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Data quality —

Part 63: Data quality management: Process measurement

Qualité des données —

Partie 63: Gestion de la qualité des données: Évaluation du processus

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 ISO documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data*.

A list of all parts in the ISO 8000 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ability to create, collect, store, maintain, transfer, process and present information and data to support business processes in a timely and cost-effective manner requires both an understanding of the characteristics of the information and data that determine its quality, and an ability to measure, manage and report on information and data quality.

ISO 8000 defines characteristics of information and data that determine its quality, and provides methods to manage, measure and improve the quality of information and data.

When assessing the quality of information and data, it is useful to perform the assessment in accordance with documented methods. It is also important to document the tailoring of standardized methods with respect to the expectation and requirements pertinent to the business case at hand.

ISO 8000 includes parts applicable to all types of data and parts applicable to specific types of data.

ISO 8000 can be used independently or in conjunction with quality management systems.

There is a limit to data quality improvement when only the nonconformity in data is corrected, since the nonconformity can recur. However, when the root causes of the data nonconformity and their related data are traced and corrected through data quality processes, recurrence of the same type of data nonconformity can be prevented. Therefore, a framework for process-centric data quality management is required to improve data quality more effectively and efficiently. Furthermore, data quality can be improved through assessing processes and improving under-performing processes identified by the assessment.

This document specifies a process measurement approach that is appropriate for use when assessing process maturity. This approach can serve when an organization is looking to improve the maturity of data quality management.

This document can be used on its own or in conjunction with other parts of ISO 8000.

This document is intended for use by those actors that have a vested interest in information or data quality, have a focus on one or more information systems and have a concern for both inter- and intra-organization views, throughout all phases of the data life cycle.

Annex A contains an identifier that unambiguously identifies this document in an open information system.

Data quality —

Part 63:
Data quality management: Process measurement

1 Scope

This document specifies a structure for process measurement stacks that organizations can instantiate to measure the characteristics of processes for data quality management. This structure consists of goal, sub goal, question, indicator and metric. The instantiated stack consists of content that is determined by a chosen model for assessing the maturity of the processes under consideration.

The following are within the scope of this document:

— the fundamentals of process measurement;

— the inspection plan and inspection order by which to perform measurement;

— the structure of the measurement stack;

— the role of the chosen maturity model in instantiating the stack.

The following are outside the scope of this document:

— methods for inspecting implemented processes;

— methods for generating measured values from the inspection of processes;

— how to choose a suitable maturity model.

This document can be used in conjunction with, or independently of, quality management systems standards.

NOTE ISO 8000-8 specifies concepts and methods for measuring information and data quality.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8000-2, *Data quality — Part 2: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8000-2 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Abbreviated terms

CMMI Capability Maturity Model Integration

EFQM European Foundation for Quality Management

TPI Test Process Improvement

5 Fundamentals of process measurement

This document specifies an approach for measuring the characteristics of data quality management processes. These processes are specified by ISO 8000-61 (see Figure 1), which describes each process with a purpose, one or more outcomes and one or more activities.

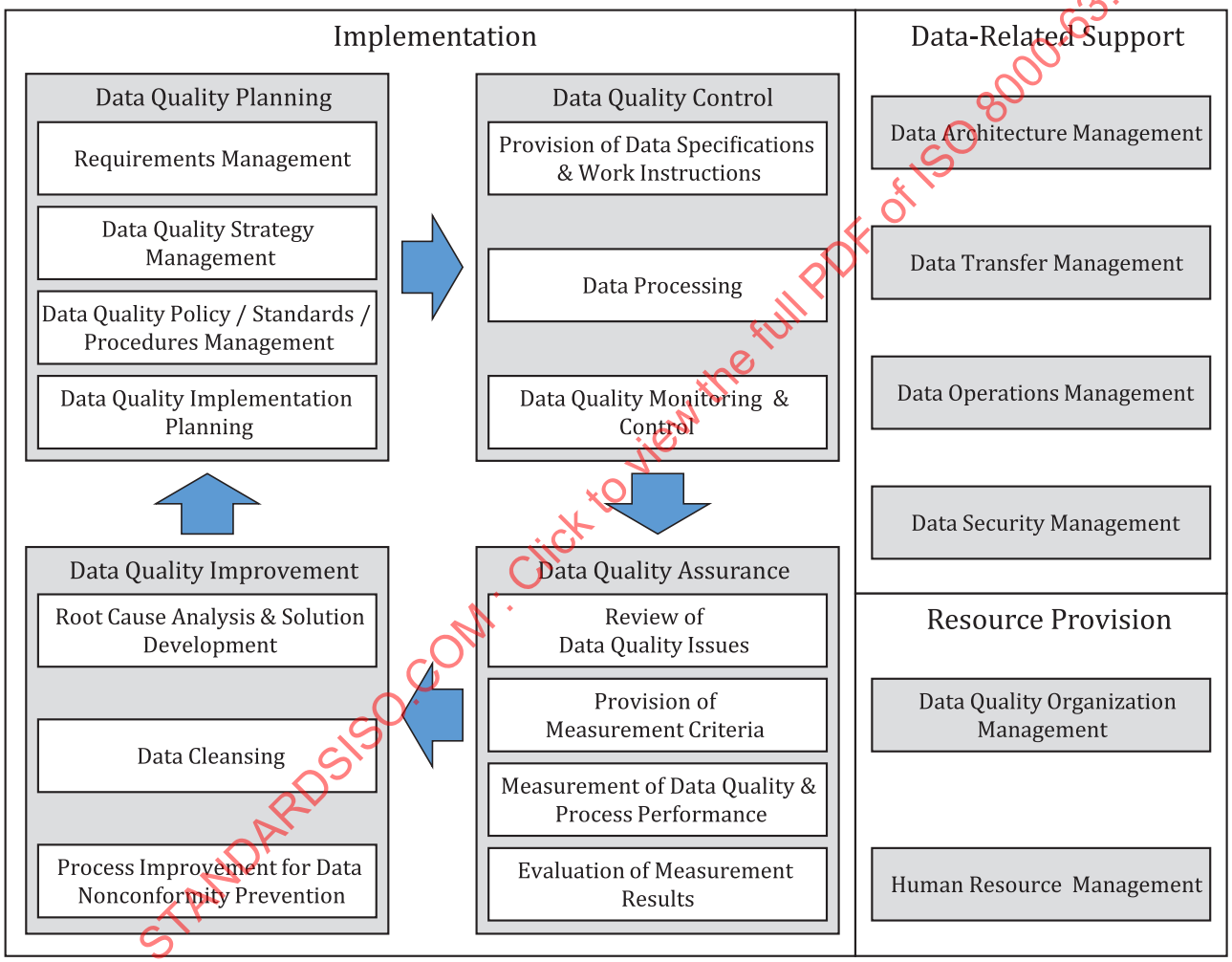


Figure 1 — Detailed structure of the data quality management processes in ISO 8000-61

This document specifies a structure that enables an organization to define a measurement stack based on the purpose, outcomes and activities of the process that the organization is intending to measure.

