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SOFTWARE QUALITY MODEL ON THE BASE OF SQUARE STANDARDS

Introduction

Given the rapid introduction of computer systems into almost all aspects of human life, the issue of assessing the software quality of is becoming increasingly important. While talking about a unified approach that can be achieved with the help of international standards [1].

Standardization ensures the unification of requirements for quality, its measurement and assessment. The use of standards provides many potential benefits for any organization, especially in such key areas as measuring the quality of software products and information and measurement systems. Accordingly, it is advisable to analyze modern standards as a basis for the formation of requirements for the software quality and measuring the quality of software, which will reduce risks in the development, implementation and maintenance of software. The relevance of this issue is also supported by the fact that the standards are adopted in Ukraine as national.

The first international standards in this area were adopted back in 1991, and have been revised several times since then. Today there is a set of standards ISO 25000 SQuaRE – Systems and software Quality Requirements and Evaluation – logically organized and unified series covering two main processes: software quality requirements specification and software quality evaluation supported by a quality measurement process [2].

SQuaRE Quality Model

SQuaRE standards include five core divisions [1]: quality requirement 2503n, quality model 2501n, quality measurement 2502n, quality evaluation 2504n and quality management 2500n, and also extension division 25050–25099.

The ISO 25000 SQuaRE standards are coordinated with ISO/IEC/IEEE 15939 [3] by content which define the general process and basis for systems and software measurement, as well as the relevant terminology from an engineer's point of view. Following modern ISO trends in terminology harmonization, ISO/IEC/IEEE 15939 adopts and adapts the metrological terminology established by VIM [4] for program and system engineering standards. The following concepts from ISO/IEC/IEEE 15939 fully compliant, adapted or based on definitions from VIM: base measure – based on the definition of the «base value»; derived measure – adapted from the definition of «derived value»; measurement – adapted; measurement method – based on the definition of the «measurement method»; measurement procedure – fully compliant; scale – based on the definition of the «scale»; unit of measurement – fully compliant.

SQuaRE standards define a software and systems quality models used to determine requirements, develop measures and measure quality. Quality model is the set of classes of characteristics. Characteristics can be divided into subcharacteristics and, in some cases, into subsubcharacteristics. Quality-related measurable properties are called quality properties. Quality properties are associated with the appropriate quality measures.

The quality in SQuaRE standards is described by four models: quality in use model and product quality model defined ISO/IEC 25010, as well as the data quality model defined ISO/IEC 25012 and IT-services quality model defined ISO/IEC 25011.

The product quality model reduces quality features to eight characteristics, each of them consists of a number of subcharacteristics (fig. 1) [5].

