X = \sum A_i/B$ i=1 to B A_i = Modifiability (as specified in ISO/IEC 25023) for each new requirement B = Total number of new requirements from specified users	✓	✓	✓		
CFl-3-S	**Proficiency independence**	X = A/B A = Number of additional user groups without specific knowledge, skills or experience who can use the product B = Total number of potential user groups without specific knowledge, skills or experience	✓	✓	✓		

Annex C
(informative)

Use of ISO/IEC 25022 for measuring usability in ISO 9241-11

The definitions of usability (updated version in ISO 9241-210) and of effectiveness and efficiency in ISO 9241-11 and are almost the same as those in ISO/IEC 25010, while the definitions of satisfaction are different.

NOTE 1 In ISO 9241-11, effectiveness, efficiency, and satisfaction are subcharacteristics of usability.

Table C.1 — Definitions of terms in ISO/IEC 25022 and ISO 9241-11

	ISO/IEC 25010	ISO 9241-210/ISO 9241-11
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	extent to which a system, product, or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use
Effectiveness	accuracy and completeness with which users achieve specified goals	accuracy and completeness with which users achieve specified goals
Efficiency	resources expended in relation to the accuracy and completeness with which users achieve goals	resources expended in relation to the accuracy and completeness with which users achieve goals
Satisfaction	degree to which user needs are satisfied when a product or system is used in a specified context of use	freedom from discomfort, and positive attitudes towards the use of the product.

Thus all the quality measures in 8.2 (Effectiveness) and 8.3 (Efficiency) can be used to measure effectiveness and efficiency in ISO 9241-11. The quality measures that can be used to measure satisfaction in ISO 9241-11 are the measures in 8.4.1 (General), 8.4.2 (Usefulness) and 8.4.3 (Trust) that are measures of positive attitudes, and the measures in 8.4.5 (Comfort) that are measures of freedom from discomfort.

NOTE 2 All the measures of satisfaction, including 8.4.4 (pleasure), are within the intended scope of the satisfaction in the new version of ISO 9241-11 which is currently being developed.

Annex D
(informative)

Quality in use evaluation process

D.1 General

The overall process in this Annex is:

- Establish evaluation requirements
  - Establish purpose of evaluation
  - Identify types of products
  - Specify quality model
- Specify the evaluation
  - Identify the contexts of use
  - Choose a context for the evaluation
  - Select measures
  - Establish criteria for assessment
  - Interpretation of measures
- Design the evaluation
- Execute the evaluation
  - Perform the user tests and collect data
- Produce a report

NOTE 1 The clauses in this Annex follow the structure of the evaluation process described in ISO/IEC 25040.

NOTE 2 ISO/TS 20282-2 provides a detailed specification for an evaluation process for the effectiveness, efficiency, and satisfaction of consumer products and products for public use that is consistent with the process in this Annex.

D.2 Establish evaluation requirements

D.2.1 Establish purpose of evaluation

The purpose of evaluating quality in use is to assess the extent to which the product enables users to meet their needs to achieve specified goals in specific contexts of use (scenarios of use).

D.2.1.1 Acquisition

Prior to development, an organization seeking to acquire a product specifically adapted to its needs can use quality in use as a framework for specifying the quality in use requirements which the product should meet and against which acceptance testing can be carried out. Specific contexts in which quality

in use is to be measured should be identified, measures of effectiveness, efficiency, satisfaction, and freedom from risk selected, and acceptance criteria based on these measures established.

D.2.1.2 Supply

A supplier can evaluate quality in use to ensure that the product meets the needs of specific types of users and usage environments. Providing the potential acquirer with quality in use results will help the acquirer judge whether the product meets their specific needs (see for example ISO/IEC 25062).

D.2.1.3 Development

A clear understanding of users' requirements for quality in use in different scenarios of usage will help a development team to orient design decisions towards meeting real user needs, and focus development objectives on meeting criteria for quality in use. These criteria can be evaluated when development is complete.

D.2.1.4 Operation

By measuring aspects of quality in use, the organization operating a system can evaluate the extent to which the system meets their needs, and assess what changes might be required in any future version.

D.2.1.5 Maintenance

For the person maintaining the software, the quality in use of the maintenance task can be measured.

D.2.1.6 Porting

For the person porting, the quality in use of the porting task can be measured.

D.2.2 Identify types of products

A working prototype or final product is required to evaluate quality in use.