6 Process measurement and maturity models

The purpose of process measurement is to provide inputs to maturity assessment of an implemented process (the "target process"). This assessment is performed using a chosen maturity model (e.g. CMMI, TPI, EFQM). Such assessment involves analysing characteristics that are specified by the maturity

model. These characteristics are represented by either qualitative or quantitative values. The model specifies how these values indicate the maturity of the target process.

This document specifies an approach that involves identifying how to generate appropriate measured values and then using rules to convert those values to the characteristics specified by the maturity model. This approach can be used with all types of maturity model.

In order to perform assessments, an organization requires an inspection plan that includes measurement stacks to identify the measured values that are appropriate for the characteristics specified by the chosen maturity model (see Figure 2).

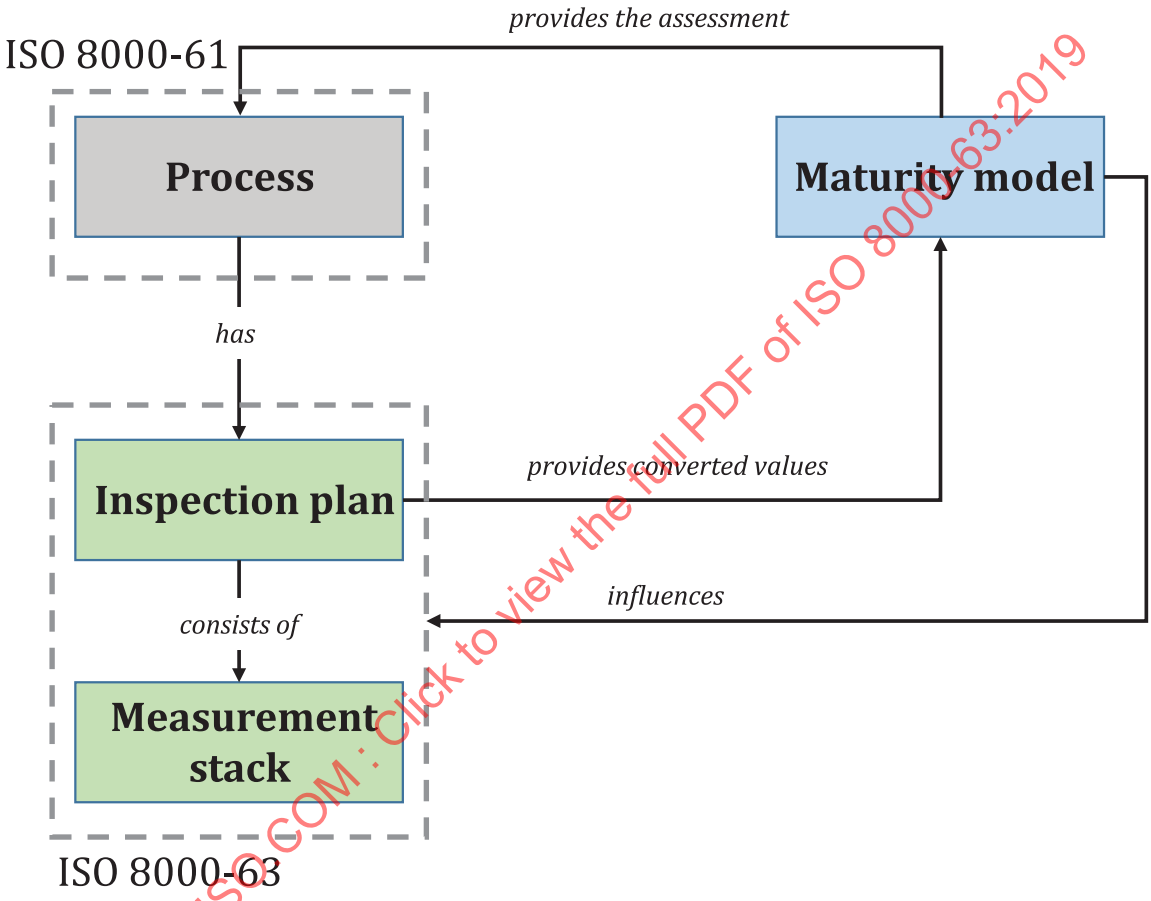
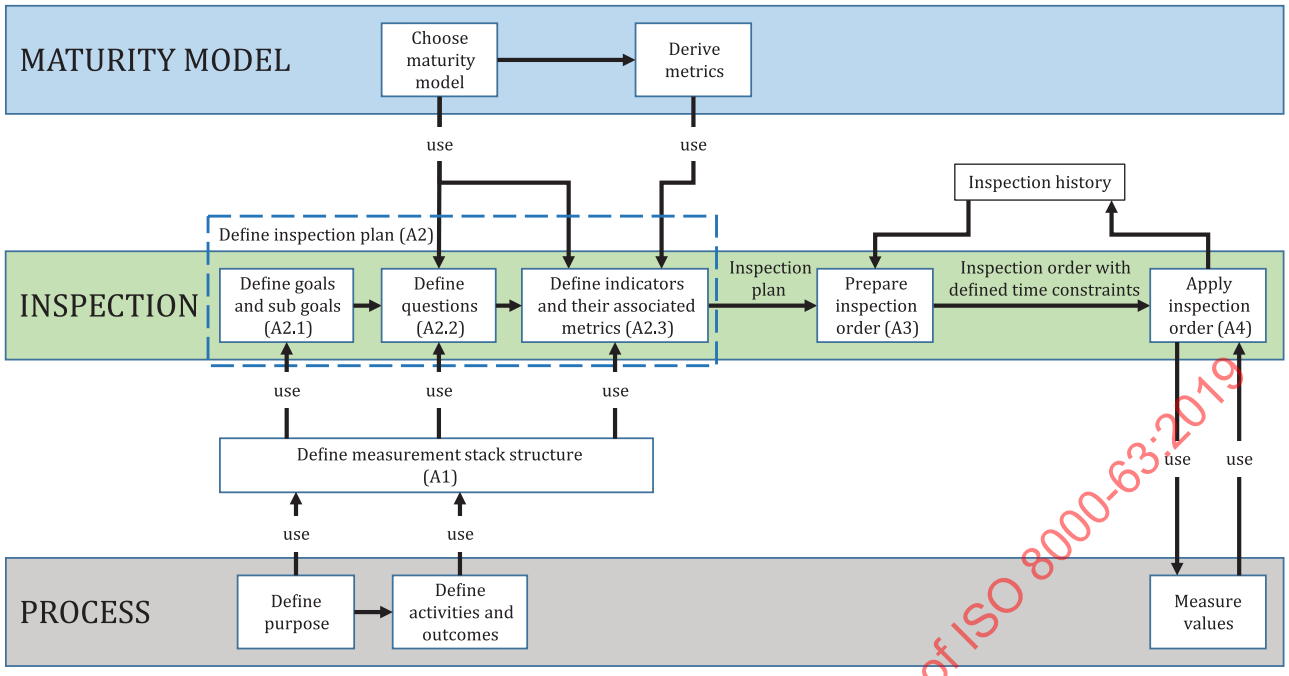


Figure 2 — Relationships between inspection plan, maturity model and process

Each inspection plan has a detailed internal structure (see Clause 7). This structure enables the plan to support assessment of the target process using the chosen maturity model (see Figure 3).