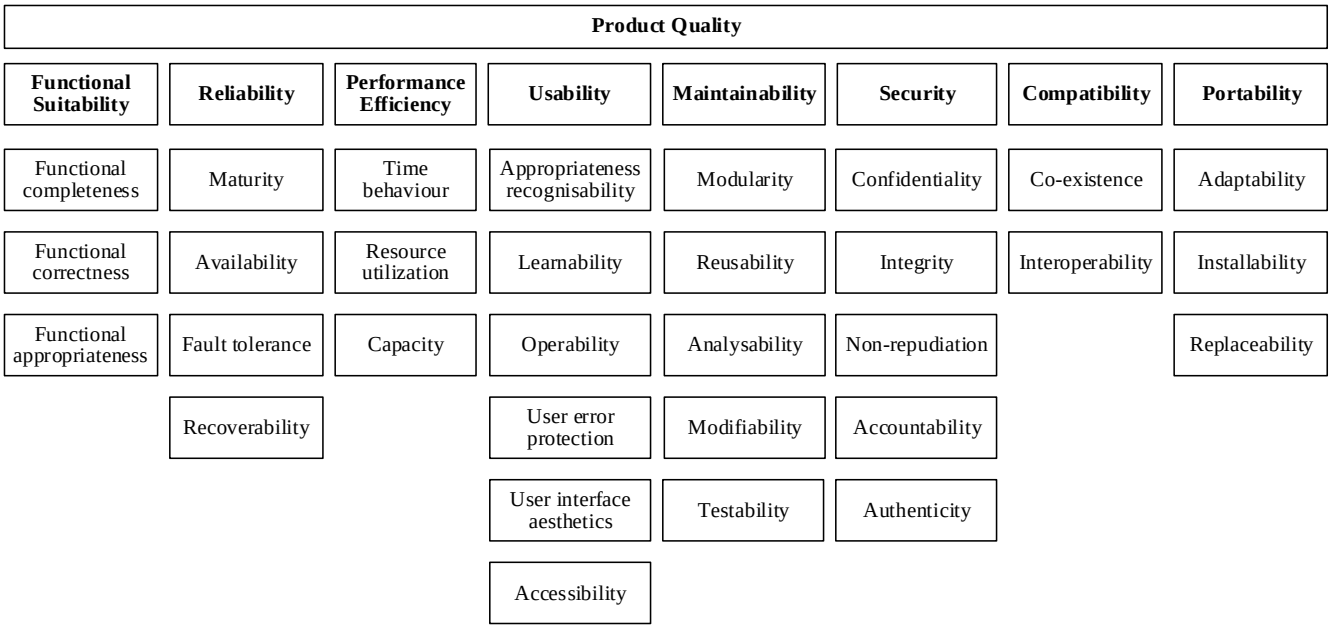

Fig. 1. The product quality model

This product quality model is complemented by a quality in use model that characterizes the impact of the product (system or software product) on the stakeholders. Quality in use is determined by the quality of the software, hardware, operating environment, as well as the characteristics of users, tasks and social environment. The quality in use model determines through five characteristics associated with the results of interaction with the system (fig. 2) [5].

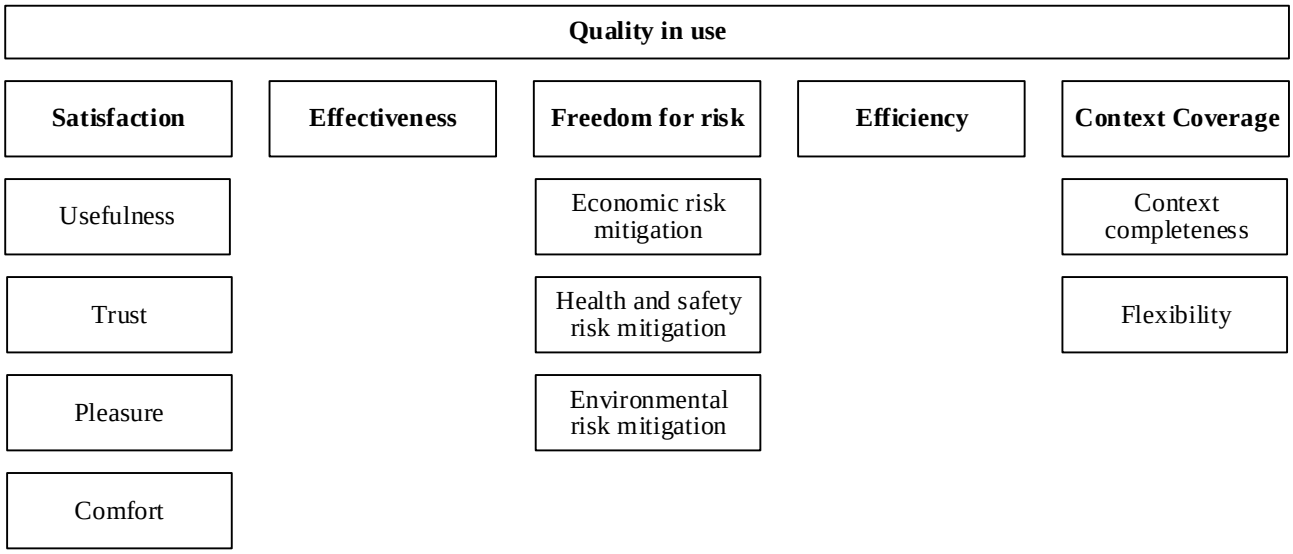

Fig. 2. The quality in use model

Models of product quality and quality in use can be used to define requirements, generate measures, and quality evaluations. The defined quality characteristics can be used as a checklist to provide a detailed study of the quality requirements, thus providing a basis for evaluating the subsequent effort and actions required in the system development process.