D.2.3 Specify quality model

The quality model used is the model for quality in use given in ISO/IEC 25010. Quality in use is defined as the degree to which a product or system can be used by specific users to meet their needs to achieve specific goals with effectiveness, efficiency, satisfaction, and freedom from risk in specific contexts of use.

D.3 Specify the evaluation

D.3.1 Identify the contexts of use

In order to specify or measure quality in use, it is necessary to identify each component of the context of use: the users, their goals, and the environment of use. It is not usually possible to test all possible contexts of use, so it is usually necessary to select important or representative user groups and tasks.

D.3.1.1 Users

Characteristics of users that can influence their performance when using the product need to be specified. These can include knowledge, skill, experience, education, training, physical attributes, and motor and sensory capabilities. It might be necessary to define the characteristics of different types of user, for example, users having different levels of experience or performing different roles.

NOTE Given the ageing population, the characteristics of older and disabled people can have an impact on their performance. This could be related to added experience enabling better performance, or physical, motor or sensory abilities making performance in different or challenging contexts of use more difficult.

D.3.1.2 Goals (intended outcomes)

The goals of use of the product should be specified. Goals specify what is to be achieved, rather than how. Goals can be decomposed into sub-goals that specify components of an overall goal and the criteria that would satisfy that sub-goal. For example, if the goal was to complete a customer order form, the sub-goals could be to enter the correct information in each field. The breadth of the overall goal depends on the scope of the evaluation. Tasks are the activities required to achieve goals.

D.3.1.3 Environment

Operating environments

The hardware and software operating environment should be specified, as this can affect the way the software performs. This includes broader aspects such as network response time.

User environments

Any aspects of the usage environment which can influence the performance of the user should also be specified, such as the physical environment (e.g. workplace, furniture), the ambient environment (e.g. temperature, lighting) and the social and cultural environment (e.g. work practices, access to assistance, and motivation).

D.3.2 Choose a context for the evaluation

It is important that the context used for the evaluation matches as closely as possible one or more environments in which the product will actually be used. The validity of the measures obtained to predict the level of quality in use achieved when a product is actually used will depend upon the extent to which the users, tasks, and environment are representative of the real situation. At one extreme, one can make measurements in the "field" using a real situation as the basis for the evaluation of the quality in use of a product. At the other end of the continuum, one can evaluate a particular aspect of the product in a "laboratory" setting in which those aspects of the context of use, which are relevant, are re-created in a representative and controlled way. The advantage of using the laboratory-based approach is that it offers the opportunity to exercise greater control over the variables that are expected to have critical effects on the level of quality in use achieved, and more precise measurements can be made. The disadvantage is that the artificial nature of a laboratory environment can produce unrealistic results.

D.3.3 Select measures

D.3.3.1 Choice of measures

To specify or evaluate quality in use, it is normally necessary to measure at least one measure for effectiveness, efficiency, satisfaction, and if appropriate, freedom from risk.

The choice of measures and the contexts in which they are measured is dependent on the objectives of the parties involved in the measurement. The relative importance of each measure to the goals should be considered. For example, where usage is infrequent, higher importance might be given to measures for understandability and learnability rather than quality in use.

Measures of quality in use should be based on data that reflect the results of users interacting with the product. It is possible to gather data by objective means, such as the measurement of output, of speed of working or of the occurrence of particular events. Alternatively, data can be gathered from the subjective responses of the users expressing feelings, beliefs, attitudes, or preferences. Objective measures provide direct indications of effectiveness and efficiency while subjective measures can be linked directly with satisfaction.

Evaluations can be conducted at different points along the continuum between the field and laboratory settings depending upon the issues that need to be investigated and the completeness of the product that is available for test. The choice of test environment and measures will depend upon the goals of the measurement activity and their relationship with the design cycle.

D.3.3.2 Effectiveness

Effectiveness measures measure the accuracy and completeness with which goals can be achieved.

For example, if the desired goal is to accurately reproduce a two-page document in a specified format, then accuracy could be specified or measured by the number of spelling mistakes and the number of deviations from the specified format, and completeness could be specified or measured by the number of words of the document transcribed divided by the number of words in the source document.

D.3.3.3 Efficiency

Measures of efficiency relate the level of effectiveness achieved to the expenditure of resources. Relevant resources can include mental or physical effort, time, materials, or financial cost. For example, human efficiency could be measured as effectiveness divided by human effort, temporal efficiency as effectiveness divided by time, or economic efficiency as effectiveness divided by cost.

If the desired goal is to print copies of a report, then efficiency could be specified or measured by the number of usable copies of the report printed, divided by the resources spent on the task such as labour hours, process expense and materials (including the costs for necessary rework) consumed.