NOTE In this figure, the references A1 to A4 are to activities in the model represented by Figures 7 to 11.

Figure 3 — The relationships between inspection plan, maturity model and process

An inspection plan is specific to one or more identified processes. Each process provides a purpose, outcomes and activities that are the basis for the measurement stacks within the plan.

The plan identifies the measurements that are necessary to support the intended assessment of maturity.

When deciding to assess an implemented process, an organization creates an inspection order from the applicable inspection plan. This inspection order takes account of previous inspection history in identifying the timing and the resources necessary to perform the inspection. The order provides a checklist of the total set of measurements to support the overall assessment of the process maturity.

7 Inspection plans

7.1 Overview of inspection plans

An inspection plan consists of:

— one or more measurement stacks (see 7.2);

— the rules by which to convert measured indicator values into converted indicator values (see 7.9).

The chosen maturity model describes how to represent the converted indicator values. It establishes a common and comparable scale for the assessment of maturity.

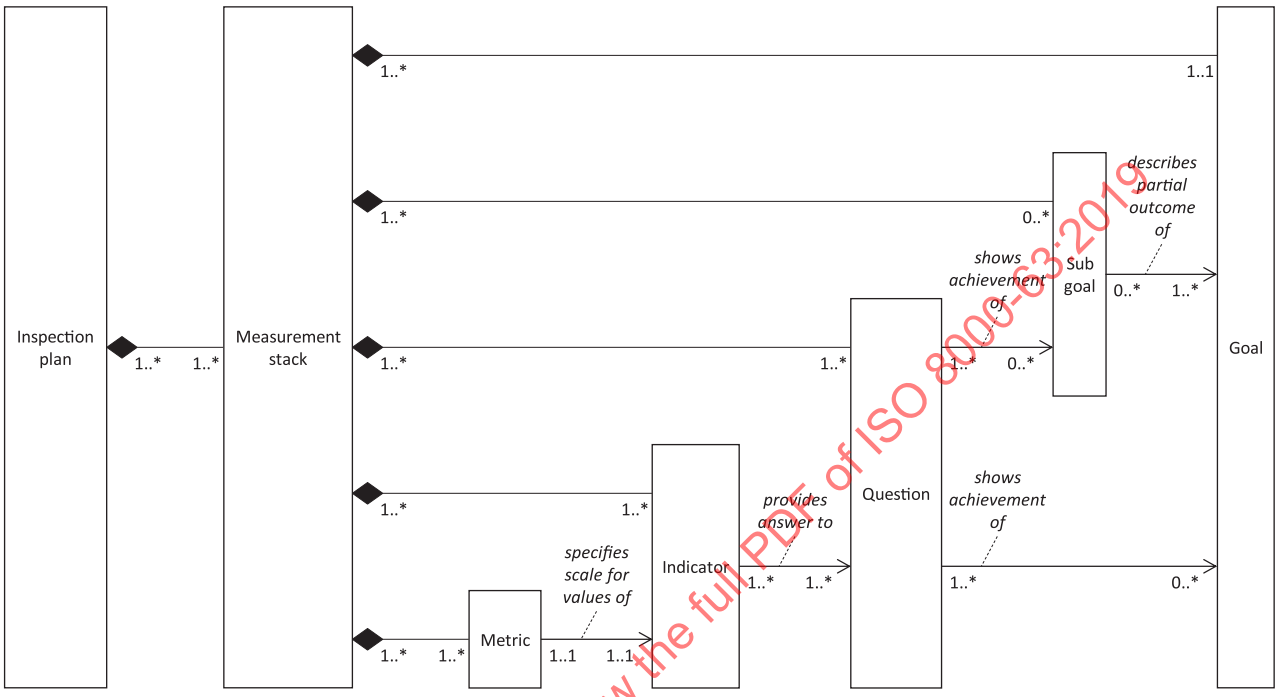
7.2 The measurement stack structure

The measurement stack structure (see Figure 4) is applicable to any type of process and any type of maturity model.

To perform a process measurement, an organization uses the structure to create an instance of the measurement stack. Each instance has specific content that depends on the details of:

— the process to be measured (including the purpose, outcomes and activities of the process);

— the chosen maturity model.



NOTE See ISO/IEC 19505-1 for details on the notation in this diagram.

Figure 4 — The measurement stack structure

Each instance of the measurement stack consists of the following elements:

— a goal (see 7.3);

— zero or more sub goals (see 7.4);

— one or more questions (see 7.5);

— one or more indicators (see 7.6);

— one or more metrics (see 7.7).

7.3 Goals

A goal defines the primary subject of interest for process measurement (i.e. if an implemented process is not achieving the identified goals then this process is a prime candidate for improvement). Each goal relates to the purpose of the target process and captures aspects of the performance of that process and the requirements of those who benefit from execution of the process (e.g. customers).

7.4 Sub goals

A goal can be represented by a set of one or more sub goals. Each sub goal is similar to a goal but is typically more specific, addressing one individual outcome, for example, of the target process.

7.5 Questions

A question identifies what needs to be measured in order to understand whether and to what degree the target process fulfils the applicable goal. Each question asks how the goal will be achieved. Each question corresponds to one or more indicators.

7.6 Indicators

An indicator is specified by the chosen maturity model as a characteristic that provides evidence of the maturity of a process.

Process measurement initially generates a measured value for the state of an indicator at the time of the measurement. This value is the measured indicator value.

The inspection plan specifies a value assessment rule for each indicator. This rule is the mathematical function that converts the measured indicator value into a converted indicator value, i.e. each rule has the form of the following mathematical formula:

$$C = f(M)$$

where

C is the converted indicator value;

f is the conversion function;

M is the measured indicator value.

The inspection plan can express the function f either as an algorithm or as a textual description.

7.7 Metrics

A metric relates to one indicator and is the scale by which the chosen maturity model represents that indicator. The metric is the scale for the converted indicator value that is generated as a result of performing process measurement (see Table B.4 for examples of indicators and metrics).

7.8 Logical coherence of the measurement stack

Each instantiated measurement stack is the basis for one measurement within the corresponding inspection plan.

Elements of one instantiated measurement stack can also be a part of one or more other measurement stacks (see Figure 4).

EXAMPLE An organization creates an inspection plan that addresses a set of processes. It includes more than one measurement stack, making multiple use of individual indicators and the corresponding metrics (see Figure 5).

