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Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Measurement of data quality

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National foreword

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ISO/IEC 25024

First edition
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Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Measurement of data quality

Ingénierie des systèmes et du logiciel — Exigences et évaluation de la qualité des systèmes et du logiciel (SQuaRE) — Mesurage de la qualité des données

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Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
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Foreword

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

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

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

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

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

— ISO/IEC 2500n — *Quality Management Division*;

— ISO/IEC 2501n — *Quality Model Division*;

— ISO/IEC 2502n — *Quality Measurement Division*;

— ISO/IEC 2503n — *Quality Requirements Division*;

— ISO/IEC 2504n — *Quality Evaluation Division*;

— ISO/IEC 25050 to ISO/IEC 25099 — *SQuaRE Extension Division*.

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

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Introduction

This International Standard is a part of the SQuaRE series of International Standards. It provides a set of data quality measures that can be used for measuring and evaluating data quality by referring other SQuaRE series of standards, especially ISO/IEC 25012.

The set of data quality measures in this International Standard is selected based on their practical value. They are not intended to be exhaustive and users of this International Standard are encouraged to refine them if necessary.

Quality measurement division

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

— ISO/IEC 25020 — **Measurement reference model and guide:** provides a reference model and guide for measuring the quality characteristics defined in ISO/IEC 2501n.

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

— ISO/IEC 25022 — **Measurement of quality in use:** provides measures including associated measurement methods and quality measure elements 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 methods and quality measure elements for the quality characteristics in the product quality model.

— ISO/IEC 25024 — **Measurement of data quality:** provides measures including associated measurement methods and quality measure elements for the quality characteristics in the data quality model.

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

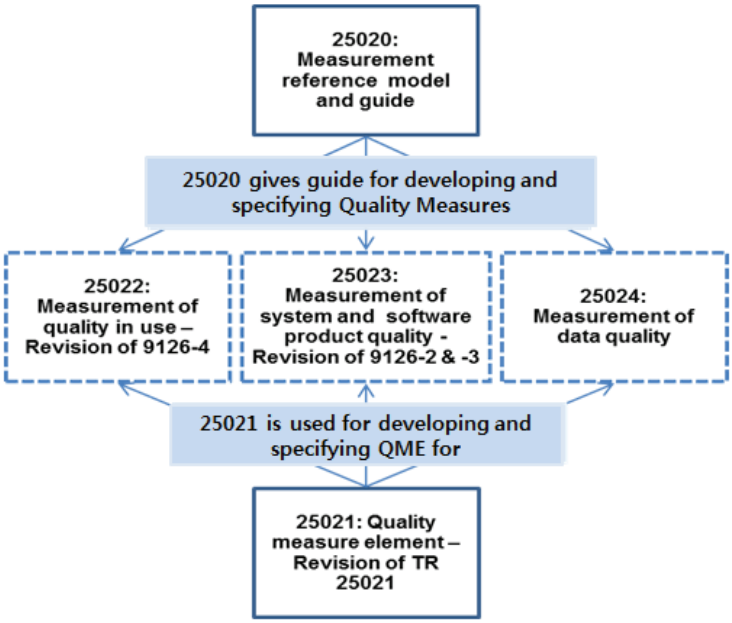

Figure 1 — Structure of the Quality Measurement Division

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Outline and organization of SQuaRe series

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

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

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

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

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

— ISO/IEC 2504n — **Quality Evaluation Division**. The standards that form this division provide requirements, recommendations, and guidelines for system/software product evaluation whether performed by independent evaluators, acquirers, or developers. The support for documenting a quality measure as an evaluation module is also presented.

ISO/IEC 25050 to ISO/IEC 25099 are reserved for SQuaRE extension International Standards which currently includes ISO/IEC 25051 and ISO/IEC 25060 to ISO/IEC 25069.

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INTERNATIONAL STANDARD ISO/IEC 25024:2015(E)

Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Measurement of data quality

1 Scope

This International Standard defines data quality measures for quantitatively measuring the data quality in terms of characteristics defined in ISO/IEC 25012.

This International Standard contains the following:

— a basic set of data quality measures for each characteristic;

— a basic set of target entities to which the quality measures are applied during the data-life-cycle;

— an explanation of how to apply data quality measures;

— a guidance for organizations defining their own measures for data quality requirements and evaluation.

