TECHNICAL REPORT

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Software engineering — Software product Quality Requirements and Evaluation (SQuaRE) — Quality measure elements

Ingénierie du logiciel — Exigences de qualité et évaluation du produit logiciel (SQuaRE) — Éléments de mesure de la qualité

Reference number
ISO/IEC TR 25021:2007(E)

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Foreword

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

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

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

In exceptional circumstances, the joint technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when the joint technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

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

ISO/IEC TR 25021, which is a Technical Report of type 2, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*.

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

— Quality Management Division,

— Quality Model Division,

— Quality Measurement Division,

— Quality Requirements Division, and

— Quality Evaluation Division.

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Introduction

The purpose of this Technical Report is to define an initial set of quality measure elements to be used throughout the software product life cycle for the purpose of Software Product Quality Requirement and Evaluation (SQuaRE). While the quality measure elements can be used for standalone measurement, their main purpose is to be used as the building blocks for other SQuaRE measures as described in ISO/IEC TR 9126-2, ISO/IEC TR 9126-3 and ISO/IEC TR 9126-4. The content of this Technical Report constitutes the link between ISO/IEC 9126 and the subsequent SQuaRE series of standards (Figure 1).

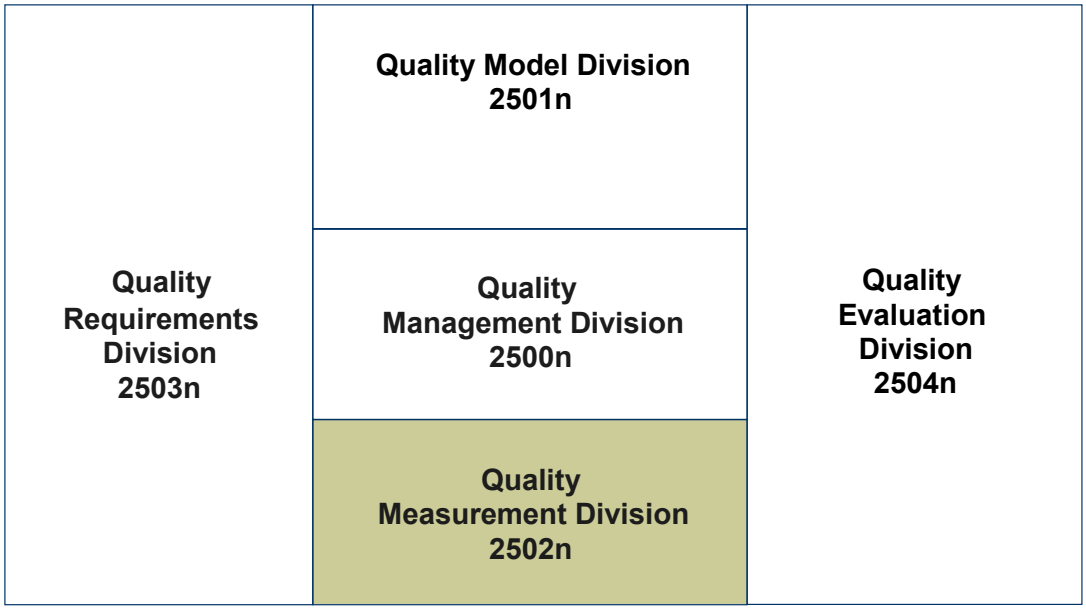

Figure 1 — Organization of SQuaRE series of standards

During the period of transition from a Technical Report to an International Standard, the intention of this Technical Report is to be only a source of support for the collection of quality measure elements. During this trial period, the applicability of this Technical Report and its content will be evaluated in the user environment. The support provided by this Technical Report for the measurement of software product quality is twofold: (a) assist in the selection of the required quality measure elements for a given quality measure, and (b) provide guidance for collecting the selected measurements.

The set of quality measures listed in this Technical Report arise from surveys involving several large commercial and academic institutions conducted during the following research projects:

— Quality Measure Validation Survey (Prague University of Economics research project GACR 201/06/0175 and Czech University of Life Sciences in Prague research projects MSM6046070904 and 2C06004);

— Conformity of Industrial Software to International Standards ES (Excellent Software) Mark (Korean Agency for Technology and Standards, Korea);

— Project for Development fund of MII (China Ministry of Information Industry): software engineering standardization.

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NOTE This set does not contain quality measure elements for all ISO/IEC 9126-1 Quality Model subcharacteristics. Some subcharacteristics were omitted because survey results did not find evidence of their use. It does not imply the ISO/IEC 9126-1 Quality Model should be changed, but rather new quality measures may need to be defined in the future.

Subsequently the quality measure elements necessary for measurement of the above quality measures set have been identified and documented. These quality measure elements represent an initial set of measures which can be used during the construction of quality measures referenced in ISO/IEC TR 9126-2, ISO/IEC TR 9126-3 and ISO/IEC TR 9126-4, as well as other measures for other purposes. Quality measures described in the SQuaRE series (Figure 2) are derived from one or more quality measure elements described in this Technical Report. When evaluating a selected quality measure, the user should first review and evaluate the relevant quality measure element(s) listed in this Technical Report.

Some important benefits from using the measures in this Technical Report are the following.

— To improve measurement productivity and consistency which will minimize measurement effort: When using quality measures such as internal, external and quality in use, there is a possibility of duplicating the attribute measurement tasks, because they are usually performed as separate activities. However by identifying the set of quality measure elements that are uniquely required to derive all the quality measures for a given product, these measurements need to be performed only once at the attribute level. This approach will improve the productivity of the measurement processes.

— Usability (guidance, cross reference): This Technical Report allows users to identify the possible indicators of quality (quality measures) that can be derived by measuring one or more measures from a selected set of quality measure elements, and thereby maximizing the benefits from the measurement process.

The quality measure elements are the common components of quality measures. The intention here is that users of this Technical Report will select measures from quality measure elements for the purpose of defining internal, external or quality-in-use measures. These are then used for the definition of quality requirements (ISO/IEC 25030), software product evaluation (ISO/IEC 2504n), quality assessment and other purposes. It is therefore strongly recommended to use this Technical Report and the other documents in the Quality Measurement Division together with the other relevant documents in the ISO/IEC 25000 series.

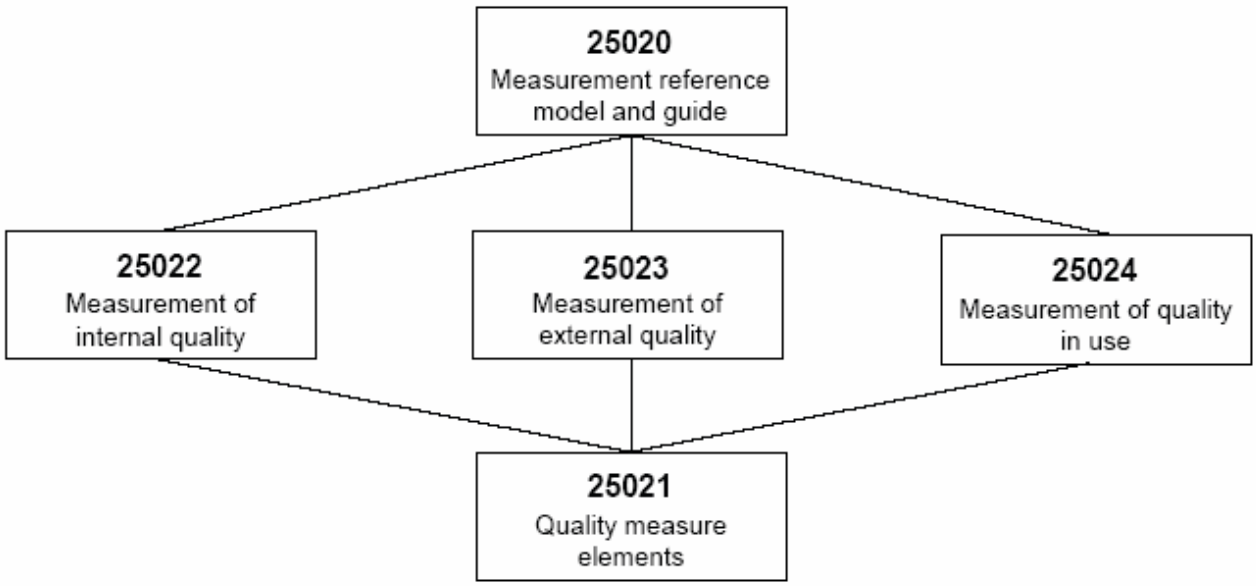

Figure 2 — Structure of the Quality Measurement Division

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Quality measure elements, together with the other support documentation offered in this Technical Report, provide added value to the ISO/IEC 9126 Technical Reports and International Standards by making them more understandable to users by clearly defining the relevant quality measure elements (Figure 3). In this sense, this Technical Report acts effectively as the common link between ISO/IEC 9126 and its follower, the SQuaRE series.