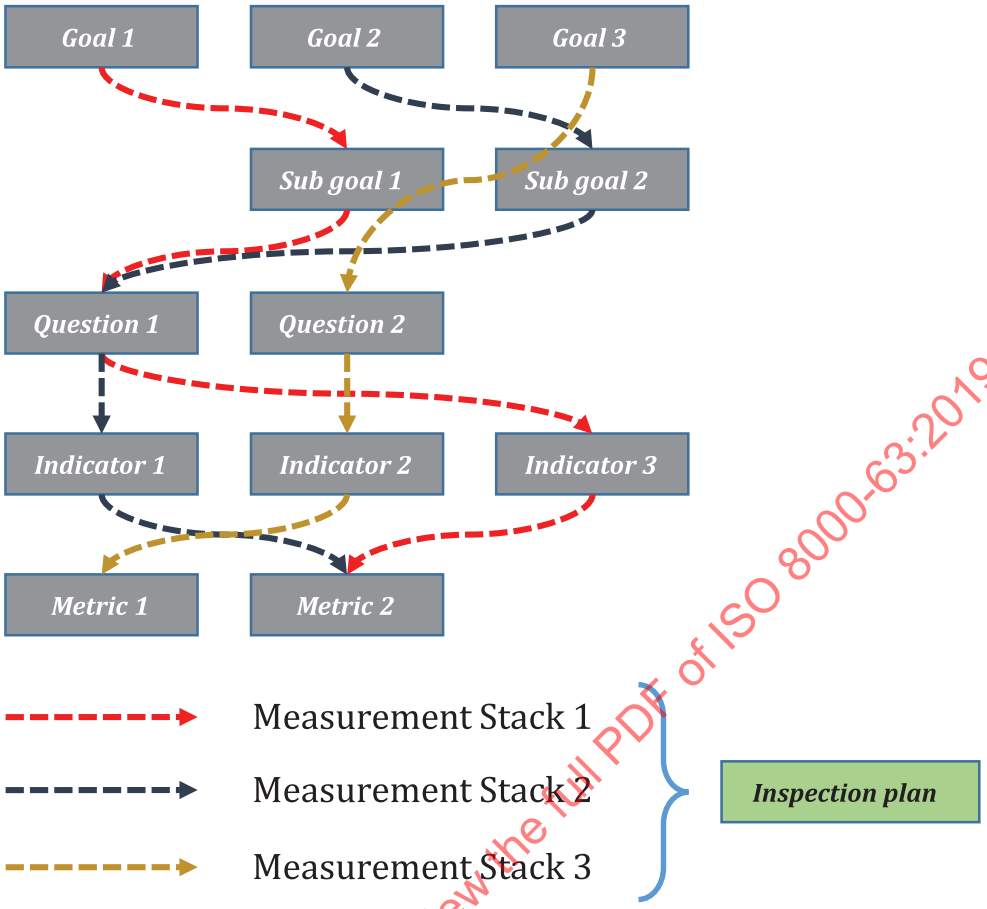
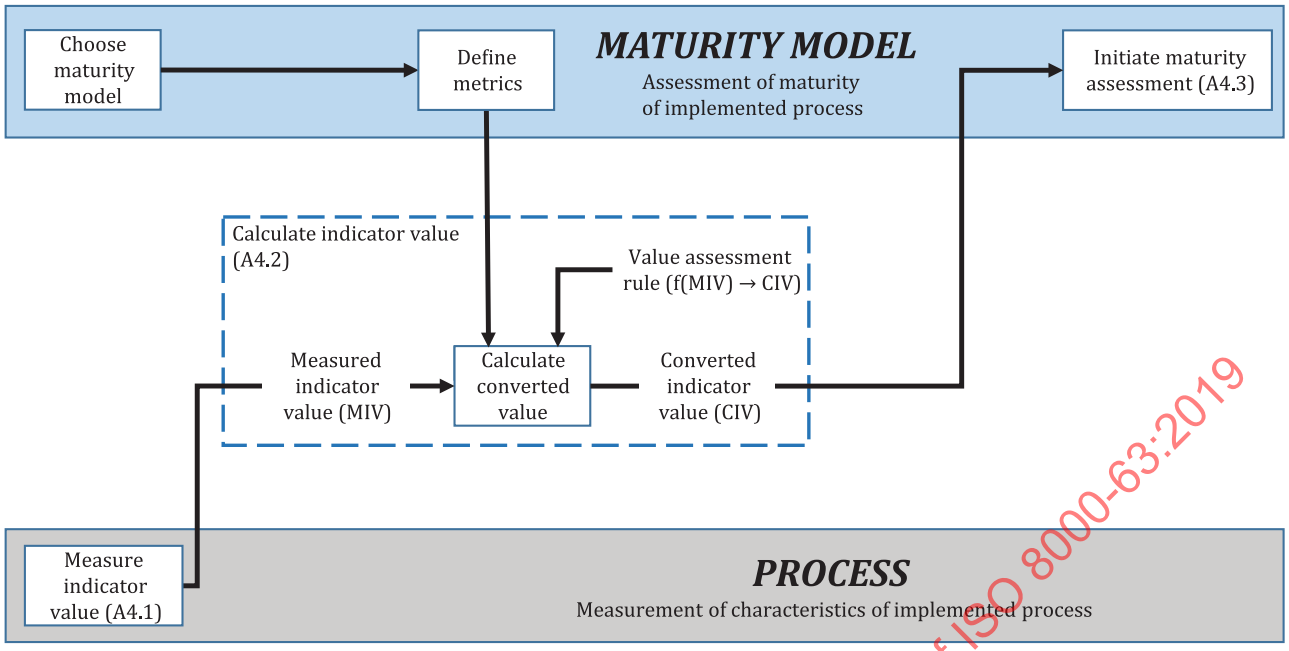


Figure 5 — Example measurement stacks

7.9 Role of value assessment rules in process measurement

Each value assessment rule (see 7.6) is the fundamental link between collecting evidence about an implemented process and determining the maturity of that process (see Figure 6). This link enables an organization to ensure maturity assessment avoids subjective judgement and is repeatable.



NOTE In this figure, the references A4.1 to A4.3 are to activities in the model represented by Figures 7 to 11.

Figure 6 — Calculating the converted indicator value from the measured indicator value

7.10 Exploiting the measurement stack with specific maturity models

Annexes B, C and D show how different maturity models can be used with this document.

Annex E shows examples of how to define characteristics to measure for data quality processes.

7.11 Performing process measurement

Process measurement (see Figure 7) consists of a hierarchy of activities, as follows:

— perform process measurement (see Figure 8);

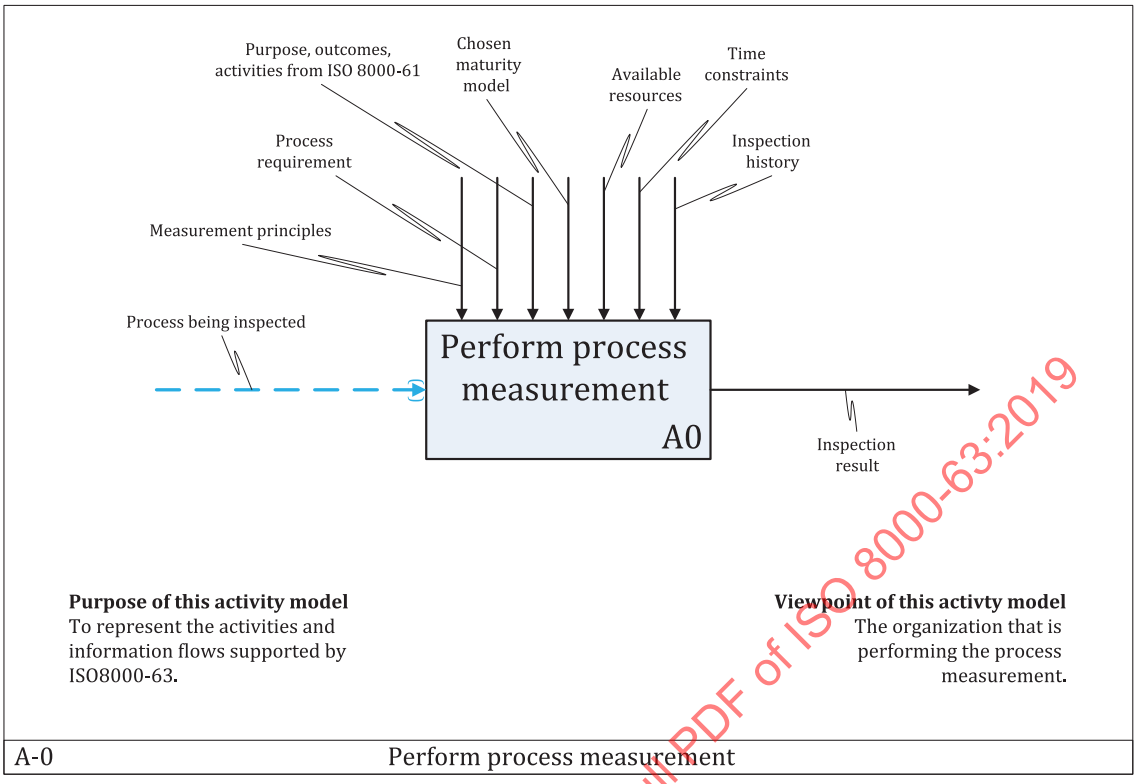
— define measurement stack structure (see Figure 9);