It includes, as informative annexes, a synoptic table of quality measure elements defined in this International standard (Annex A), a table of quality measures associated to each quality measure element and target entitiy (Annex B), considerations about specific quality measure elements (Annex C), a list of quality measures in alphabetic order (Annex D), and a table of quality measures grouped by characteristics and target entities (Annex E).

This International Standard does not define ranges of values of these quality measures to rate levels or grades because these values are defined for each system by its nature depending on the system context and users' needs.

This International Standard can be applied to any kind of data retained in a structured format within a computer system used for any kinds of applications.

People managing data and services including data are the primary beneficiaries of the quality measures.

This International Standard is intended to be used by people who need to produce and/or use data quality measures while pursuing their responsibilities.

— Acquirer (an individual or organization that acquires or procures data from a supplier).

— Evaluator (an individual or organization that performs an evaluation, which can, for example, be a testing laboratory, the quality department of an organization, a government organization, or a user).

— Developer (an individual or organization that performs development activities including requirements, analysis, design, implementation, and testing data during the data-life-cycle).

— Maintainer (an individual or organization that performs operation and maintenance activities of data).

— Supplier (an individual or organization that enters into a contract with the acquirer for the supply of data or service under the terms of the contract).

— User (an individual or organization that uses data to perform a specific function).

— Quality manager (an individual or organization that performs a systematic examination of the data).

— Owner (an individual or organization that takes responsibility for the management and financial value of the data with the legal authority and responsibility to establish for them evaluation, collections, access, dissemination, storage, security, and cancellation).

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This International Standard takes into account a large range of data of target entities.

It can be applied in many types of information systems, for example, such as follows:

— legacy information system;

— data warehouse;

— distributed information system;

— cooperative information system;

— world wide web.

The scope does not include the following:

— knowledge representation;

— data mining techniques;

— statistical significance for random sample.

2 Conformance

Any measurement process for requirement, implementation, or evaluation of data quality shall be conformed to this International Standard:

a) selecting data quality characteristics to be specified or evaluated as defined in ISO/IEC 25012;

b) selecting a target entity for which data quality characteristic shall be measured;

c) selecting the appropriate data quality measures defined in Clause 8 by each data quality characteristic concerning a target entity;

d) providing the rationale for any changes when modify the data quality measures;

e) listing any additional quality measures or quality measure elements used that are not included in this International Standard.

Order of items a) and b) can be applied in reverse.

When using modified or new data quality measures, the user shall specify the target entities, measurement method, and related data quality characteristics of ISO/IEC 25012 or specifying any other data quality model that is being used. This International Standard does not provide a complete list of quality measure related to data defined during the data-life-cycle. The user may also identify some other quality measures depending on the technology applied. Even if a number of quality measures included in this International Standard have not been empirically validated and some of them are not based yet on best practices observed in industry, this International Standard is still a good base and an opportunity to improve the data quality measures.

3 Normative references

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

ISO/IEC 25000, *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Guide to SQuaRE*

ISO/IEC 25012:2008, *Software engineering — Software product Quality Requirements and Evaluation (SQuaRE) — Data quality model*

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ISO/IEC 25021, *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Quality measure elements*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 25000, ISO/IEC 25012, ISO/IEC 25021, and the following apply.

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

4.1
architecture
<system> fundamental concepts or properties of a system in its environment embodied in its *elements* (4.19), relationships, and in the principles of its design and evolution

[SOURCE: ISO/IEC 42010:2011]

Note 1 to entry: In this International Standard, the term "architecture" is intended as "architecture of data", a particular view of the architecture being the work products considered expression of the perspective of a specific system that concerns *data* (4.5). Architecture of data includes architecture elements such as *contextual schema* (4.4), conceptual, logical, physical data models, *data dictionary* (4.6), and documents. In practice architecture of data and data modelling, from the beginning of software engineering, have many levels, such as external model (view), conceptual, and physical (see ANSI/X3/SPARK Three Level Architecture, 1975).

Note 2 to entry: The term "environment" is used in ISO/IEC 42010 to refer (system) context determining the setting and circumstances of all influences upon a system that includes developmental, technological, business, operational, organizational, political, economic, legal, regulatory, ecological, and social influences (in this International Standard, the (system) context, where *data models* (4.10) are applied, can be represented by the *contextual schema* (4.4)).