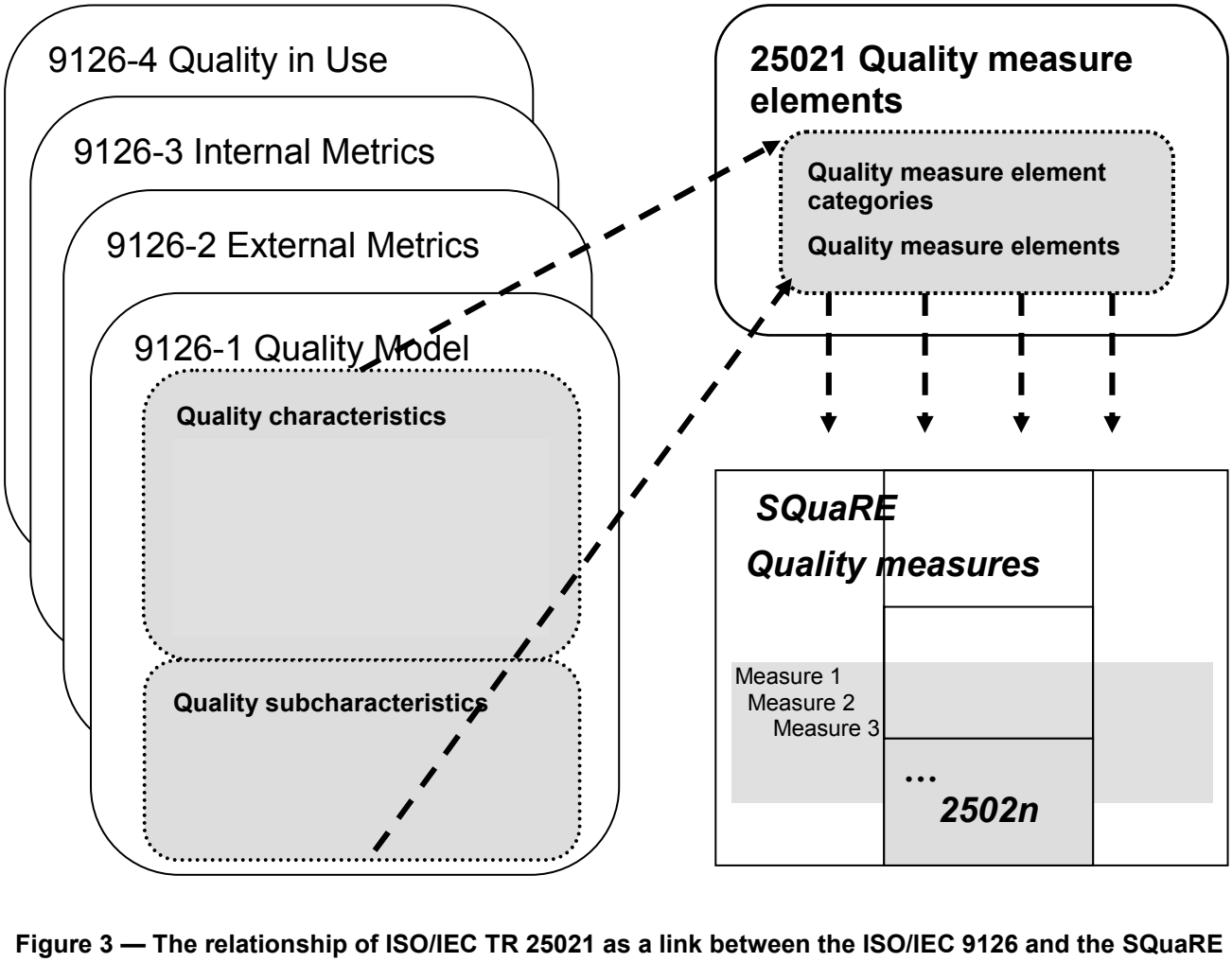

Figure 3 — The relationship of ISO/IEC TR 25021 as a link between the ISO/IEC 9126 and the SQuaRE series of standards

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Software engineering — Software product Quality Requirements and Evaluation (SQuaRE) — Quality measure elements

1 Scope

This Technical Report specifies an initial set of quality measure elements in order to assist users of ISO/IEC TR 9126-2, ISO/IEC TR 9126-3 and ISO/IEC TR 9126-4 and users of the SQuaRE series of quality measurement standards ISO/IEC 2502n in the selection and use of the quality measures for software product quality evaluation and in the selection of the entities to be measured in the software product lifecycle.

This Technical Report contains

a) a description of the concept of quality measure elements,

b) considerations for using quality measure elements,

c) a set of quality measure elements.

This Technical Report is intended for, but not limited to, developers, acquirers and independent evaluators of software product, particularly those responsible for defining software product quality requirements and for software product evaluation.

2 Conformance

There are no conformance requirements in this Technical Report.

3 Normative references

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

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

ISO/IEC 25020, *Software engineering – Software product Quality Requirements and Evaluation (SQuaRE) – Measurement reference model and guide*

ISO/IEC 15939, *Systems and software engineering – Measurement process*

ISO/IEC TR 9126-2, *Software engineering — Product quality — Part 2: External metrics*

ISO/IEC TR 9126-3, *Software engineering — Product quality — Part 3: Internal metrics*

ISO/IEC TR 9126-4, *Software engineering — Product quality — Part 4: Quality in use metrics*

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4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 25000, ISO/IEC 25020 and ISO/IEC 15939 apply.

NOTE The following definitions are replicated here for the convenience of the user.

4.1
attribute
inherent property or characteristic of an entity that can be distinguished quantitatively or qualitatively by human or automated means

NOTE 1 Based on ISO/IEC 15939:2007.

NOTE 2 ISO 9000 distinguishes two types of attributes: a permanent characteristic existing inherently in something; and an assigned characteristic of a product, process or system (e.g. the price of a product, the owner of a product). The assigned characteristic is not an inherent quality characteristic of that product, process or system.

4.2
base measure
measure defined in terms of an attribute and the method for quantifying it

NOTE A base measure is functionally independent of other measures.

[ISO/IEC 15939:2007, based on the definition in the International Vocabulary of Basic and General Terms in Metrology, 1993]

4.3
derived measure
measure that is defined as a function of two or more values of base measures

[ISO/IEC 15939:2007, based on the definition in the International Vocabulary of Basic and General Terms in Metrology, 1993]

NOTE A transformation of a base measure using a mathematical function can also be considered as a derived measure.

4.4
external software quality
capability of a software product to enable the behaviour of a system to satisfy stated and implied needs when the system is used under specified conditions

NOTE Attributes of the behaviour can be verified and/or validated by executing the software product during testing and operation.

EXAMPLE The number of failures found during testing is an external software quality measure related to the number of faults present in the program. The two measures are not necessarily identical since testing may not find all faults, and a fault may give rise to apparently different failures in different circumstances.

4.5
indicator
measure that provides an estimate or evaluation of specified attributes derived from a model with respect to defined information needs

[ISO/IEC 15939:2007]

NOTE In ISO/IEC 14598, this definition of “indicator” was: “a measure that can be used to estimate or predict another measure”.

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4.6
information need
insight necessary to manage objectives, goals, risks and problems

[ISO/IEC 15939:2007]

4.7
internal software quality
capability of a set of static attributes of a software product to satisfy stated and implied needs when the software product is used under specified conditions

NOTE 1 Static attributes include those that relate to the software architecture, structure and its components.

NOTE 2 Static attributes can be verified by review, inspection and/or automated tools.

EXAMPLE The number of lines of code, complexity measures and the number of faults found in a walk through are all internal software quality measures made on the product itself.

4.8
measure, noun
variable to which a value is assigned as the result of measurement

NOTE The term “measures” is used to refer collectively to base measures, derived measures, and indicators.

[ISO/IEC 15939:2007]

4.9
measure, verb
make a measurement

[ISO/IEC 14598-1:1999]

4.10
measurement
set of operations having the object of determining a value of a measure

[ISO/IEC 15939:2007, based on the definition in the International Vocabulary of Basic and General Terms in Metrology, 1993]

NOTE Measurement can include assigning a qualitative category such as the language of a source program (ADA, C, COBOL, etc.).

4.11
measurement function
algorithm or calculation performed to combine two or more base measures

[ISO/IEC 15939:2007]

4.12
measurement method
logical sequence of operations, described generically, used in quantifying an attribute with respect to a specified scale

[ISO/IEC 15939:2007, based on the definition in the International Vocabulary of Basic and General Terms in Metrology, 1993]

4.13
quality in use (measure)
extent to which a product used by specific users meets their needs to achieve specific goals with effectiveness, productivity, safety and satisfaction in specific contexts of use

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4.14
quality measure element
base measure or derived measure that is used for constructing software quality measures

NOTE The software quality characteristics or subcharacteristics of the entity are derived afterwards by calculating a software quality measure.

5 Symbols and abbreviated terms

For the purposes of this Technical Report, the symbols and abbreviations given in ISO/IEC 25000, ISO/IEC 25020 and the following apply.

QME Quality Measure Element

SPQM-RM Software Product Quality Measurement Reference Model

6 Quality measure elements concept

Quality measure elements are used throughout the software product lifecycle as an input for the internal, external and quality in use measures listed in ISO/IEC TR 9126-2, ISO/IEC TR 9126-3 and ISO/IEC TR 9126-4. They measure:

— Attributes of resources consumed, or activities performed during the software product development, testing, and maintenance that relate to software product quality,

— Attributes of the software product itself,

— Attributes of the specific context of use,

— Attributes of the software product when used in a specific context of use, and the effects connected with such use (effects on the user and the result of their task).