— define inspection plan (see Figure 10);

— prepare inspection order (see Figure 11);

— apply inspection order (see Figure 12).

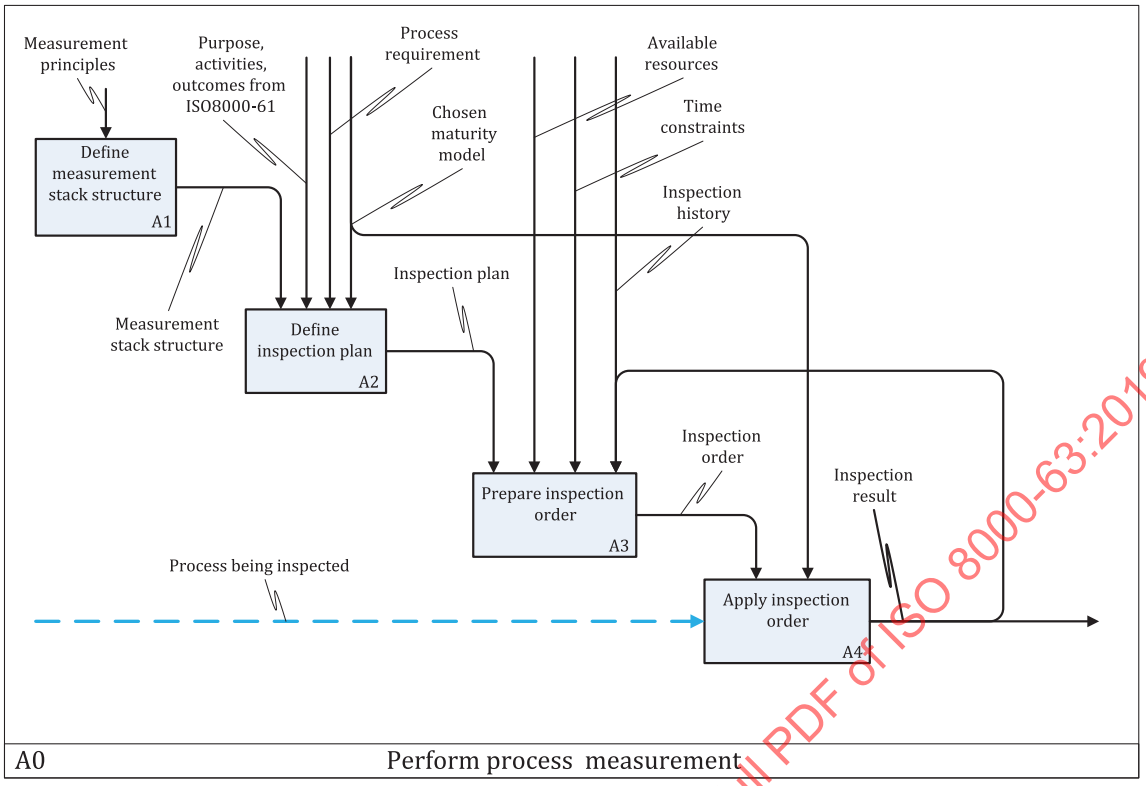
NOTE Using the notation of ISO/IEC/IEEE 31320-1, Figures 7 and 12 represent the content of Figures 3 and 6.



NOTE 1 See ISO/IEC/IEEE 31320-1 for details on the notation in this diagram.

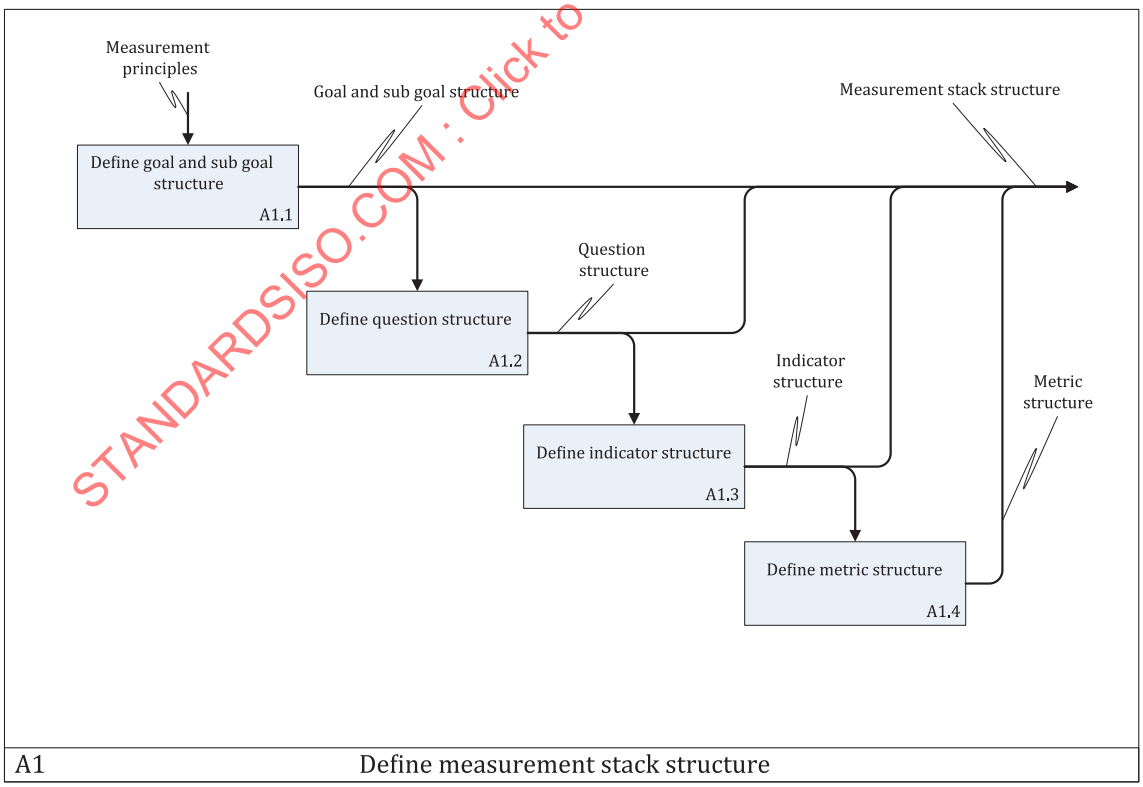
NOTE 2 The dashed arrow represents the instance of a data quality management process and is the subject of the process measurement. All other arrows in the activity model are solid lines and represent information.