SQuaRE Quality Measurement Division

The Quality Measurement Division (2502n) includes six standards:

– ISO/IEC 25020 – Quality measurement framework: provides a framework for developing quality measurement;

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

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

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

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

– ISO/IEC TS 25025 – Measurement of IT service quality: provides measures for the IT service quality model.

Figure 3 shows the Structure of SQuaRE Quality Measurement Division.

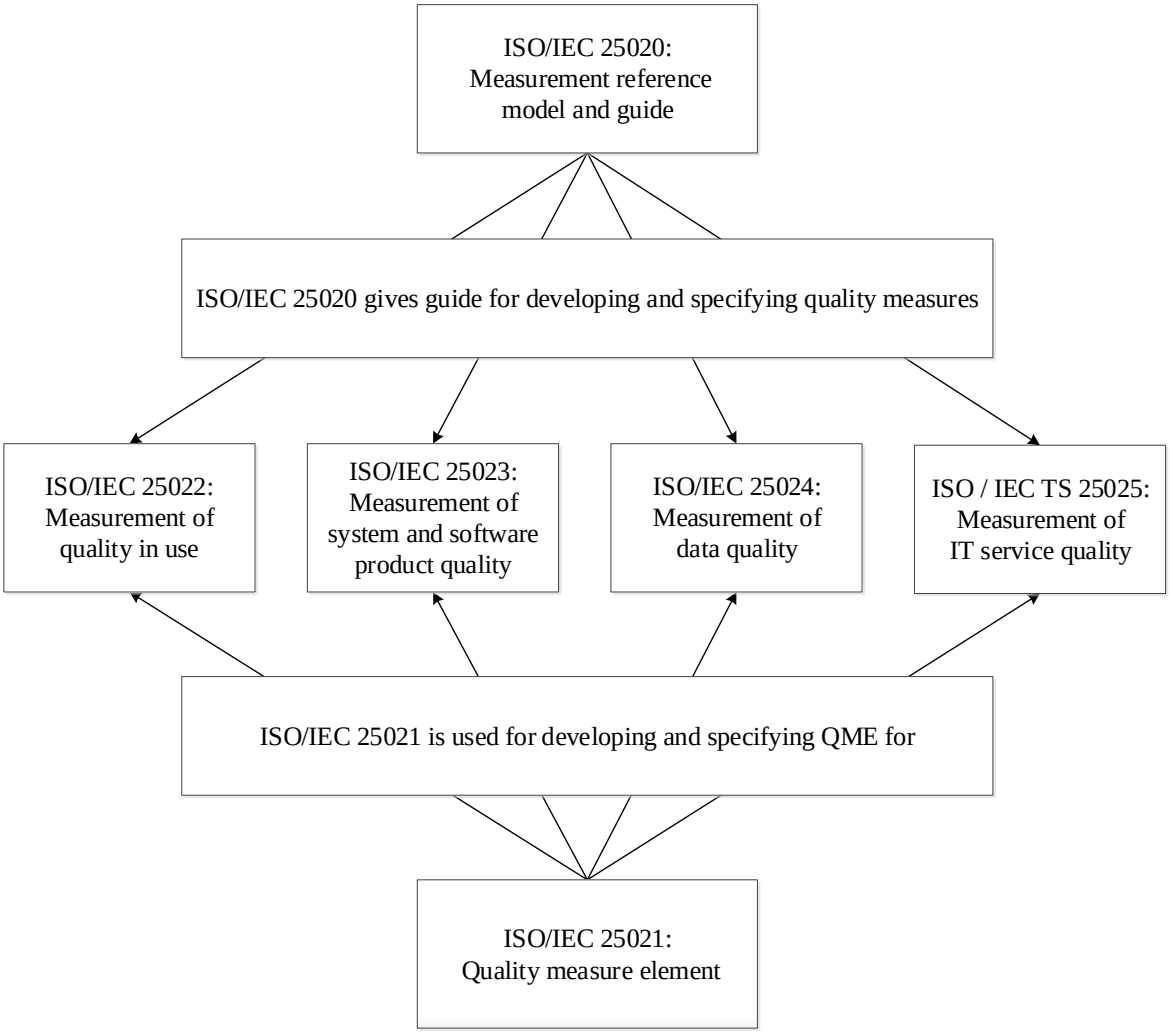

Fig. 3. Structure of SQuaRE Quality Measurement Division

Quality measure element as the basis of quality measurement

ISO/IEC 25020 provides framework for developing quality measures [6]. Measurement of software quality is based on two concepts: quality measure and quality measure element.

Quality measure element (QME) is an indicator defined in terms of a feature and a measurement method to quantify that feature, including a selective transformation using a mathematical function.

The main purposes of defining and using of QME:

1) provide guidance for organizations that develop and implement their own QME;