6.1 Quality measure elements in the Software Product Quality Measurement Reference Model (SPQM-RM)

International Standard ISO/IEC 25020 defines the Software Product Quality Measurement Reference Model (SPQM-RM) to be used for the software product quality requirements specification process (top-down approach) and for the software product quality evaluation process (bottom-up approach).

SPQM-RM (Figure 4) defines the position of quality measure elements in the software product quality measures definition process. Any single quality measure element by itself generally will not indicate the quality of the measured entity. The quality measure is derived afterwards by computing the results of quality measure element values as stated in the formula of the quality measure that is being measured.

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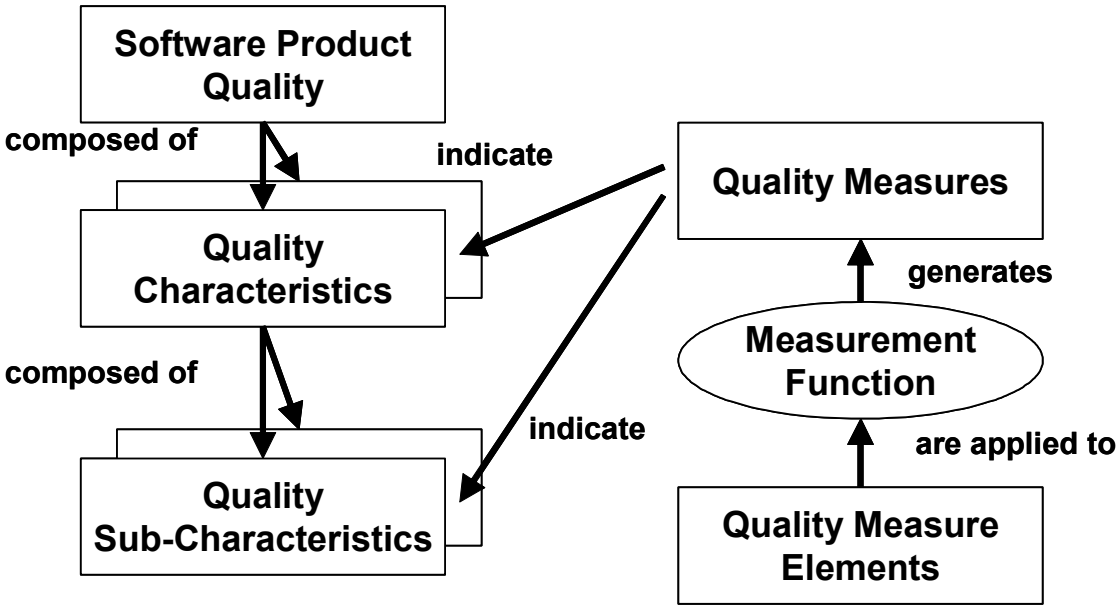

Figure 4 — Quality measure elements concept in SPQM-RM

A quality measure is derived from one or more quality measure elements. A quality measure element can be an input to more than one quality measure. This relationship can be represented in the form of a two-dimensional cross-reference table, which allows a user of this Technical Report to select the proper quality measure elements that are necessary for measuring an individual set of quality measures. It also allows the user of this Technical Report to identify quality measures, which could be derived from a given set of quality measure elements.

The layout of the cross-reference table is shown in Table 1. In this table the quality measures and quality measure elements can be any of those stated in this document. This table works in both ways: by row, a cross associates a quality measure element to all the quality measures where its usage applies; by column, all the crosses indicate the quality measure elements that are required for the quality measure in that column.

Table 1 — Layout of the cross-reference table representing the relationship between QMEs and quality measures

	Quality measure 1	Quality measure 2	Quality measure 3
Quality measure element 1	X	X	
Quality measure element 2	X		X
Quality measure element 3			X

When evaluating the quality measure elements, a user should be familiar with the information given in the quality measure element table and consider all the limitations and rules given for a listed quality measure element, prior to applying the formula to obtain the value of the quality measure.

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6.2 Quality measure elements and their categories

Quality measures in ISO/IEC TR 9126-2, ISO/IEC TR 9126-3 and ISO/IEC TR 9126-4 are described in different level of detail. Some of them are specified precisely, such that the QME and their measurement methods could be easily derived from them; others are described in a way that permits different QME and measurement methods to be used. The concept of the QME Category is used to indicate this difference.

6.3 Aspects of quality measure elements

Users of this Technical Report should consider each of the aspects listed in this section (while evaluating the quality measure elements) in order to avoid accidental misuse of the measurement process, and possible omission of essential measurement steps.

The purpose of quality measure elements is to measure different attributes of a software product or process at any stage during the software product lifecycle. This requires consideration of different aspects of the quality measure elements construction and application of specific practices, such as data selection, measurement process, documentation, arithmetic operations, etc. that are described in each clause.

For the purpose of this Technical Report these aspects are:

— Measurement scale type – the scale type used for measurement,

— Measurement focus in the software product quality lifecycle – the scope and objective of the measurement (e.g. the software product itself, software product in a system, software product in a system used by a specified user in a specified scenario),

— Measurement method type – the measurement method type relating to the quality measure element used for measurement.

These aspects are followed with an essential, but not exclusive set of considerations. While measuring any quality measure element a user of this Technical Report should examine relevant considerations from all the above listed aspects.

NOTE 1 The following aspects and considerations relate to common issues that are relevant to the collection or measurement of (non-exclusive) sets of QMEs.

NOTE 2 Some of the described considerations (e.g. nominal scale etc.) are not relevant for any of the QME listed in this Technical Report. They have bee included to bring the complete description of each aspect and allow measurement of QMEs not listed in this Technical Report.

6.3.1 Measurement scale type

The type of scale depends on the nature of the relationship between values on the scale. Five types of scales are commonly used and connected considerations are:

NOTE Scale is defined in ISO/IEC 25000. The following are examples of types of scale.

Nominal scale - The purpose of nominal scale type measures is to classify measured attributes. No ordering is implied even if numbers are used. The numbers assigned to measures in nominal scale type measurement identify only the category (type) of measured attribute. Therefore the order, minimum, maximum, median, arithmetic mean, percentage, etc. derived from these numbers do not have any empirical meaning.

EXAMPLE Software product fault types or categories. Type of function based on the software product quality model (e.g., type of quality characteristics or subcharacteristics)

Ordinal scale - The purpose of ordinal scale type measures is to assign an order to measured attributes. The ordinal scale is often useful to augment the nominal scale with information about an ordering of the classes or categories. The minimum, maximum and median derived from the measures in the ordinal scale type

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measurement have empirical meaning. The arithmetic mean, percentage etc. do not have an empirical meaning.

EXAMPLE Software product failure by severity (e.g. negligible, marginal, critical, catastrophic)

Interval scale - The purpose of interval scale type measures is to measure a difference between measures. If a ratio is calculated from the quality measure elements of the same type, it does not have an empirical meaning.

EXAMPLE Cyclomatic complexity has a minimum value of one, but each increment represents an additional path. The value of zero is not possible.

Ratio scale - The ratio scale is similar to the interval scale but includes the value zero, representing total lack of an attribute. Ratio scale quality measure elements include ordered rating scales, where the difference between two measures, and the ratio of two measures, has the same empirical meaning. Ratio and average are giving meaning to the values.

EXAMPLE Effort (time) spent to change, Buffer size, Number of detected faults

Absolute scale - The purpose of absolute scale type measures is to measure a proportion between measures with the same units. Absolute scale quality measure elements include measures resulting from dividing one ratio scale measure to another ratio scale measure where the measurement unit is the same in both cases.

EXAMPLE Number of comment lines divided by total lines of code

6.3.2 Measurement focus in software product quality lifecycle

NOTE ISO/IEC 25020 defines the relationship between the software product quality lifecycle and the quality measures. A short summary of these relationships is also described in clause 6.1 Quality measure elements in the Software Product Quality Measurement Reference Model (SPQM-RM).

Internal software quality measure - The purpose of internal software quality measures is to measure internal attributes of a software product. Internal attributes are those that can be measured in terms of the software product itself, i.e., separate from its behaviour. Internal software quality measures provide the users with the ability to measure the internal quality characteristics of the intermediate deliverables and thereby manage the development of the product to achieve the specified quality requirements. The quality measure element can be measured only if the user has access to the software product structure (source code, design specifications etc.).

NOTE Internal software quality is defined in ISO/IEC 25000

EXAMPLE The number of lines of code, complexity measures and the number of faults found in a walk through are all internal software quality measures made on the product itself.

External software quality measure - The purpose of external software quality measures is to measure external attributes of a software product. External attributes are those that can be measured only with regard to how the product relates to its environment, i.e., by observing its behaviour in the system environment in which it is intended to operate, or in a similar environment. External software quality measures provide users, evaluators, testers, and developers with the insight into the quality of the software product by collecting measures during the execution of the software product. The value of a quality measure element of that type is influenced either by the attributes of the product itself or by the attributes of the process of using it.

NOTE External software quality is defined in ISO/IEC 25000

EXAMPLE The number of failures found during testing – it could be influenced by quality of the software product but also by the testing process.

Quality in use measure - The purpose of quality in use measures is to measure quality in use attributes. Quality in use attributes are those that can be measured when executing the software product in a specified

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context of use. Quality in use measures provides users with the benefit that they are able to evaluate the results of using the software product rather than the properties of the software product itself. The value of the quality measure element is influenced by the context of use, which includes skills of the user who is using the software product. The context of use has to be stated while presenting the measurement results.