Figure 7 — Perform process measurement (activity model diagram A-0)



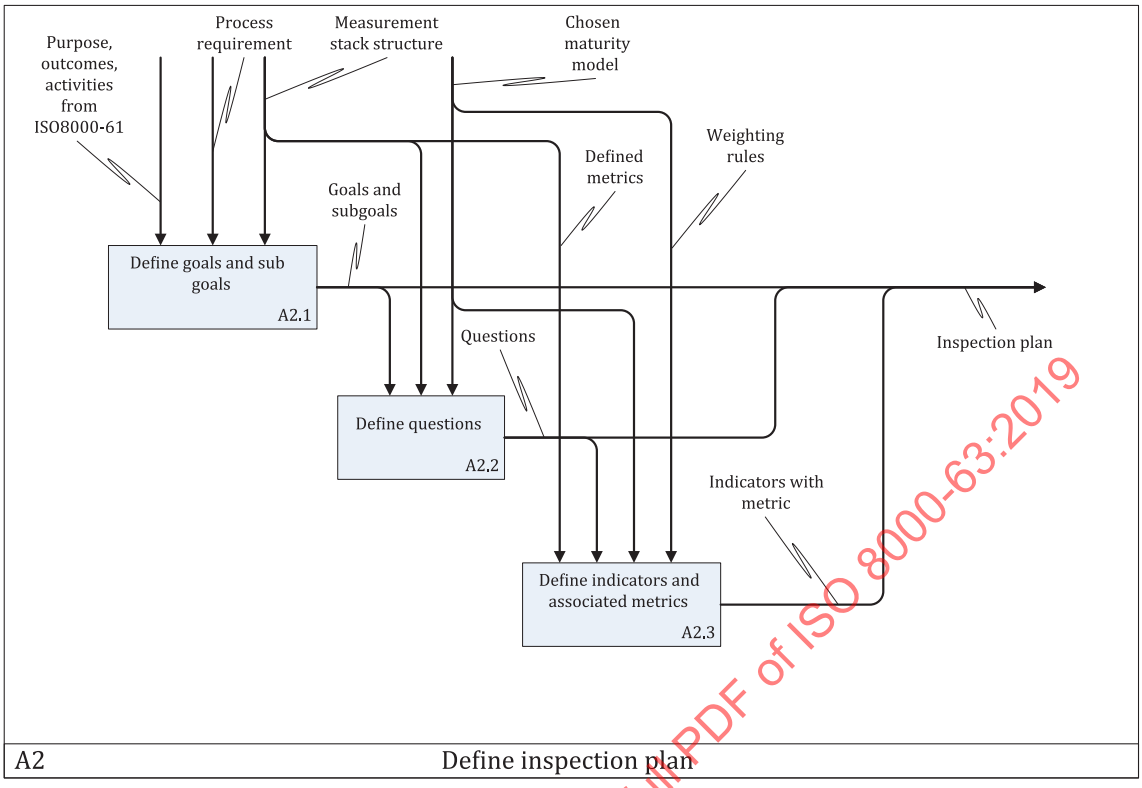
NOTE See ISO/IEC/IEEE 31320-1 for details on the notation in this diagram.

Figure 8 — Perform process measurement (activity model diagram A0)



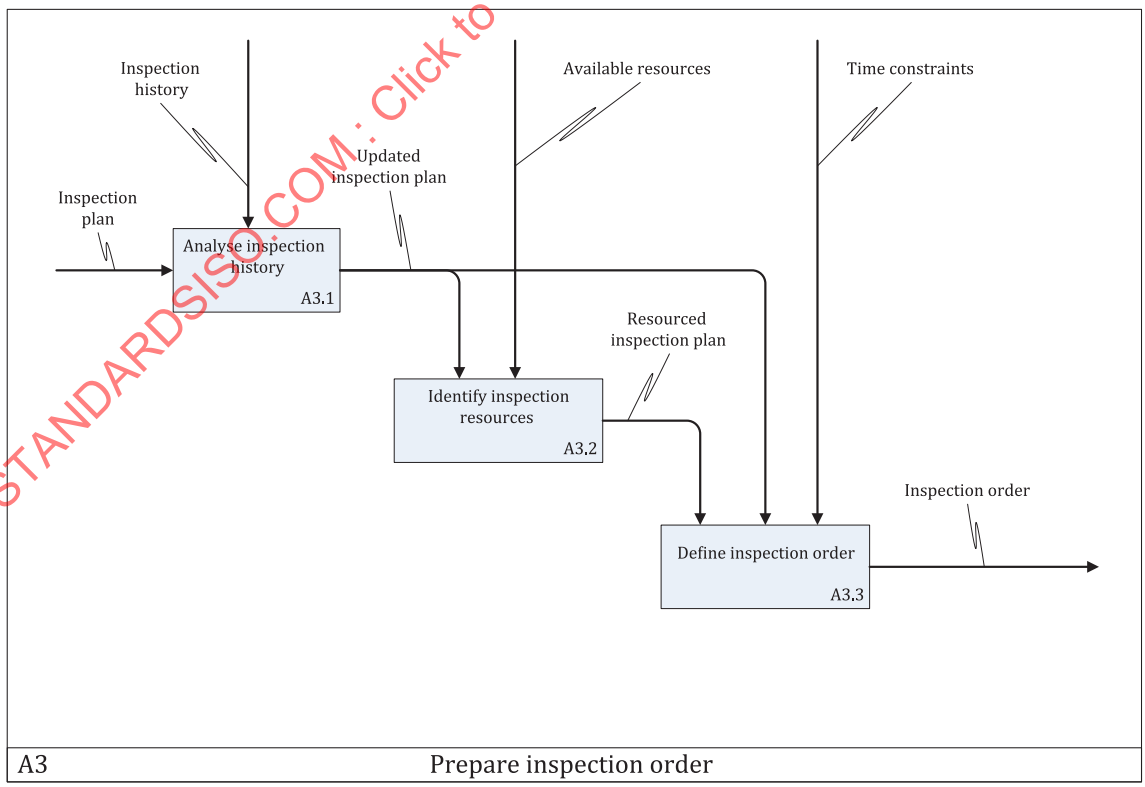
NOTE See ISO/IEC/IEEE 31320-1 for details on the notation in this diagram.