2) to promote the consistent application of a given QME for measuring and using product features that relate to different characteristics and sub-characteristics of product quality;

3) to help identify a set of QME's that are uniquely in demand, to obtain all the quality indicators of this set of characteristics or sub-characteristics of the product.

The quality measures and, accordingly, the QME are determined to understand and indicate the characteristics and sub-characteristics of quality. The measurement function is applied to the EPC to generate the quality measures. The measurement method must be applied to the property to establish and identify a method for quantifying QME.

The user of the measurement method must identify and collect data related to the quantification of the property (fig. 4). Depending on the context of use and the purposes of EPC, a number of properties and subproperties can be identified. They are the input data for the measurement method. These properties are defined and retrieved from artifacts, components, content, or behavior of the target object (eg, documentation, code).

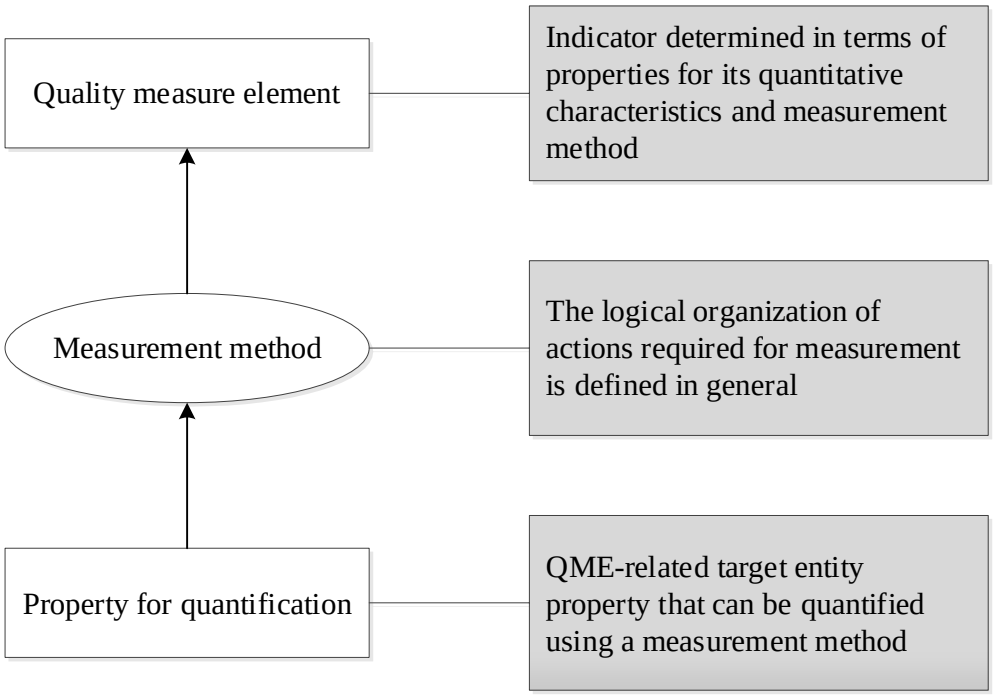

Fig. 4. Relationship between quantification property, measurement method and QME

So, the ISO / IEC 25000 defines 36 quality characteristics and over 200 quality measures and expected further multiplication of characteristics.