NOTE Quality in use (measure) is defined in ISO/IEC 25000

EXAMPLE Number of times that specific software product functions/applications/systems are used to fulfil a specific user task, expert user's task efficiency

6.3.3 Measurement method type

Considerations related to the measurement method type with regard to the quality measure element used for measurement are:

Subjective measurement method - Subjective measurements are those where quantification is influenced by human judgment. Subjective measures are used when no formal objective procedures of measurement can be applied. The value of the quality measure element is influenced by human judgment as an evaluator. Therefore it is necessary to interpret the results with respect to the number of evaluators and statistical methods used for the measurement result calculation. Both should be stated while presenting the measurement results.

EXAMPLE Number of times the user pauses for a long period, expert user's task efficiency

Objective measurement method - Objective measurements provide quantification that is based on numerical rules for selection, such as counting. The application of these rules may be implemented via human or automated means. When using this type of measures, no additional considerations are necessary.

EXAMPLE Number of lines of code, total number of tasks tested

6.4 Table format of quality measure elements

The following information is given in this Technical Report for each quality measure element in the form of a table:

a) QME category name: Name of quality measure element category, measured by this QME,

b) QME name: Name of quality measure element,

c) QME ID: Unique Identification of quality measure element,

d) Detail: Detail specification of measurement method,

e) Input: Source of data which could be used to measure the quality measure element,

f) Documentation: Documentation which should be prepared in order to measure the quality measure element. This is also used while interpreting the measurement for proper justification of measurement results (e.g. for justification of type of functions counted),

g) Considerations connected with the quality measure element use:

   — Measurement concept,

   — Measurement scale,

   — Measurement focus in Software Product Quality Lifecycle,

   — Measurement method type.

NOTE A more detailed explanation is given in clause 6.2 Quality measure elements and their categories

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h) Used for: Specifies the relevant internal, external, or quality in use characteristics, subcharacteristics and measure where a given QME is used.

NOTE Mapping of QME or QME Category to specific quality characteristics or subcharacteristics is not provided in this table; they are in special annexes of this TR (**Error! Reference source not found.** and 0).

7 Quality measure element categories

Quality measure element categories are listed in the following table:

Table 2 — Quality measure element categories

Quality measure element category name	Description
Data size	The number of records of the same structure, class or format that satisfy the conditions given in the relevant QME definitions. This number of records can be expressed as: — Count of records, — Size in bytes.
Number of Data Items	The count of different types of structures, classes, or formats of data that satisfy the condition given in the relevant QME definitions.
Number of Failures	The count of all failures which occur in a given time span and which also satisfy the condition given in the relevant QME definitions. EXAMPLE # of expected failures, # of detected failures, # of resolved failures, # of failures of a given severity level.
Number of Faults	The count of software product faults detected (or estimated) in a given software product component and satisfy the condition given in the relevant QME definitions. NOTE # fault of a given category, # faults of a given severity, # faults successfully corrected, etc.
Number of Functions	The count of all the functions that satisfy the condition given in the relevant QME definitions. NOTE Functions can be for example, required, implemented, tested, essential, optional, or any combination of these and more.
Number of I/O Events	The count of the number of I/O events that satisfy the condition given in the relevant QME definitions. NOTE We can distinguish between messages from the system to the observer - Interaction between observer and the system e.g. a dialogue, - Transaction: the sequence of interactions between the observer and system which must be executed atomically to accomplish an operation, e.g. a wizard (with options).

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Quality measure element category name	Description
Number of Requirements	The count of requirement clauses that satisfy the condition given in the relevant QME definitions. NOTE Requirements can be i.e. essential, optional, validated, or any combination of these and more.
Number of Restarts	The count of the number of attempts for a system to resume computation after a critical failure, and satisfies the condition given in the relevant QME definitions. We distinguish between System restart Recover
Number of System Operations	The count of complete operations performed by the system that satisfy the condition given in the relevant QME definitions. NOTE We count the number of complete operations, not the individual steps required in each operation.
Number of Tasks	A Task is the set or sequence of activities required to achieve a given goal. The number of tasks is the count of tasks that satisfy the condition given in the relevant QME definitions. We distinguish between — User tasks: activities performed by the user (using software product) towards a specified goal, — System tasks: activities performed by the system to support user tasks.
Number of Test Cases	Refers to the count of different test input data and scenarios that satisfy the condition given in the relevant QME definitions, e.g. test cases designed, required, executed (successfully or failed), etc.
Number of Trials	The count of attempts to perform the same operation to satisfy the condition given in the relevant QME definitions. These attempts can be — Evaluation: iterations with same input and same scenario (e.g. stress testing), — Cases: iterations with different input and/or different scenarios.
Number of User Operations	The count of number of operations performed by the user that satisfy the condition given in the relevant QME definitions, where an operation is a sequence of steps required to perform a task.

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Quality measure element category name	Description
Product Size	The count of software product components according to a desired criterion. This can be lines of code (LOC), function points (see note), modules, classes, or visual structures such as diagrams or their parts. NOTE 1 Software product components can be counted only if some additional properties are satisfied e.g. only executable lines of code, lines of code which also contain commenting, only comment lines, declaration or type casting, bracket/braces only, etc. NOTE 2 There are four ISO/IEC standards defining the function point product size.
Time Duration	Refers to the interval between a starting time and an end time of any process described in the relevant QME definitions (Time duration = end time – start time). We distinguish between — Execution Time: Refers to time measured internally by the computer clock, e.g. CPU time, I/O time, etc., or any time measured via inserted code or software tools (e.g. test suites), — Observation time: Refers to time measured externally by the observer, using an external clock, e.g. time to finish a transaction or user task, — Set time: A fixed time process or observation, but meaningful for a measure evaluation that is independent of action, e.g. required response time.

8 Set of quality measure elements

8.1 Data Size

8.1.1 Number of change log data actually recorded

QME Category	Data Size
QME Name	Number of change log data actually recorded
QME ID	QME0101
Detail	Count the number of change log data that have been actually recorded (as internal files, as database records) during the software product change.
Input	Maintenance report
Documentation	
Measurement scale	Ratio
Measurement focus	External

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Measurement method	Objective
Used for	Software change control capability

8.1.2 Number of change log data planned to be recorded as sufficient to trace software changes

QME Category	Data Size
QME Name	Number of change log data planned to be recorded as sufficient to trace software changes
QME ID	QME0102
Detail	Derive from specification of required change log data items to be recorded.
Input	REQ Spec.
Documentation	
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Software change control capability

8.1.3 Number of data actually recorded during operation

QME Category	Data Size
QME Name	Number of data actually recorded during operation
QME ID	QME0103
Detail	Document the data size that has been recorded during operation items.
Input	Test report
Documentation	
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Audit trail capability

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8.1.4 Number of data planned to be recorded as sufficient to monitor status of software during operation

QME Category	Data Size
QME Name	Number of data planned to be recorded as sufficient to monitor status of software during operation
QME ID	QME0104
Detail	Count the number of data items to be recorded during operation as specified in requirements.
Input	Requirements
Documentation	
Measurement scale	Ratio
Measurement focus	External
Measurement method	Subjective
Used for	Audit trail capability

8.2 Number of Data Items

8.2.1 Number of data formats to be exchanged as in the specifications

QME Category	Number of Data Items
QME Name	Number of data formats to be exchanged as in the specifications
QME ID	QME0201
Detail	Count the number of data formats to be exchanged as in the specifications.
Input	REQ spec.
Documentation	
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Data exchangeability (Data format based)

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8.2.2 Number of data items implemented with specific levels of precision, confirmed in evaluation

QME Category	Number of Data Items
QME Name	Number of data items implemented with specific levels of precision, confirmed in evaluation
QME ID	QME0202
Detail	Count the number of data items that meet the requirements of specific levels of precision. Data items are various formats used in input and/or output operations - input or output windows on the screen, output files etc.
Inputs	REQ spec. Design spec. Source code Review report
Documentation	List of data items reviewed
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Precision

8.2.3 Number of data items that require specific levels of precision

QME Category	Number of Data Items
QME Name	Number of data items that require specific levels of precision
QME ID	QME0203
Detail	Count the total number of data items with specific level of precision defined in requirements or design specification. Data items are various formats used in input and/or output operations - input or output windows on the screen, output files etc.
Input	REQ spec. Design spec.
Documentation	List of data items reviewed
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Precision

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8.2.4 Number of data structures, which are operable and have no limitation after adaptation

QME Category	Number of Data Items
QME Name	Number of data structures, which are operable and have no limitation after adaptation
QME ID	QME0204
Detail	Count the number of data structures which are operable and has no limitation after adaptation, confirmed in review.
Inputs	REQ spec. Design spec. Review report
Documentation	List of data items reviewed
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Adaptability of data structures

8.2.5 Number of input and output data items available from the interface

QME Category	Number of Data Items
QME Name	Number of input and output data items available from the interface
QME ID	QME0205
Detail	Count the number of input and output data items available for user from the interface as described in the user manual. Data items are various formats used in input and/or output operations - input or output windows on the screen, output files etc.
Input	User manual
Documentation	List of input data items List of output data items
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Understandable input and output

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8.2.6 Number of input and output data items which user successfully understands