Figure 9 — Define measurement stack structure (activity model diagram A1)



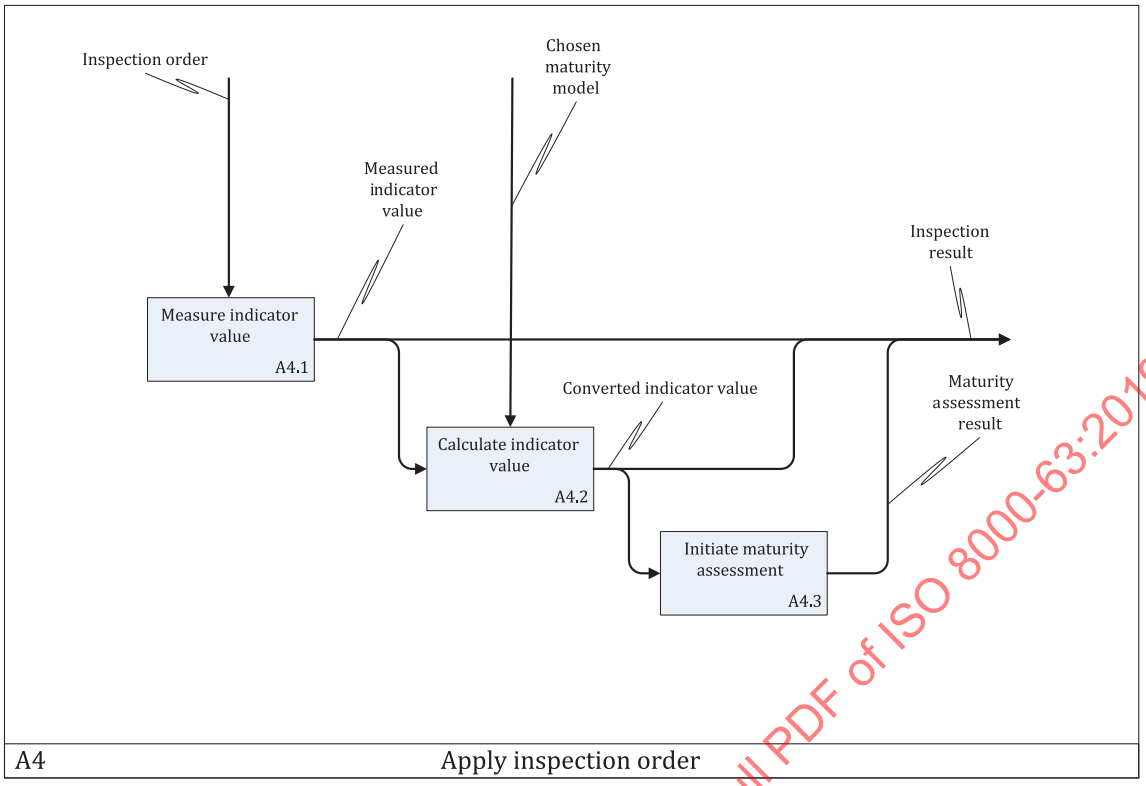
NOTE See ISO/IEC/IEEE 31320-1 for details on the notation in this diagram.

Figure 10 — Define inspection plan (activity model diagram A2)



NOTE See ISO/IEC/IEEE 31320-1 for details on the notation in this diagram.

Figure 11 — Prepare inspection order (activity model diagram A3)



NOTE See ISO/IEC/IEEE 31320-1 for details on the notation in this diagram.

Figure 12 — Apply inspection order (activity model diagram A4)

Annex A
(informative)

Document identification

To provide for unambiguous identification of an information object in an open system, the object identifier

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{ iso standard 8000 part(63) version(1) }
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is assigned to this document. The meaning of this value is defined in ISO/IEC 8824-1 and is described in ISO 10303-1.

Annex B
(informative)

Reference tables for particular process assessment models

This annex provides examples of how to define questions for different process assessment models[14].

For each of these models, a table below lists the process capability levels in the model and, for each level, the type of questions that are necessary to determine if the assessed process is achieving that level. The models are:

— the process assessment model in ISO/IEC 33020 and related standards (see Table B.1), where the process outcomes of the assessed process and process attributes results from ISO/IEC 33020 are the basis for questions;

— the process institutionalization model of CMMI for Development (see Table B.2), where the generic practices are the basis for questions;

— from applying the Test Process Improvement method (see Table B.3), where the outcomes and activities are the basis for questions.

In addition, special indicator types can be used as input for different models (see Table B.4).

Table B.1 — Capability based on ISO/IEC 33020

Process capability level	Source for the questions to determine achievement of the capability level
1. Performed process	Outcomes of the assessed process
2. Managed process	Performance management results Work product management results
3. Established process	Process definition results Process deployment results
4. Predictable process	Process measurement results Process control results
5. Innovating process	Process innovation results Process innovation implementation results
NOTE The questions address the process attributes specified by ISO/IEC 33020.	

Table B.2 — Capability based on CMMI (Capability Maturity Model Integration)

Process capability level	Subject of the questions to determine achievement of the capability level
1. Performed process	Performing specific practices
NOTE The questions address the generic practices specified by CMMI for Development.	

Table B.2 *(continued)*

Process capability level	Subject of the questions to determine achievement of the capability level
2. Managed process	Establishing an organizational policy Planning the process Providing resources Assigning responsibility Training people Controlling work products Identifying and involving relevant stakeholders Monitoring and controlling the process Objectively evaluating adherence Reviewing status with higher level management
3. Defined process	Establishing a defined process Collecting process-related experiences
NOTE The questions address the generic practices specified by CMMI for Development.	

Table B.3 — Capability based on the TPI method

Process capability level	Subject of the questions to determine achievement of the capability level
1. Controlled process	Control of process and environment
2. Efficient process	Achieving efficiency and better integration
3. Optimized process	Optimization
NOTE In line with the Test Process Improvement method, the questions address the outcomes and activities of the process.	

Table B.4 — Example indicators for the different process assessment models

Example	ISO/IEC 33020	CMMI for Development	ISO 9004	EFQM	TPI method
Indicator	Process performance	Status of commitment	Name of author existing	Mean error probability of commitment	Name of author existing
Metric	"N" | "P" | "L" | "F" where "N" = not achieved "P" = partially achieved "L" = largely achieved "F" = fully achieved	0: not achieved 1: partially achieved 2: largely achieved 3: fully achieved	Yes/No	Qualitative: insignificant/ noticeable/ critical/ catastrophic Quantitative: 0 to 100 %	A: 0 to ≤15 % B: >15 % to ≤50 % C: >50 % to ≤85 % D: >85 % to ≤100 % Depend on the requirements
Measured indicator value	65 %	10 %	Yes	35 %	30 %
Converted indicator value	"L"	"1"	Yes	Qualitative: noticeable Quantitative: 35 %	"B"

Annex C
(informative)

Example measurement stacks for data quality management

This annex shows example measurement stacks for the following processes from ISO 8000-61:

— Data Quality Strategy Management;

— Data Quality Policy/Standards/Procedures Management.

For each stack, the outcomes of the corresponding process determine appropriate goals and sub goals.

The annex also shows how the following different maturity models determine the appropriate metric to define in the measurement stack:

— EFQM, requiring the use of percentage as the metric (see Table C.1);

— ISO 9004, requiring the use of "yes" and "no" as the metric (see Table C.2).