Practical Usage of SQuaRE Quality Measurement Model

The Quality Measurement Reference Model describes the relationship between a quality model and the construction of quality measures from quality measure elements (fig. 5).

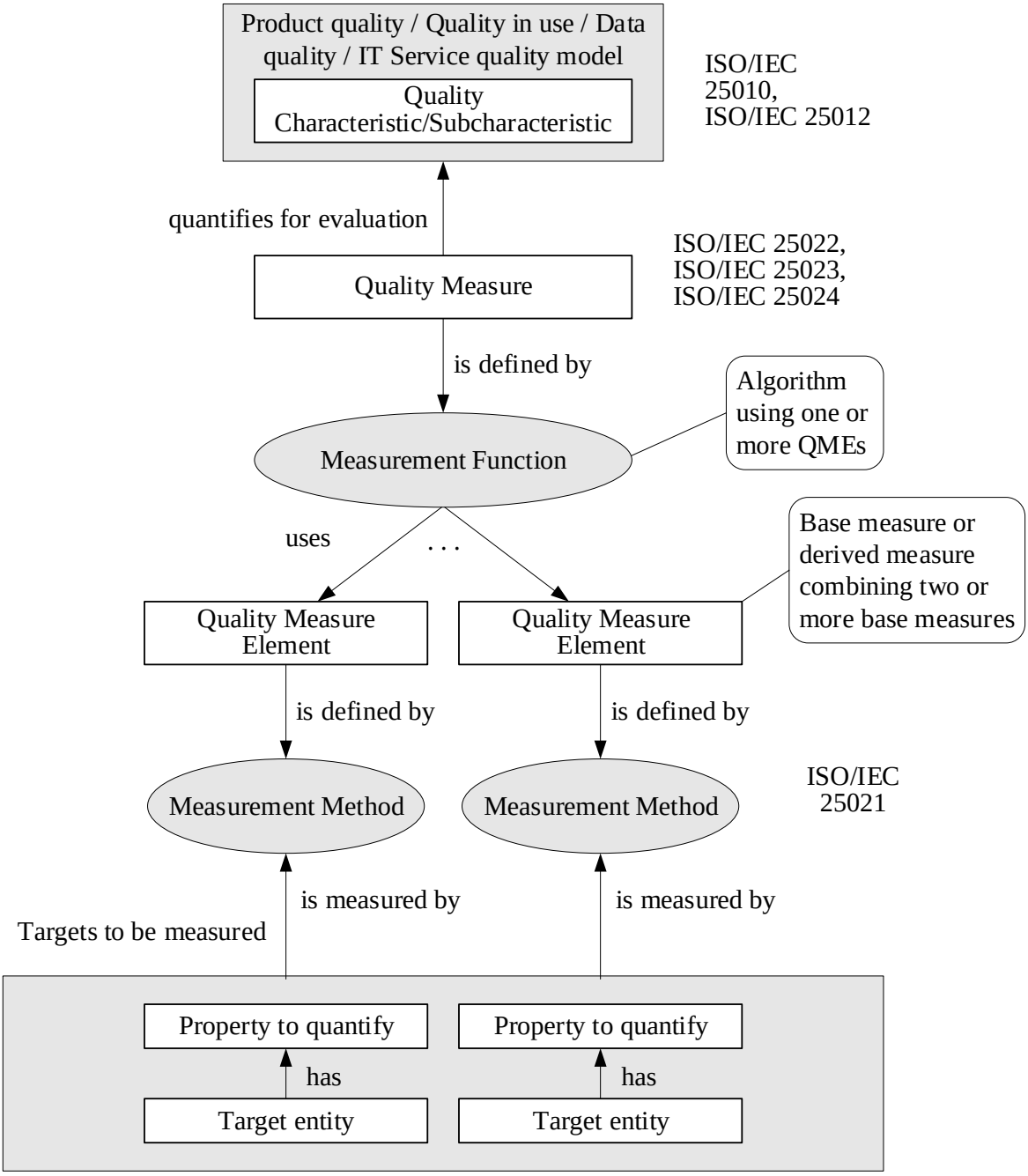

Fig. 5. Relationship among quality model, quality measures, quality measure elements, property to quantify, target entity