QME Category	Number of Data Items
QME Name	Number of input and output data items which user successfully understands
QME ID	QME0206
Detail	Conduct user test and interview user with questionnaire or observe user behaviour and count data items classified as understood. Data items are various formats used in input and/or output operations - input or output windows on the screen, output files etc.
Inputs	User manual Operation report
Documentation	List of input data items List of output data items Criteria (method) used for understandability classification
Measurement scale	Ratio
Measurement focus	External
Measurement method	Subjective
Used for	Understandable input and output

8.2.7 Number of interface data formats that have been implemented correctly as in the specifications

QME Category	Number of Data Items
QME Name	Number of interface data formats that have been implemented correctly as in the specifications
QME ID	QME0207
Detail	Count the number of interface data formats that have been implemented correctly in the source code with respect to the interface.
Inputs	REQ spec. Design spec. Source code Review report
Documentation	List of interface data formats List of incorrectly implemented data formats
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Data exchangeability (Data format based)

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8.2.8 Total number of data structures requiring adaptation capability

QME Category	Number of Data Items
QME Name	Total number of data structures requiring adaptation capability
QME ID	QME0208
Detail	Count the total number of data structures requiring adaptation capability, confirmed in review, design or REQ spec.
Inputs	REQ spec. Design spec. Review report
Documentation	
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Subjective
Used for	Adaptability of data structures

8.3 Number of Failures

8.3.1 Number of detected failures

QME Category	Number of Failures
QME Name	Number of detected failures
QME ID	QME0301
Detail	Count the number of detected failures during defined trial period of using the software product. Each failure has to be categorized and weighted by its importance.
Inputs	Test report Operation report Problem report
Documentation	List of test cases applied List of failures with their categories List of failures categories and their weights
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Failure density against test cases

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8.3.2 Number of resolved failures

QME Category	Number of Failures
QME Name	Number of resolved failures
QME ID	QME0302
Detail	Count the number of failures that did not reoccur during defined trial period under the similar conditions (e.g. under same test cases executed).
Inputs	Test report Operation report
Documentation	List of failures categories and their weights List of resolved failures and their categories
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Failure resolution

8.3.3 Number of transmission related error messages and failures

QME Category	Number of Failures
QME Name	Number of transmission related error messages and failures
QME ID	QME0303
Detail	Emulate a condition where by the system reaches a situation of expected load. Run the application and record the number of error messages and failures related to transmission.
Inputs	Operation report showing elapse time Test report
Documentation	Measurement Tool name and version Computer HW specification Operating system name and version
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Mean occurrence of transmission error

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8.3.4 Total number of actually detected failures

QME Category	Number of Failures
QME Name	Total number of actually detected failures
QME ID	QME0304
Detail	Count the total number of actually detected failures during observed operation time. Create and maintain a problem resolution report describing status of all the failures.
Inputs	Operation report Test report
Documentation	List of test cases applied List of failures categories and their weights List of failures with their categories
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Failure resolution Mean time between failures (MTBF)

8.4 Number of Faults

8.4.1 Number of corrected faults in design/coding

QME Category	Number of Faults
QME Name	Number of corrected faults in design/coding
QME ID	QME0401
Detail	Count the number of faults corrected (removed) during design/coding.
Input	Fault removal report
Documentation	List of fault categories and their weights List of corrected faults with their categories
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Fault removal

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8.4.2 Number of detected faults

QME Category	Number of Faults
QME Name	Number of detected faults
QME ID	QME0402
Detail	Count the number of detected faults during defined trial period of using software product. Each fault has to be categorized and weighted by its importance. Source of each fault has to be identified (e.g. design, code, etc.)
Inputs	Operation report Test report Problem report Source code Review report REQ spec.
Documentation	List of test cases applied List of fault categories and their weights Lists of detected faults and their categories
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Fault removal

8.4.3 Number of faults detected in review

QME Category	Number of Faults
QME Name	Number of faults detected in review
QME ID	QME0403
Detail	Count the numbers of faults detected in review, during design/coding.
Input	Review report
Documentation	List of fault categories and their weights Lists of detected faults and their categories
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Fault removal

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8.5 Number of Function

8.5.1 Number of functions

QME Category	Number of Functions
QME Name	Number of functions implemented
QME ID	QME0501
Detail	Count the number of functions implemented, (both correctly and incorrectly implemented). Each reviewed function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Review report
Documentation	List of functions implemented
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Completeness of user documentation and/or help facility Physical accessibility Completeness of description

8.5.2 Number of functions (or types of functions) described in the product description

QME Category	Number of Functions
QME Name	Number of functions (or types of functions) described in the product description
QME ID	QME0502
Detail	Count the number of functions, which are adequately described in the product description.
Inputs	REQ spec. Design spec. Review report Product description (documentation)
Documentation	
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Subjective
Used for	Completeness of description Completeness of user documentation and/or help facility

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8.5.3 Number of functions reviewed

QME Category	Number of Functions
QME Name	Number of functions reviewed
QME ID	QME0503
Detail	Count the number of implemented functions that were reviewed during the validation process. The following may be measured : — all or parts of design specifications, — completed modules/parts of software products. Each counted function has to be categorized and weighted by its importance.
Inputs	Review report Test report
Documentation	List of functions reviewed
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Functional adequacy

8.5.4 Number of functions described in requirement specifications

QME Category	Number of Functions
QME Name	Number of functions described in requirement specifications
QME ID	QME0504
Detail	Count the number of functions described in the requirement specifications. Each reviewed function has to be categorized and weighted by its importance.
Input	REQ spec.
Documentation	List of functions required
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Functional implementation completeness Functional implementation coverage

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8.5.5 Number of functions for which specific accuracy requirements need to be implemented

QME Category	Number of Functions
QME Name	Number of functions for which specific accuracy requirements need to be implemented.
QME ID	QME0505
Detail	Count the number of functions with specific accuracy requirements needs to be implemented and listed the specific accuracy requirements according specification. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Source code
Documentation	List of accuracy requirements
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Computational Accuracy

8.5.6 Number of functions in which problems are detected in evaluation

QME Category	Number of Functions
QME Name	Number of functions in which problems are detected in evaluation
QME ID	QME0506
Detail	Count the number of functions in which problems are detected during evaluation. The following may be measured: — all or parts of design specification, — completed modules/parts of software products. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Source code Review report Test report
Documentation	List of problem categories and their weights List of problems with their categories List of functions, which have problems
Measurement scale	Ratio

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Measurement focus	Internal
Measurement method	Objective
Used for	Functional adequacy

8.5.7 Number of functions in which specific accuracy requirements had been implemented, confirmed in evaluation

QME Category	Number of Functions
QME Name	Number of functions in which specific accuracy requirements had been implemented, confirmed in evaluation
QME ID	QME0507
Detail	Count the number of functions that have implemented the accuracy requirements and that were confirmed during the evaluation process. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Source code Test report
Documentation	
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Computational Accuracy

8.5.8 Number of functions, which can be customized

QME Category	Number of Functions
QME Name	Number of functions, which can be customized
QME ID	QME0508
Detail	Count the number of implemented functions, which can be customized. Each reviewed function has to be categorized and weighted by its importance. The meaning of "customization" has to be also defined and documented before starting each measurement.
Inputs	REQ spec. Review report
Documentation	List of customizable functions

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Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Physical accessibility

8.5.9 Number of implemented functions, which are capable of achieving, required results in specified multiple HW environments as specified

QME Category	Number of Functions
QME Name	Number of implemented functions, which are capable of achieving, required results in specified multiple HW environments as specified
QME ID	QME0509
Detail	Count the number of implemented functions, which are capable of achieving, required results in specified multiple HW environments as specified, confirmed in review. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Review report
Documentation	List of implemented functions, which have H/W portability
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Hardware environmental adaptability (adaptability to hardware devices and

8.5.10 Number of implemented functions, which are capable of achieving, required results in specified multiple system software environments as specified

QME Category	Number of Functions
QME Name	Number of implemented functions, which are capable of achieving, required results in specified multiple system software environments as specified
QME ID	QME0510
Detail	Count the number of implemented functions, which are capable of achieving, required results in specified multiple system software environments as specified, confirmed in review. Each counted function has to be categorized and weighted by its importance.