Note 3 to entry: In ISO/IEC 42010, 4.2.4, Note 1, "the architecture of a system is a holistic conception of that system's fundamental properties best understood via multiple views of that architecture".

4.2
attribute
inherent property or characteristic of a *target entity* (4.36) that can be distinguished quantitatively or qualitatively by human or automated means

[SOURCE: ISO/IEC 25000:2014]

4.3
computer system
system containing one or more components and *elements* (4.19) such as computers (hardware), associated software, and *data* (4.5)

4.4
contextual schema
formal description of the boundary of the context of use where *data models* (4.10) are applied

Note 1 to entry: It is a high-level description of the business' informational needs. It is more general than a conceptual model (see Note 1 in 4.10) as it includes a holistic vision of a (system) context of the *architecture* (4.1).

4.5
data
reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing

Note 1 to entry: Data can be processed by humans or by automatic means.

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[SOURCE: ISO/TS 19104:2008, B.103]

Note 2 to entry: The definition does not make reference to the one in ISO/IEC 25000 relative to the result of the *measurement* (4.27).

4.6
data dictionary
collection of *information* (4.21) about *data* (4.5) such as name, description, creator, owner, provenance, translation in different languages, and usage

4.7
data file
set of related *data records* (4.15) treated as a unit

Note 1 to entry: In this International Standard, data set is a synonym of data file.

4.8
data format
arrangement of *data* (4.5) for storage or display

Note 1 to entry: Format can be referred to *data type* (4.16) and length of *data item* (4.9).

4.9
data item
smallest identifiable unit of *data* (4.5) within a certain context for which the definition, identification, permissible values, and other *information* (4.21) is specified by means of a set of properties

[SOURCE: ISO/IEC 25021:2012, Annex A]

Note 1 to entry: Field is considered a synonym of data item.

Note 2 to entry: Data item is a physical object "container" of *data values* (4.17).

4.10
data model
graphical and textual representation of analysis that identifies the *data* (4.5) needed by an organization to achieve its mission, functions, goals, objectives, and strategies and to manage and rate the organization.

[SOURCE: ISO/IEC/IEEE 31320-2:2012, 3.1.44]

Note 1 to entry: It is usual to distinguish conceptual model (a model of the concepts relevant to some endeavor), logical, and physical when they represent data at different level of abstraction from high to low.

Note 2 to entry: The formal description of the boundary of the context of use where data models are applied is called *contextual schema* (4.4).

Note 3 to entry: A data model identifies the entities, domains (*attributes*) (4.2), and relationships (associations) with other data and provides the conceptual view of the data and the relationships among data.

4.11
data quality
degree to which the characteristics of *data* (4.5) satisfy stated and implied needs when used under specified conditions

4.12
data quality characteristic
category of data quality attributes that bears on *data quality* (4.11)

[SOURCE: ISO/IEC 25012:2008, 4.4]

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4.13
data quality measure
variable to which a value is assigned as the result of *measurement* (4.27) of a *data quality characteristic* (4.12)

[SOURCE: ISO/IEC 25012:2008, 4.5]

4.14
data quality model
defined set of characteristics which provides a framework for specifying data quality requirements and evaluating *data quality* (4.11)

[SOURCE: ISO/IEC 25012:2008, 4.6]

4.15
data record
set of related *data items* (4.9) treated as a unit

[SOURCE: ISO/IEC/IEEE 15289:2015, 5.22]

4.16
data type
categorization of an abstract set of possible values, characteristics, and set of operations for an *attribute* (4.2)

Note 1 to entry: Examples of data types are character strings, texts, dates, numbers, images, sounds, etc.

[SOURCE: ISO/IEC 25012:2008, 4.7]

4.17
data value
content of *data item* (4.9)

Note 1 to entry: In ISO/IEC 25012, 5.1.1, it is specified that from the "Inherent" point of view, *data quality* (4.11) refers to *data* (4.5) itself such as data domain values and possible restrictions.

Note 2 to entry: Number or category assigned to an *attribute* (4.2) of a *target entity* (4.36) by making a *measurement* (4.27).

[SOURCE: ISO/IEC 25000:2005]

4.18
database management system
organized collection of structured data

Note 1 to entry: In order to use database management systems (DBMS), it is necessary to represent *data* (4.5) and the relative operations on it in terms of a *data model* (4.10), a data definition and manipulation language (see Table C.3.1).