Quality properties are measured by means of a measurement method. A measurement method is a logical sequence of operations used to quantify properties relative to a specific scale. The result of applying the measurement method is quality measure elements. Quality characteristics and subcharacteristics can be quantified using the measurement function. A measure function is an algorithm used to combine the quality measure elements. Quality measures are constructed by applying a measurement function to a set of quality measure elements. The result of using the measurement function is called the software quality measure. Thus, software quality measures become quantitative indicators of quality characteristics and subcharacteristics. Several software quality measures can be used to measure a characteristic or subcharacteristic of quality.

ISO/IEC 25022 [7], ISO/IEC 25023 [8], ISO/IEC 25024 [9] provides a set of quality measures for the characteristics of system/software products for the quality in use and product quality models defined by ISO/IEC 25010, and data quality model defined by ISO/IEC 25012. This quality

measures can be used for specifying requirements, measuring and evaluating the system/software product quality. Based on the measurement task, quality measures are selected from standards ISO/IEC 25022, ISO/IEC 25023, ISO/IEC 25024 to satisfy the needs of developers, acquirers, managers, direct and indirect users and other stakeholders. Moreover, include measurement functions for each proposed quality measures, summary consideration for usage of quality measures and quality measure elements. Quality measure elements are presented by ISO/IEC 25021 [10].

Based on the analysis of SQuaRE Quality Model and Quality Measurement Divisions, an algorithm of Measurement of Software Quality is proposed:

1) define quality models by ISO/IEC 25010, ISO/IEC 25012 for identification of relevant software quality characteristics;

2) select quality measures for each quality characteristic using ISO/IEC 25022, ISO/IEC 25023, ISO/IEC 25024;

3) measure the quality measure elements using the measurement methods from ISO/IEC 25021;

4) selected quality measures are constructed by applying a measurement function to quality measure elements.

The table shows examples of the application of SQuaRE standards for measurement of software quality.

Table

Examples of the application of SQuaRE standards for measurement of software quality

Quality characteristic/ subcharacteristic	Quality measure. Description	Measurement function	Quality measure element	Measurement method
Functional completeness	Functional coverage. What proportion of the specified functions has been implemented?	$X = 1 - A / B,$ A – number of functions missing, B – number of functions specified	Number of available functions	View and analyze individual system/software functions that are available to a user with a disability to call and execute, and count the number of functions that could not be successfully used
Time behavior	Mean response time. How long is the mean time taken by the system to respond to a user task or system task?	$X = \sum_{i=1}^{n} A_i \Big/ n,$ A_i – time taken by the system to respond to a specific user task or system task at *i*-th measurement, n – number of responses measured	Duration	Duration is based on the total amount of time and is linked to the International System of Units (VIM)
Learnability	User guidance completeness What proportion of features are described in sufficient detail in the user documentation and/or help center to allow the user to apply the features?	$X = A / B,$ A – number of functions described in the user documentation and/or help center, if required, B – number of implemented functions that need to be documented	Number of documented functions	View and analyze individual system/software features that are available to a user with disabilities to call and execute, and count the number of features that are described in the user documentation

Conclusions

1. The SQuaRE 2501n Quality Models division describes software quality models that support clear definition of software quality requirements. The characteristics in the quality-in-use model and the product quality model are intended to be used as a set in the specification or assessment of the quality of a software product or computer system.

2. Measuring of software quality is based on two concepts: a quality measure and a quality measure element. A reference model for quality measurement is described in the ISO/IEC 25020 standard.

3. The ISO/IEC 25022, ISO/IEC 25023, ISO/IEC 25024 define the quality measures and the measurement function for each quality characteristic of the model.

4. The measurement function associates quality measures with quality measure elements of that is directly measured. A fairly wide list of elements of quality measures elements contains the ISO/IEC 25021.

5. The main advantages of a series of standards SQuaRE is that they provide coordination methodologies for measuring and evaluating quality software products, a guide to specifications of software quality requirements product and harmonization with the standard ISO/IEC 15939 in the form of a reference model of measurements quality.

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