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Inputs	REQ spec. Design spec. Review report
Documentation	List of implemented functions, which have S/W portability
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	System software environmental adaptability (adaptability to OS, network software and co-operated application software

8.5.11 Number of incorrectly implemented or missing functions detected

QME Category	Number of Functions
QME Name	Number of incorrectly implemented or missing functions detected
QME ID	QME0511
Detail	Count the number of incorrectly implemented or missing functions detected in validation, in comparison to the actual version of requirements or design specifications. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Source code Review report
Documentation	List of incorrectly implemented or missing functions with their categories
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Functional implementation coverage

8.5.12 Number of missing functions detected in evaluation

QME Category	Number of Functions
QME Name	Number of missing functions detected in evaluation
QME ID	QME0512

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Detail	Count the number of missing functions detected in evaluation in comparison to the requirements or design specifications. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Source code Review report
Documentation	List of missing functions with their categories
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Functional implementation completeness

8.5.13 Number of user interface functions

QME Category	Number of Functions
QME Name	Number of user interface functions
QME ID	QME0513
Detail	Count the number of implemented user interface functions. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Review report User manual
Documentation	
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Function understandability

8.5.14 Number of user interface functions where the purpose is understood by the user

QME Category	Number of Functions
QME Name	Number of user interface functions where the purpose is understood by the user
QME ID	QME0514

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Detail	Count the number of user interface functions where the purposes are understandable to the user. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Review report
Documentation	List of user interface functions Description of the method for assessing understandability
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Subjective
Used for	Function understandability

8.5.15 Total number of functions with H/W environment adaptation capability requirements

QME Category	Number of Functions
QME Name	Total number of functions with H/W environment adaptation capability requirements
QME ID	QME0515
Detail	Count the total number of functions with H/W environment adaptation capability requirements. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Review report
Documentation	
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Hardware environmental adaptability (adaptability to hardware devices and network facilities)

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8.5.16 Total number of functions with system software environment adaptation capability requirements

QME Category	Number of Functions
QME Name	Total number of functions with system software environment adaptation capability requirements
QME ID	QME0516
Detail	Count the total number of functions with system software environment adaptation capability requirements. Each counted function has to be categorized and weighted by its importance.
Inputs	REQ spec. Design spec. Review report
Documentation	
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	System software environmental adaptability (adaptability to OS, network software and co-operated application software)

8.6 Number of I/O Events

8.6.1 Number of I/O messages during evaluation

QME Category	Number of I/O Events
QME Name	Number of I/O messages during evaluation
QME ID	QME0601
Detail	Run application and monitor result(s) I/O messages for specific evaluation.
Input	Operation report
Documentation	Measurement tool name and version Computer HW specification Operating system name and version
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	I/O loading limits

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8.6.2 Required maximum number of I/O messages

QME Category	Number of I/O Events
QME Name	Required maximum number of I/O messages
QME ID	QME0602
Detail	Required maximum number of I/O messages can be derived from specification of required real-time processing, user expectation of business needs, or observation of user reaction. A user cognitive aspect of human ergonomics may be considerable if required maximum number of I/O messages is not specified in requirements. Take into account that it can be different number for different user.
Inputs	Testing report Operation report showing elapse time
Documentation	Prediction model applied Historical data used
Measurement scale	Ratio
Measurement focus	External
Measurement method	Subjective
Used for	I/O loading limits

8.6.3 Required maximum number of transmission related error messages and failures

QME Category	Number of I/O Events
QME Name	Required maximum number of transmission related error messages and failures
QME ID	QME0603
Detail	This should be derived from requirements specifications
Input	REQ spec.
Documentation	
Measurement scale	Ratio
Measurement focus	External
Measurement method	Subjective
Used for	Maximum transmission utilization

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8.7 Number of Requirements

8.7.1 Number of access controllability requirements implemented correctly as in the specifications

QME Category	Number of Requirements
QME Name	Number of access controllability requirements implemented correctly as in the specifications.
QME ID	QME0701
Detail	Count the number of access controllability requirements implemented correctly as in the specification.
Inputs	REQ spec. Design spec. Source code Review report
Documentation	
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Access controllability

8.7.2 Number of access controllability requirements in the specifications

QME Category	Number of Requirements
QME Name	Number of access controllability requirements in the specifications
QME ID	QME0702
Detail	Count the number of access controllability requirements in the specifications. Each counted requirement has to be categorized and weighted by its importance.
Input	REQ spec.
Documentation	List of access controllability requirements
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Access controllability

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8.8 Number of Restarts

8.8.1 Number of restarts which met required time during testing or user operation support

QME Category	Number of Restarts
QME Name	Number of restarts which met required time during testing or user operation support
QME ID	QME0801
Detail	Count the number of attempts for a system to resume computation after a critical failure or system start, which met the set, required time. It means the number of system restart providing service to users within a required time.
Inputs	Test report Operation report REQ spec.
Documentation	Set time - time required to restart
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Restartability

8.8.2 Total number of restarts during testing or user operation support

QME Category	Number of Restarts
QME Name	Total number of restarts during testing or user operation support
QME ID	QME0802
Detail	Count the number of attempts for a system to resume computation after a critical failure or system start during the trial period
Inputs	Operation report Test report
Documentation	List of restart times and their reasons
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Restartability

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8.9 Number of Tasks

8.9.1 Number of accesses to help until a user completes his/her task

QME Category	Number of Tasks
QME Name	Number of accesses to help until a user completes his/her task
QME ID	QME0901
Detail	Conduct user test and observe user behaviour. Count the number of cases that user accesses help to complete his/her task. All these counts must be performed with in the context of a proper experiment, where both tasks and subjects are a random selection from their respective populations.
Inputs	Operation report or Test report User monitoring record
Documentation	List of user tasks tested Record of accesses to help
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Help frequency

8.9.2 Number of completed tasks

QME Category	Number of Tasks
QME Name	Number of completed tasks
QME ID	QME0902
Definition	The total number of user tasks, which have been successfully completed during testing or operation.
Detail	Conduct user test and observe user behaviour or observe user behaviour during operation. Count the number of user tasks successfully completed. All these counts must be performed with in the context of a proper experiment, where both tasks and subjects are a random selection from their respective populations.
Inputs	Operation report or Test report User monitoring record
Documentation	List of user tasks successfully completed
Measurement scale	Ratio
Measurement focus	External

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Measurement method	Objective
Used for	Effectiveness of the user documentation and/or help system

8.9.3 Number of tasks successfully completed after accessing online help and/or user documentation

QME Category	Number of Tasks
QME Name	Number of tasks successfully completed after accessing online help and/or user documentation
QME ID	QME0903
Detail	Conduct user test and observe user behaviour or observe user behaviour during operation. Count the number of user tasks successfully completed after accessing online help and/or user documentation. All these counts must be performed with in the context of a proper experiment, where both tasks and subjects are a random selection from their respective populations.
Inputs	Operation report or Test report User monitoring record
Documentation	List of user tasks tested Record of completed tasks after accessing online help and/or user documentation.
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Effectiveness of the user documentation and/or help system

8.9.4 Throughput

QME Category	Number of Tasks
QME Name	Throughput
QME ID	QME0904
Detail	Execute a number of concurrent tasks. Count the number of job tasks completed in a given time period. Keep a record of each attempt. This QME needs to part of an experiment where operational profiles are used to determine appropriate task mixed.
Inputs	Testing report Operation report showing elapse time
Documentation	List of tasks executed during the testing Record of completed number of tasks for each time period

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Measurement scale	Ratio
Measurement focus	External, Quality In Use
Measurement method	Objective
Used for	Mean throughput (mean amount of throughput) Task completion

8.9.5 Total number of tasks tested

QME Category	Number of Tasks
QME Name	Total number of tasks tested
QME ID	QME0905
Detail	Count the total number of user tasks tested.
Input	User monitoring record or Operation report
Documentation	List of user tasks tested
Measurement scale	Ratio
Measurement focus	External, Quality In Use
Measurement method	Objective
Used for	Effectiveness of the user documentation and/or help system Help accessibility Task completion

8.10 Number of Test Cases

8.10.1 Number of passed test cases during testing or operation

QME Category	Number of Test Cases
QME Name	Number of passed test cases during testing or operation
QME ID	QME1001
Detail	Count the number of test cases passed (with no deviations from the expected test case results) which have been actually executed during testing or operation.
Input	Test report
Documentation	List of test cases passed
Measurement scale	Ratio

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Measurement focus	External
Measurement method	Objective
Used for	Test maturity

8.10.2 Number of performed test cases

QME Category	Number of Test Cases
QME Name	Number of performed test cases during testing or operation
QME ID	QME1002
Detail	Count the number of test cases which have been actually executed during testing or operation.
Input	Test report
Documentation	List of test cases applied
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Test maturity

8.10.3 Number of test cases required

QME Category	Number of Test Cases
QME Name	Number of test cases required
QME ID	QME1003
Detail	Count the number of test cases to be performed as per requirements. If the number of test cases is not defined in requirements specification, it should be defined in the test plan (covering all requirements). It is recommended to perform stress testing using live historical data especially from peak periods. It is also recommended to ensure that the following test types are executed and passed successfully: - User operation scenario; - Peak stress; Overloaded data input.
Input	REQ spec. Test plan
Documentation	List of test cases to be applied per requirement

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Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Test maturity

8.11 Number of Trials

8.11.1 Number of cases which a user succeeded to change install operation for his/her convenience

QME Category	Number of Trials
QME Name	Number of cases which a user succeeded to change install operation for his/her convenience
QME ID	QME1101
Detail	Observe user's or maintainer's behaviour when user is trying to install software in operation environment. Count the number of cases, when user successfully installed the software product as expected.
Input	Test report
Documentation	List of test cases to be applied per requirement
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Ease of installation

8.11.2 Number of evaluations

QME Category	Number of Trials
QME Name	Number of evaluations
QME ID	QME1102
Detail	Count the number of attempts to perform the iterations with same input under same scenario containing the system response
Inputs	Test spec. Operation report Test report
Documentation	Executed scenario Input to scenario

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Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	I/O loading limit Maximum memory utilization Maximum transmission utilization Mean occurrence of transmission error Mean response time (Mean time to response) Mean throughput (Mean amount of throughput) Mean turnaround time (Mean time for turnaround)

8.11.3 Total number of cases which a user attempted to change install operation for his/her convenience

QME Category	Number of Trials
QME Name	Total number of cases, which a user attempted to change install operation for his/her convenience
QME ID	QME1103
Detail	Observe user's or maintainer's behaviour when user is trying to install software to operation environment. Count the number of cases, when user tried to install the software product.
Input	Test report
Documentation	
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Ease of installation

8.12 Product Size

8.12.1 Product Size

QME Category	Product Size
QME Name	Non-comment source statements (NCSS) Product Size
QME ID	QME1201
Detail	Count the non-comment source statements (NCSS) that include executable statements and data declaration statements with logical source statements.