D.3.3.4 Freedom from risk

Measures of freedom from risk relate to the risk of operating the software or computer system over time, conditions of use and the context of use. Freedom from risk can be analysed in terms of operational risk reduction and contingency risk reduction. Operational risk reduction is the ability of the software to meet user requirements during normal operation without harm to other resources and the environment. Contingency risk reduction is the ability of the software to operate outside its normal operation and divert resources to prevent an escalation of risk.

D.3.3.5 Satisfaction

Satisfaction measures the extent to which users are free from discomfort and their attitudes towards the use of the product.

Satisfaction can be specified and measured by subjective rating on scales such as: liking for the product, satisfaction with product use, acceptability of the workload when carrying out different tasks, or the extent to which particular quality in use objectives (such as efficiency or learnability) have been met. Other measures of satisfaction might include the number of positive and negative comments recorded during use. Additional information can be obtained from longer term measures such as rate of absenteeism, observation of overloading or underloading of the user's cognitive or physical workload, or from health problem reports, or the frequency with which users request transfer to another job.

Subjective measures of satisfaction are produced by quantifying the strength of a user's subjectively expressed reactions, attitudes, or opinions. This process of quantification can be done in a number of ways, for example, by asking the user to give a number corresponding to the strength of their feeling at any particular moment, or by asking users to rank products in order of preference, or by using an attitude scale based on a questionnaire.

Attitude scales, when properly developed, have the advantage that they can be quick to use, have known reliabilities, and do not require special skills to apply. Attitude questionnaires which are developed using psychometric techniques will have known and quantifiable estimates of reliability and validity, and can be resistant to factors such as faking, positive or negative response bias, and social desirability. They also enable results to be compared with established norms for responses obtained in the past. See the Bibliography for examples of questionnaires that measure satisfaction with computer systems.

D.3.4 Establish criteria for assessment

The choice of criterion values of measures of quality in use depends on the requirements for the product and the needs of the organisation setting the criteria. Quality in use objectives can relate to a primary

goal (e.g. produce a letter) or a sub-goal (e.g. search and replace). Focusing quality in use objectives on the most important user goals can mean ignoring many functions, but is likely to be the most practical approach. Setting quality in use objectives for specific sub-goals can permit evaluation earlier in the development process.

When setting criterion values for a group of users, the criteria can be set as an average (e.g. average time for completion of a task to be no more than 10 minutes), for individuals (e.g. all users can complete the task within 10 minutes), or for a percentage of users (e.g. 90 % of users are able to complete the task in 10 minutes).

When setting criteria, care should be taken that appropriate weight is given to each measurement item. For example, to set criteria based on errors, it might be necessary to assign weightings to reflect the relative importance of different types of error.

D.3.5 Interpretation of measures

Because the relative importance of characteristics of quality in use depends on the context of use and the purposes for which quality in use is being specified or evaluated, there is no general rule for how measures should be chosen or combined.

Care should be taken in generalizing the results of any quality in use measures to another context that could have significantly different types of users, tasks, or environments. If measures of quality in use are obtained over short periods of time, the values might not take account of infrequent events that could have a significant impact on quality in use, for example intermittent system errors.

For a general-purpose product, it will generally be necessary to specify or measure quality in use in several different representative contexts, which will be a subset of the possible contexts and of the tasks that can be performed. There can be differences between quality in use in these contexts.

D.4 Design the evaluation

The evaluation should be carried out in conditions as close as possible to those in which the product will be used. It is important that

— users are representative of the population of users who use the product,

NOTE ISO/TS 20282-2, Annex C explains in detail how to select a representative sample of users, including how to take account of minor user groups (such as a specific nationality or a specific disability).

— tasks are representative of the ones for which the system is intended, and

— conditions are representative of the normal conditions in which the product is used (including access to assistance, time pressures and distractions).

By controlling the context of evaluation, experience has shown that reliable results can be obtained with a sample of only eight participants (see ISO/IEC 25062).

D.5 Execute the evaluation

D.5.1 Perform the user tests and collect data.

When assessing quality in use, it is important that the users work unaided, only having access to forms of assistance that would be available under normal conditions of use. As well as measuring effectiveness, efficiency, and satisfaction, it is usual to document the problems users encounter and to obtain clarification by discussing the problems with users at the end of the session. It is often useful to record the evaluation on video, which permits more detailed analysis, and production of video clips. It is also easier for users to work undisturbed if they are monitored remotely by video.