4.19
element
smaller part of an *architecture* (4.1)

Note 1 to entry: In this International Standard, the term is used with reference to the architecture of data and to the computer program domain such as *data model* (4.10) or *data dictionary* (4.6).

4.20
form
module or formulary to collect *data* (4.5)

Note 1 to entry: It can be paper-based (paper form) or digital.

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4.21
information
in information processing, knowledge concerning objects, such as facts, events, things, processes, or ideas, including concepts, that within a certain context have a particular meaning

[SOURCE: ISO/IEC 25012:2008, 4.10]

Note 1 to entry: Information will necessarily have a representation form to make it communicable. It is the interpretation of this representation (the meaning) that is relevant in the first place.

4.22
information item
separately identifiable body of *information* (4.21) that is produced, stored, and delivered for human use

[SOURCE: ISO/IEC/IEEE 15289:2015, 5.13]

Note 1 to entry: Information product is a synonym.

Note 2 to entry: Information item can be produced in several versions during a project data-life-cycle.

4.23
information item content
information (4.21) included in an *information item* (4.22), associated with a system, product, or service to satisfy a requirement or need

[SOURCE: ISO/IEC/IEEE 15289:2015, 5.14]

4.24
information system
one or more *computer systems* (4.3) and communication systems together with associated organizational resources such as human, technical, and financial resources that provide and distribute *information* (4.21)

[SOURCE: ISO/IEC 25012:2008, 4.14]

4.25
master data
data (4.5) held by an organization that describes the entities that are both independent and fundamental for an enterpirse that it needs to reference in order to perform its transaction

[SOURCE: ISO 22745-2:2010, 14.9, modified]

Note 1 to entry: Master data is a subset of data of a *computer system* (4.3), identified, categorized, and managed that are essential for the core business of an enterprise.

4.26
measure
variable to which a value is assigned as the result of *measurement* (4.27)

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

[SOURCE: ISO/IEC 25010:2011, 4.4.5]

4.27
measurement
set of operations having the object of determining a value of a *measure* (4.26)

[SOURCE: ISO/IEC 25010:2011, 4.4.7]

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4.28
measurement function
algorithm or calculation performed to combine two or more *quality measure elements* (4.32)

[SOURCE: ISO/IEC 25021:2012, 4.7]

4.29
metadata
data (4.5) that describe other data

[SOURCE: ISO/IEC 25012:2008, 4.13]

4.30
presentation device
device used to present *data* (4.5) to the intended user of a system

4.31
quality measure
measure (4.26) that is defined as a *measurement function* (4.28) of two or more values of *quality measure elements* (4.32)

[SOURCE: ISO/IEC 25010:2011, 4.3.10]

4.32
quality measure element
measure (4.26) defined in terms of a property and the measurement method for quantifying it, including optionally the transformation by mathematical function

[SOURCE: ISO/IEC 25021:2012, 4.14]

4.33
quality model
defined set of characteristics, and of relationships between them, which provides a framework for specifying quality requirements and evaluating quality

[SOURCE: ISO/IEC 25010:2011, 4.4.8]

4.34
relational database management system
management system for relational database

Note 1 to entry: In order to use relational data base management systems (RDBMS), it is necessary to represent relational model of data that organizes *data* (4.5) with specific characteristics (tables or relations, unique key, etc.) (see Table C.3.1).

4.35
semantics
meaning of the syntactic components of a language

[SOURCE: ISO/IEC/IEEE 31320-2:2012, 3.1.175]

4.36
target entity
fundamental thing of relevance to the user, about which *information* (4.21) is kept, and need to be measured

[SOURCE: ISO/IEC 25021:2012, 4.17]

Note 1 to entry: Possible synonyms of target entity are input to information product and work product.

Note 2 to entry: Examples of target entities are *architecture* (4.1), *contextual schema* (4.4), conceptual and logical and physical data models, *data dictionary* (4.6), document, *data file* (4.7), database management, relational database management system, *form* (4.20), and *presentation device* (4.30).

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Note 3 to entry: Target entities are precisely defined by properties. Examples of properties are *attribute* (4.2), *element* (4.19), information, *metadata* (4.29), *vocabulary* (4.38), *data format* (4.8), *data item* (4.9), *data value* (4.17), *information item* (4.22), *information item content* (4.23), and *data record* (4.15).

4.37
tuple
set of fields or *data items* (4.9)

Note 1 to entry: Tuple can be used in place of record.