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Inputs	Source code
Documentation	Programming language
Measurement scale	Ratio
Measurement focus	Internal
Measurement method	Objective
Used for	Estimated latent fault density, Fault Density

8.13 Time Duration

8.13.1 Failure resolution time

QME Category	Time Duration
QME Name	Failure resolution time
QME ID	QME1301
Detail	Time measured externally by the observer, using an external clock, identifying the duration of the failure resolution (the time duration between failure occurrence and its final resolution).
Inputs	Operation report Test report
Documentation	
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Mean time between failures (MTBF)

8.13.2 Operation time

QME Category	Time Duration
QME Name	Operation time
QME ID	QME1302
Detail	Time measured externally by the observer, using an external clock, identifying the duration when the software is under discrete operation or continuous operation. In intermittent operation mode, it should be assumed that the time measurement is done only for the period when the software is active.

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Inputs	Operation report
Documentation	
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Computational accuracy Mean time between failures (MTBF) Precision

8.13.3 Response time

QME Category	Time Duration
QME Name	Response time
QME ID	QME1303
Detail	Execution time (or observation time) interval between user action and system response for specific user operation. Response time is usually a measure of an interactive system's efficiency that tracks the speed with which the system will respond to a user's command.
Inputs	Test report Operation report Special computer message
Documentation	Measurement method (execution or observation time) User operation identification Record of response time for each user operation
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Mean response time (Mean time to response)

8.13.4 Task time

QME Category	Time Duration
QME Name	Task time
QME ID	QME1304
Detail	Task time is usually a measured for a user attempting to fulfil a specified task.

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Inputs	Test report Operation report
Documentation	Task description User operation identification Record of response time for each user operation
Measurement scale	Ratio
Measurement focus	Quality in Use
Measurement method	Objective
Used for	Task time

8.13.5 Turnaround time

QME Category	Time Duration
QME Name	Turnaround time
QME ID	QME1305
Detail	Emulate a condition where a load is placed on the system by executing a number of concurrent tasks (sample shot). Measure the time it takes to complete the selected job task in the given traffic with given input data. Keep a record of each attempt.
Inputs	Operation report showing elapse time Test report
Documentation	List of tasks executed during the testing Record of turnaround time for each task
Measurement scale	Ratio
Measurement focus	External
Measurement method	Objective
Used for	Mean turnaround time (Mean time for turnaround)

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Annex A
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Selected quality measures

Listed quality measures arise from research projects described in Introduction. They represent a default kernel of quality measures, which are proven to be used in common practice. They are also used and described in other documents, together with a wide range of other measurements that are required for more specific purposes. These documents are the ISO/IEC TR 9126-2, ISO/IEC TR 9126-3 and ISO/IEC TR 9126-4.

NOTE This set does not contain information for all ISO/IEC 9126-1 Quality Model subcharacteristics. Some subcharacteristics were omitted, because survey results did not find evidence of their use. It does not imply the ISO/IEC 9126-1, Quality Model should be changed, but rather the new quality measures should be defined in the future.

Table A.1 — Set of Quality Measures

Document	Quality Characteristics	Quality Subcharacteristics	Quality Measure Name	Number of QME defined for this Quality Measure
External Quality Measures ISO/IEC TR 9126-2	Functionality	Suitability	Functional implementation completeness	2
			Functional adequacy	2
			Functional implementation coverage	2
		Accuracy	Computational accuracy	3
			Precision	3
		Interoperability	Data exchangeability (Data format based)	2
		Security	Access controllability	2
	Reliability	Maturity	Estimated latent fault density	3
			Failure density against test cases	1
			Failure resolution	2
			Fault density	2
			Fault removal	3
			Mean time between failures (MTBF)	2

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Document	Quality Characteristics	Quality Subcharacteristics	Quality Measure Name	Number of QME defined for this Quality Measure
			Test maturity	2
		Recoverability	Restartability	2
	Usability	Understandability	Completeness of description	2
			Function understandability	2
			Understandable input and output	2
		Learnability	Effectiveness of the user documentation and/or help system	2
			Help accessibility	1
		Operability	Physical accessibility	2
	Efficiency	Time Behaviour	Mean response time (Mean time to response)	3
			Mean throughput (Mean amount of throughput)	2
			Mean turnaround time (Mean time for turnaround)	3
		Resource Utilization	I/O loading limits	3
			Maximum memory utilization	1
			Maximum transmission utilization	2
			Mean occurrence of transmission error	3
	Maintainability	Analyzability	Audit trail capability	2
		Changeability	Software change control capability	2
	Portability	Adaptability	Adaptability of data structures	2
			Hardware environmental adaptability (adaptability to hardware devices and network facilities)	2
			System software environmental adaptability (adaptability to OS, network software and co-operated application software	2
		Installability	Ease of installation	2

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Document	Quality Characteristics	Quality Subcharacteristics	Quality Measure Name	Number of QME defined for this Quality Measure
Internal Quality Measures ISO/IEC TR 9126-3	Functionality	Suitability	Functional implementation completeness	2
			Functional adequacy	2
			Functional implementation coverage	2
		Accuracy	Computational accuracy	3
			Precision	3
		Interoperability	Data exchangeability (Data format based)	2
		Security	Access controllability	2
	Reliability	Maturity	Fault removal	3
	Usability	Understandability	Completeness of description	2
			Function understandability	2
		Learnability	Completeness of user documentation and/or help facility	2
		Operability	Physical accessibility	2
	Portability	Adaptability	Adaptability of data structures	2
			Hardware environmental adaptability (adaptability to hardware devices and network facilities)	2
			System software environmental adaptability (adaptability to OS, network software and co-operated application software	2
Quality in Use Measures ISO/IEC TR 9126-4	Effectiveness		Task completion	2
	Productivity		Task time	1

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Annex B
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Cross reference table between quality measures and quality measure element categories

Following table depicts the relationship (cross-reference) between quality measures and quality measure element categories listed in this Technical Report. Values in columns are showing the number of quality measure elements in relevant QME category defined for each quality measure.

NOTE This set does not contain information for all ISO/IEC 9126-1 Quality model subcharacteristics. Some subcharacteristics were omitted, because survey results did not find evidence of their use. It does not imply the ISO/IEC 9126-1 Quality model should be changed, but rather the new quality measures should be defined in the future.

Table B.1 — Cross Reference table between quality measures and quality measure element categories

Document	Quality Characteristics	Quality Subcharacteristics	Quality Measure Name	Data Size	Number of I/O	Number of Data Items	Number of Failures	Number of Faults	Number of Functions	Number of Requirements	Number of Restarts	Number of Tasks	Number of Test Cases	Number of Trials	Product Size	Time Duration
External Quality Measures ISO/IEC TR 9126-2	Functionality	Suitability	Functional implementation completeness						2							
			Functional adequacy						2							
			Functional implementation coverage						2							
		Accuracy	Computational accuracy						2							1
			Precision											2		1
		Interoperability	Data exchangeability (Data format based)			1								1		
		Security	Access controllability			2										

Document	Quality Characteristics	Quality Subcharacteristics	Quality Measure Name	Data Size	Number of I/O	Number of Data Items	Number of Failures	Number of Faults	Number of Functions	Number of Requirements	Number of Restarts	Number of Tasks	Number of Test Cases	Number of Trials	Product Size	Time Duration
	Reliability	Maturity	Estimated latent fault density					2							1	
			Failure density against test cases				1									
			Failure resolution				2									
			Fault density					1							1	
			Fault removal					3								
			Mean time between failures (MTBF)				1									1
			Test maturity										2			1
		Recoverability	Restartability								2					
	Usability	Understandability	Completeness of description						2							
			Function understandability						2							
			Understandable input and output			2										
		Learnability	Effectiveness of the user documentation and/or help system	1						1						
			Help accessibility							1						
		Operability	Physical accessibility						2							
	Efficiency	Time Behaviour	Mean response time (Mean time to response)									1				2

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Document	Quality Characteristics	Quality Subcharacteristics	Quality Measure Name	Data Size	Number of I/O	Number of Data Items	Number of Failures	Number of Faults	Number of Functions	Number of Requirements	Number of Restarts	Number of Tasks	Number of Test Cases	Number of Trials	Product Size	Time Duration
			Mean throughput (Mean amount of throughput)	1								1				
			Mean turnaround time (Mean time for turnaround)									1				2
		Resource Utilization	I/O loading limits		2							1				
			Maximum memory utilisation									1				
			Maximum transmission utilisation		1							1				
			Mean occurrence of transmission error				2					1				
	Maintainability	Analyzability	Audit trail capability			2										
		Changeability	Software change control capability			2										
	Portability	Adaptability	Adaptability of data structures			1								1		
			Hardware environmental adaptability (adaptability to hardware devices and network facilities)						2							
			System software environmental adaptability (adaptability to OS, network software and co-operated application software						2							
		Installability	Ease of installation									2				