Table C.1 — Example measurement stacks for use with EFQM

Process:	Data Quality Strategy Management (see ISO 8000-61:2016, 6.2.3)					
Purpose:	The purpose of Data Quality Strategy Management is to establish the basis on which subsequently to develop policies, standards, procedures and implementation plans that apply to data quality management across the organization and that align with strategic intentions for data quality.					
Goal:	G1	Top management is committed to the improvement of data quality to agreed levels at the organizational level.				
Sub goal:	S1.1	Clear definition of the commitment.				
Question			**Indicator**		**Metric**	
Q1.1.1	Who defines the commitment?		I1.1.1	Name of author existing (0 .. 100 %)	M1.1.1	%
Q1.1.2	Where is the commitment defined?		I1.1.2	Location of commitment known (0 .. 100 %)		
Sub goal:	S1.2	Clear definitions of responsibilities.				
Question			**Indicator**		**Metric**	
Q1.2.1	Are there any responsibilities?		I1.2.1	Degree of responsibility	M1.2.1	%
Goal:	G2	A data quality strategy is created, describing the vision, long-term goals, an implementation roadmap and short-term objectives, which are defined in terms of quantitative outcomes.				
Sub goal:	S2.1	Clear definition of the data quality strategy.				
Question			**Indicator**		**Metric**	
Q2.1.1	What is meant under data quality?		I2.1.1	Degree of qualification (educated user)	M2.1.1	%
Q2.1.2	What should a data quality strategy contain?		I2.1.2	Degree of fulfilment (management manual, internal auditing)		

Table C.1 *(continued)*

Sub goal:	S2.2	Clear description of the vision for the data quality strategy.				
Question		**Indicator**		**Metric**		
Q2.2.1	What should a vision for the data quality strategy contain?	I2.2.1	Degree of qualification (educated user)	M2.2.1	%	
Q2.2.2	Which methods are used for evaluating the vision?	I2.2.2	Degree of fulfilment (management manual, internal auditing)			
Sub goal:	S2.3	Clear description of the long-term goals for the data quality strategy.				
Question		**Indicator**		**Metric**		
Q2.3.1	How many years has to be understood under "long-term"?	I2.3.1	Degree of qualification (educated user)	M2.3.1	%	
Q2.3.2	Which processes should fulfil the long-term goals for the data quality strategy?	I2.3.2	Degree of maturity (processes)			
Sub goal:	S2.4	Clear description of the implementation roadmap for the data quality strategy.				
Question		**Indicator**		**Metric**		
Q2.4.1	Who is doing the implementation roadmap?	I2.4.1	Degree of description (implementation roadmap)	M2.4.1	%	
Q2.4.2	Who is responsible for the coordination of the implementation roadmap?					
Q2.4.3	Is there a project team for the implementation roadmap?					
Q2.4.4	Who is checking and controlling the results of each step of the implementation roadmap?					
Q2.4.5	Which criteria are necessary to evaluate the implementation roadmap?					
Goal:	G3	A framework is created for establishing and reviewing the data quality strategy.				
Sub goal:	...	...				
Question		**Indicator**		**Metric**		
...	...	...	...	...	...	
Goal:	G4	Results are evaluated to determine the performance of the data quality strategy, leading to the strategy being updated as necessary.				
Sub goal:	...	...				
Question		**Indicator**		**Metric**		
...	...	...	...	...	...	

Table C.1 *(continued)*

Goal:	G5	The data quality strategy is communicated throughout the organization.			
Sub goal:	...	...			
Question		**Indicator**		**Metric**	
...	...	...	...	...	...
Process:	Data Quality Policy / Standards / Procedures Management (see ISO 8000-61:2016, 6.2.4)				
Purpose:	The purpose of Data Quality Policy/Standards/Procedures Management is to capture rules that apply to performing Data Quality Control, Data Quality Assurance, Data Quality Improvement, Data-Related Support and Resource Provision consistently across the organization.				
Goal:	G1	Appropriate and inappropriate actions are defined as fundamental intentions and rules governing the data quality management process.			
Sub goal:	...	...			
Question		**Indicator**		**Metric**	
...	...	...	...	...	...

Table C.2 — Example measurement stacks for use with ISO 9004

Process:	Data Quality Strategy Management (see ISO 8000-61:2016, 6.2.3)				
Purpose:	The purpose of Data Quality Strategy Management is to establish the basis on which subsequently to develop policies, standards, procedures and implementation plans that apply to data quality management across the organization and that align with strategic intentions for data quality.				
Goal:	G1	Top management is committed to the improvement of data quality to agreed levels at the organizational level.			
Sub goal:	S1.1	Clear definition of the commitment.			
Question		**Indicator**		**Metric**	
Q1.1.1	Who defines the commitment?	I1.1.1	Name of author existing (0 .. 100 %)	M1.1.1	“yes” | “no”
Q1.1.2	Where is the commitment defined?	I1.1.2	Location of commitment known (0 .. 100 %)		
Sub goal:	S1.2	Clear definitions of responsibilities.			
Question		**Indicator**		**Metric**	
Q1.2.1	Are there any responsibilities?	I1.2.1	Responsibilities existing (0 .. 100 %)	M1.2.1	“yes” | “no”
Goal:	...	...			
Sub goal:	...	...			
Question		**Indicator**		**Metric**	
...	...	...	...	...	...

Annex D
(informative)

Example of process assessment based on ISO/IEC 33020

D.1 The measurement stack

This example shows how the measurement stack can support the ISO/IEC 33020 approach to process assessment and how this approach can be used to assess data quality management as specified by ISO 8000-61.

For this approach, the core mapping of the measurement stack is as follows:

— goal = data quality management as specified by ISO 8000-61;

— sub goal = one for each of the purposes of the twenty processes specified by ISO 8000-61;

— question = for each process, one for each of the process outcomes of that process as specified by ISO 8000-61 and one for each of the process attribute results as specified by ISO/IEC 33020 (other than the result "the process achieves its defined process outcomes", which is addressed by the questions against the outcomes specified by ISO 8000-61);

— indicator = the nine process attributes specified by ISO/IEC 33020;

— metric = "N" | "P" | "L" | "F" as specified by ISO/IEC 33020 (see E.2 for further detail).

Based on this measurement stack, an organization can assess the level of maturity of data quality management (as shown by ISO 8000-62).

ISO/IEC 33020 also specifies how to convert percentage achievements into the metric "N" | "P" | "L" | "F" (see E.2). This conversion forms part of the necessary function *f(MIV)* → *CIV* (see Figure 6) to generate the indicator values.

The following table illustrates the above mapping for the single process "data quality strategy management" but only shows the process attributes "performance management" and "work product management". The table does not include the questions, indicators and metrics for process attributes of process capability levels 3 to 5 (i.e. established process, predictable process and process innovation process).

Table D.1 — A partial measurement stack for process assessment based on ISO/IEC 33020

Goal:		Data quality management				
Sub goal:		S2	Data quality strategy management (see ISO 8000-61:2016, 6.2.3)			
Question			**Indicator**		**Metric**	
Q2.1	Is top management committed to the improvement of data quality to agreed levels at the organizational level? (See outcomes specified by ISO 8000-61:2016, 6.2.3)	I2.1	Process performance (see ISO/ IEC 33020:2015, 5.2.2.1)	M2.1	"N" | "P" | "L" | "F"	