4.38
vocabulary
collection of *information* (4.21) related to a specific subset of terms related to a specific domain

Note 1 to entry: Vocabulary is generally used to keep consistency, to avoid duplication, and to support synonyms.

5 Abbreviated terms

The following abbreviations are used in this International Standard.

QM	Quality Measure
QME	Quality Measure Element
DLC	Data-Life-Cycle
DBMS	Database Management System
RDBMS	Relational Database Management System

6 Use of data QMs

6.1 Data quality measurement concepts

Stated and implied needs of system/software quality are represented in the SQuaRE series of standards by quality models that categorise system/software product quality, quality in use and data quality characteristics. The concept of data quality characteristics is defined in ISO/IEC 25012 that categorizes data quality into 15 characteristics.

The measurable quality-related properties of a data are called properties to quantify, with associated QMs. These properties are measured by applying a measurement method. A measurement method is a logical sequence of operations used to quantify properties with respect to a specified scale. The application of a measurement method is called a QME.

The data quality characteristics can be quantified by applying measurement functions. A measurement function is an algorithm used to combine QMEs. The result of applying a measurement function derives QM. In this way, QMs become quantifications of the data quality characteristics. More than one QM can be used for the measurement of a data quality characteristic (see ISO/IEC 25021, Figure 5).

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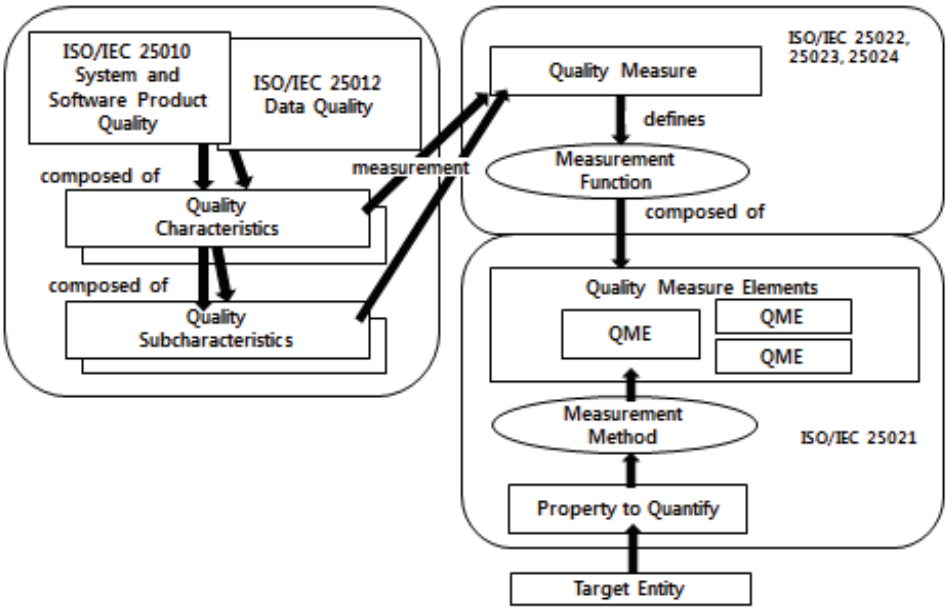

Figure 2 — Relationship among quality models, QM, QME, property to quantify, target entity

Figure 2 describes the relationship among quality models, QMs, QMEs, properties to quantify, and target entities. Referring to the data quality model described in ISO/IEC 25012, the arrows indicate the following:

— data quality model outlines quality characteristics;

— quality characteristics can be evaluated using QMs that are defined by applying a measurement function to QMEs;

— each QME is defined by applying a measurement method to a property to quantify;

— properties are attributes of related target entities.

According to ISO/IEC 25012, data quality can be measured from ”Inherent” and “System-dependent” points of view.

The QMs from “Inherent” point of view may be applied to data itself, in particular to the following:

— data domain values and possible restrictions (e.g. business rules governing the quality required for the characteristic in a given application);

— relationships of data values (e.g. consistency);

— metadata.

The QMs from the “System dependent” point of view may be used to quantify the influence on data of computer systems components, such as hardware devices, computer system software and other software.

QMs on data are expected to be correlated with other QMs and other target entities of quality. The relationship between data QMs and other types of QMs related to “process quality” and “quality in use” is shown in Figure 3.

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