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Document	Quality Characteristics	Quality Subcharacteristics	Quality Measure Name	Data Size	Number of I/O	Number of Data Items	Number of Failures	Number of Faults	Number of Functions	Number of Requirements	Number of Restarts	Number of Tasks	Number of Test Cases	Number of Trials	Product Size	Time Duration
Internal Quality Measures ISO/IEC TR 9126-3	Functionality	Suitability	Functional implementation completeness						2							
			Functional adequacy						2							
			Functional implementation coverage						2							
		Accuracy	Computational accuracy						2							1
			Precision											2		1
		Interoperability	Data exchangeability (Data format based)			1								1		
		Security	Access controllability			2										
	Reliability	Maturity	Fault removal					3								
	Usability	Understandability	Completeness of description						2							
			Function understandability						2							
		Learnability	Completeness of user documentation and/or help facility						2							
		Operability	Physical accessibility						2							
	Portability	Adaptability	Adaptability of data structures			1								1		
			Hardware environmental adaptability (adaptability to hardware devices and network facilities)						2							
			System software environmental adaptability (adaptability to OS, network software and co-operated application software)						2							

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Document	Quality Characteristics	Quality Subcharacteristics	Quality Measure Name	Data Size	Number of I/O	Number of Data Items	Number of Failures	Number of Faults	Number of Functions	Number of Requirements	Number of Restarts	Number of Tasks	Number of Test Cases	Number of Trials	Product Size	Time Duration
Quality in Use Measures ISO/IEC TR 9126-4	Effectiveness		Task completion									2				
	Productivity		Task time													1

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Annex C
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Cross reference table between set of quality measure elements and quality measures

The following table depicts the relationship (cross-reference) between set of quality measure elements and quality measures listed in this Technical Report. Values in columns are showing how many times a quality measure element is used in relevant quality measure subcharacteristics.

Table C.1 — Cross reference table between set of quality measure elements and quality measures

QME Category	QME Name	QME ID	External																Internal												Quality in Use	
			Functionality			Reliability				Usability			Efficiency			Maintainability			Portability			Functionality				Reliability		Usability				Portability			
			Accuracy	Interoperability	Security	Suitability	Maturity	Recoverability	Learnability	Operability	Understandability	Resource Utilization	Time Behaviour	Analyzability	Changeability	Adaptability	Installability	Accuracy	Interoperability	Security	Suitability	Maturity	Learnability	Operability	Understandability	Adaptability	Effectiveness	Productivity
Data size	Number of change log data actually recorded	QME0101													1																	
	Number of change log data planned to be recorded enough to trace software changes	QME0102													1																	
	Number of data actually recorded during operation	QME0103												1																		

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Quality in Use									
	Effectiveness								
	Productivity								
Internal	Portability	Adaptability						1	
		Understandability							
		Operability							
	Usability	Learnability							
	Reliability	Maturity							
		Suitability							
	Functionality	Security							
		Interoperability		1					
		Accuracy			1		1		
External	Portability	Installability							
		Adaptability						1	
		Changeability							
	Maintainability	Analyzability	1						
		Time Behaviour							
	Efficiency	Resource Utilization							
		Understandability							1
	Usability	Operability							
		Learnability							
	Reliability	Recoverability							
		Maturity							
		Suitability							
		Security							
	Functionality	Interoperability		1					
		Accuracy			1		1		

QME Category	QME Name	QME ID
	Number of data planned to be recorded enough to monitor status of software during operation	QME0104
Number of Data items	Number of data formats to be exchanged as in the specifications	QME0201
	Number of data items implemented with specific levels of precision, confirmed in evaluation	QME0202
	Number of data items that require specific levels of precision	QME0203
	Number of data structures, which are operable and have no limitation after adaptation	QME0204
	Number of input and output data items available from the interface	QME0205

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			External															Internal									Quality in Use	
			Functionality		Reliability				Usability		Efficiency		Maintainability		Portability			Functionality				Reliability	Usability	Portability			Effectiveness	Productivity
QME Category	QME Name	QME ID	Accuracy	Interoperability	Security	Suitability	Maturity	Recoverability	Learnability	Operability	Understandability	Resource Utilization	Time Behaviour	Analyzability	Changeability	Adaptability	Installability	Accuracy	Interoperability	Security	Suitability	Maturity	Learnability	Operability	Understandability	Adaptability		
	Number of input and output data items which user successfully understands	QME0206									1																	
	Number of interface data formats that have been implemented correctly as in the specifications	QME0207		1															1									
	Total number of data structures requiring adaptation capability	QME0208														1										1		
Number of Failures	Number of detected failures	QME0301					1																					
	Number of resolved failures	QME0302					1																					
	Number of transmission related error messages and failures	QME0303										1																
	Total number of actually detected failures	QME0304					2																					
Number of Faults	Number of corrected faults in design/coding	QME0401					1															1						

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			External															Internal									Quality in Use	
			Functionality		Reliability				Usability		Efficiency		Maintainability		Portability			Functionality				Reliability	Usability	Portability			Effectiveness	Productivity
QME Category	QME Name	QME ID	Accuracy	Interoperability	Security	Suitability	Maturity	Recoverability	Learnability	Operability	Understandability	Resource Utilization	Time Behaviour	Analyzability	Changeability	Adaptability	Installability	Accuracy	Interoperability	Security	Suitability	Maturity	Learnability	Operability	Understandability	Adaptability		
	Number of detected faults	QME0402					1															1						
	Number of faults detected in review	QME0403					1															1						
Number of Functions	Number of functions	QME0501								1	1												1	1	1			
	Number of functions (or types functions) described in the product description	QME0502									1												1		1			
	Number of functions reviewed	QME0503				1															1							
	Number of functions described in requirement specification	QME0504				2															2							
	Number of functions for which specific accuracy requirements need to be implemented	QME0505	1															1										
	Number of functions in which problems are detected in evaluation	QME0506				1															1							

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QME Category	QME Name	QME ID	External															Internal									Quality in Use	
			Functionality		Reliability				Usability		Efficiency		Maintainability		Portability			Functionality				Reliability	Usability	Portability			Effectiveness	Productivity
			Accuracy	Interoperability	Security	Suitability	Maturity	Recoverability	Learnability	Operability	Understandability	Resource Utilization	Time Behaviour	Analyzability	Changeability	Adaptability	Installability	Accuracy	Interoperability	Security	Suitability	Maturity	Learnability	Operability	Understandability	Adaptability		
	Number of functions in which specific accuracy requirements had been implemented, confirmed in evaluation	QME0507	1															1										
	Number of functions, which can be customised	QME0508								1														1				
	Number of implemented functions, which are capable of achieving, required results in specified multiple HW environment as specified	QME0509														1										1		
	Number of implemented functions, which are capable of achieving, required results in specified multiple system software environment as specified	QME0510														1										1		
	Number of incorrectly implemented or missing functions detected	QME0511				1															1							

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QME Category	QME Name	QME ID	External																		Internal										Quality in Use	
			Functionality		Reliability			Usability		Efficiency		Maintainability			Portability						Functionality					Reliability	Usability		Portability				
			Accuracy	Interoperability	Security	Suitability	Maturity	Recoverability	Learnability	Operability	Understandability	Resource Utilization	Time Behaviour	Analyzability	Changeability	Adaptability	Installability	Accuracy	Interoperability	Security	Suitability	Maturity	Learnability	Operability	Understandability	Adaptability	Effectiveness	Productivity
Number of I/O Events	Number of missing functions detected in evaluation	QME0512				1															1											
	Number of user interface functions	QME0513									1													1								
	Number of user interface functions whose purpose is understood by the user	QME0514									1													1								
	Total number of functions with H/W environment adaptation capability requirements	QME0515														1									1							
	Total number of functions with system software environment adaptation capability requirements	QME0516														1									1							
	Number of I/O messages during evaluation	QME0601										1																				
	Required maximum number of I/O messages	QME0602										1																				

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	Required maximum number of transmission related error messages and failures	QME0603										1																
Number of Requirements	Number of access controllability requirements implemented correctly in the specifications	QME0701			1															1								
	Number of access controllability requirements in the specifications	QME0702			1															1								
Number of Restarts	Number of restarts which met required time during testing or user operation support	QME0801						1																				
	Total number of restarts during testing or user operation support	QME0802						1																				
Number of tasks	Number of access to help until a user complete his/her task	QME0901			1																							

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Number of Test Cases	Number of completed tasks	QME0902							1																							
	Number of tasks successfully completed after accessing online help and/or user documentation	QME0903							1																							
	Throughput	QME0904																									1					
	Total number of tasks tested	QME0905							2																							
Number of Test Cases	Number of passed test cases during testing or operation	QME1001					1															1										
	Number of performed test cases	QME1002					1															1										
	Number of test cases required	QME1003					1															1										
Number of Trials	Number of cases which a user succeeded to change install operation for his/her convenience	QME1101														1																

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	Number of evaluations	QME1102										4	3				1												
	Total number of cases which a user attempted to change install operation for his/her convenience	QME1103																2											
Product size	Product size	QME1201					2																						
Time Duration	Failure resolution time	QME1301					1																						
	Operation time	QME1302	2				1																						
	Response time	QME1303											1																
	Task Time	QME1304																										1	
	Turnaround time	QME1305											1																

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