D.6 Produce a report

If a comprehensive report is required, the Common Industry Format (ISO/IEC 25062) provides a good structure for reporting the effectiveness, efficiency, and satisfaction components of quality in use.

Annex E
(informative)

Relationship between different quality models

The quality of a system/software product is the degree to which it 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 system/software product quality into characteristics, which in some cases are further subdivided into subcharacteristics.

User needs for quality include requirements for system quality in use in specific contexts of use. These identified needs can be used when specifying external and internal measures of quality using system quality in use characteristics and subcharacteristics.

Software quality can be evaluated by measuring internal properties (typically static measures of intermediate products) or by measuring external properties (typically by measuring the behaviour of the code when executed). System product quality in use can be evaluated by measuring quality in use properties (when the product is in real or simulated use). Appropriate internal properties of the software are a pre-requisite for achieving the required external behaviour, and appropriate external behaviour is a pre-requisite for achieving quality in use (see Figure E.1).

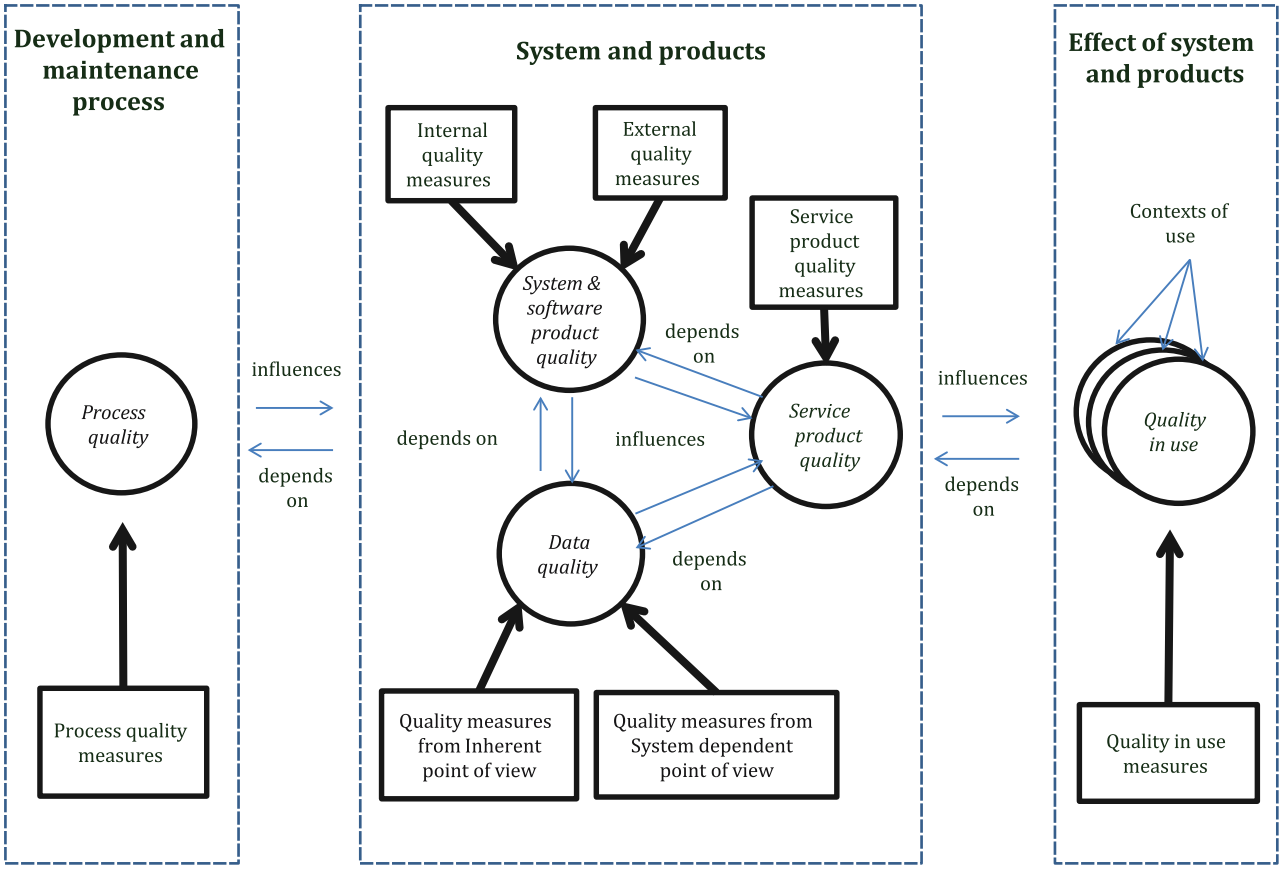


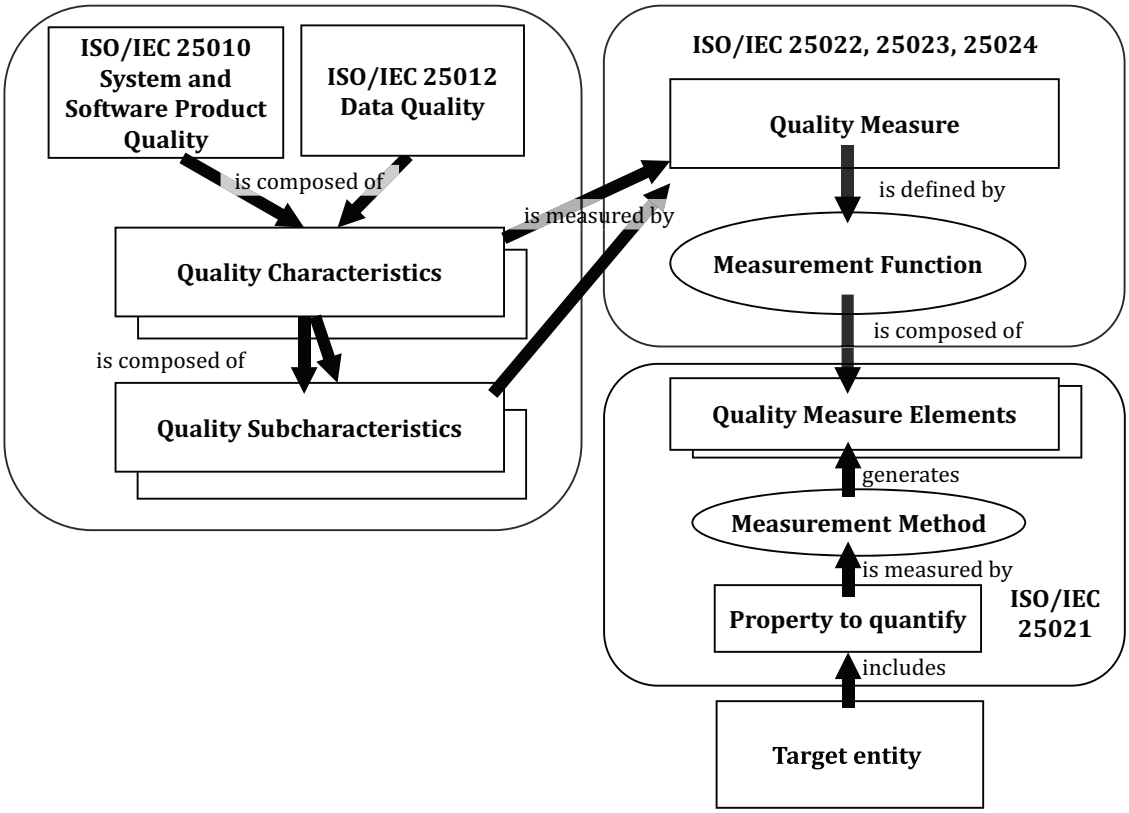
Figure E.1 — Relationship between types of quality measures

Annex F
(informative)

Quality measurement concepts

The measurable quality-related properties of a system/software product are called properties to quantify, with associated quality measures. These properties are measured by applying a measurement method. A measurement method is a logical sequence of operations used to quantify properties with respect to a specified scale. The result of applying a measurement method is called a quality measure element.

The quality characteristics and subcharacteristics can be quantified by applying measurement functions. A measurement function is an algorithm used to combine quality measure elements. The result of applying a measurement function is called a quality measure. In this way, quality measures become quantifications of the quality characteristics and subcharacteristics. More than one quality measure may be used for the measurement of a quality characteristic or subcharacteristic (Figure F.1).



NOTE Target entity can be a System, Software Product, Data or a User. See ISO/IEC 25010, Figure 5.

Figure F.1 — Measurement of quality characteristics

Annex G
(informative)

QMEs used to define quality measures

Most QMEs are fully described in the definition of each quality measure. Some QMEs used in several quality measures are defined below.

task

activities undertaken by a user to achieve a goal

objective

purpose of the task

user error

act or belief of the user that unintentionally deviates from what is correct, right, or true

tasks with errors

tasks where the user unintentionally deviates from a correct solution

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