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Environmental management — Quantitative environmental information — Guidelines and examples

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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 207, *Environmental management*, Subcommittee SC 4, *Environmental performance evaluation*.

This first edition cancels and replaces ISO/TS 14033:2012, which has been technically revised.

The main changes compared with the previous edition are as follows:

— definitions have been added and principles have been modified;

— the framework has been elaborated and new examples of general application have been added;

— extended explanations of data sources and categories of data have been added;

— new topics in the ISO 14000 family of standards, such as financial applications, have been added;

— the relationship between quantitative environmental information and industrial digitalization has been added;

— the relationship between systems analytical environmental data and metrological aspects of acquiring data has been added;

— Annexes D and E have been added.

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

This document provides guidelines and examples for the acquisition and provision of quantitative environmental information. It is also intended to support review and verification of quantitative information. This document supports the continual improvement of environmental management and the achievement of sustainable development. The purpose of this document is to help break down the complexity of environmental data handling, by applying systems analysis and metrology, into distinguishable practical steps, each with low complexity and a clear objective, to assist the process of gathering and processing quantitative environmental information. This document is intended for use by those who work with environmental quantitative information, including data acquisition, compilation, reporting and review.

Since this document addresses data measurement, data acquisition and compilation, it is also closely linked to areas of digitalization, such as digital twins, positioning of sensors, and acquisition, handling and interpretation of sensor data, as well as concepts related to "big data", such as statistical analysis and statistical inference. This document provides guidelines on how to effectively and efficiently position sensors (or other data sources) for such analyses, as well as on how to transparently make references to such data sources, to help interpret and review big data statistical analyses.

The guiding framework adheres to the general principles of continual improvement and follows an iterative Plan-Do-Check-Act (PDCA) approach.

This document addresses data quality by providing guidelines and examples on how to acquire, compile and report data to reach the data quality requested by the application of quantitative environmental information. Data quality is an intended and implicit result from the guidelines provided by this document, but it is not specifically addressed throughout the text.

The guidelines range from planning, defining and acquiring quantitative data to performing mathematical processing. They can be used to review the work that results in environmental quantitative information for an application as part of a method or tool, such as life cycle assessment or environmental performance evaluations. The guidelines do not include specific methods or tools, but they address how to acquire and provide quantitative data for such applications. This document refers to data as individual entities rather than sets of values such as databases. The guidelines are developed with an understanding that many applications of quantitative environmental information are intended for different types of assessments within organizations. Quantitative environmental information therefore impacts the level of confidence for decision making, including technology development, investments and financial decisions. Any type of intended application and related assessment is dependent on first identifying the expectations linked to the results generated using the quantitative environmental information before establishing statistical and numerical design criteria to be used for data collection.

The guidelines are developed with the understanding that many applications of environmental information are intended for quantitative comparisons, such as levelling and benchmarking, controlling continual improvement (comparing with the previous year), quantitative identification of priority areas, numerical appraisal and comparison of risks, decisions about design, investment or procurement. This document supports quantitative comparisons by highlighting perspectives of the planning of the acquisition and provision that are particularly relevant to achieving comparable quantitative results.

This document provides guidelines for acquiring and providing a broad variety of quantitative environmental information and data. When an organization applies this document for various purposes within its environmental management system, or for specific tools, purposes or applications, maximum benefit is gained by following the principles described in Clause 5.

For adequate application of this document for the acquisition, compilation and reporting of quantitative environmental information, particular consideration should be given to identifying the skills needed by the practitioner.

Annex E provides explanatory information to prevent misinterpretation of the guidance presented in this document.

Environmental management — Quantitative environmental information — Guidelines and examples

1 Scope

This document gives guidelines for the systematic and methodical acquisition and review of quantitative environmental information and data about systems. It supports the application of standards and reports on environmental management.

This document gives guidelines for organizations on the general principles, policies, strategies and activities necessary to obtain quantitative environmental information for internal and/or external purposes. Such purposes can be, for example, to establish inventory routines and support decision making related to environmental policies and strategies, aimed in particular at comparing quantitative environmental information. The information is related to organizations, activities, facilities, technologies and products.

This document addresses issues related to defining, collecting, processing, interpreting and presenting quantitative environmental information. It provides guidelines on how to establish accuracy, verifiability and reliability for the intended use. It uses proven and well-established approaches for the preparation of information adapted to the specific needs of environmental management.

This document is applicable to all organizations, regardless of their size, type, location, structure, activities, products, level of development and whether or not they have an environmental management system in place.

NOTE 1 Quantitative information specifically addresses quantification of environmental performance in the form of environmental performance indicators in accordance with ISO 14031.

NOTE 2 Quantitative information also addresses quantification of risk for risk management purposes.

This document supplements the contents of other International Standards on environmental management.

NOTE 3 Annexes A and B provide illustrative and general examples of how to apply the guidelines and the framework. Annexes C and D provide sector-specific case studies on the application of the framework and case studies on selected documents from the ISO 14000 family, respectively. Annex E provides explanatory information to prevent misinterpretation of the guidance of this document.

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 14050, *Environmental management — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14050 and the following 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/

3.1 Types of information

3.1.1
basic data
data acquired from a data acquisition process

Note 1 to entry: Basic data consist of one or several values and units, depending on the nature of the item that the basic data represent. Some basic data can be dimensionless and have no units, e.g. an index or ratio.

3.1.2
activity data
quantitative measure of an activity that results in an environmental impact

3.1.3
quantitative data
numerical data item that includes its unit, or context for non-dimensional data

3.1.4
quantitative information
quantitative data (3.1.3) that has been processed or analysed to be meaningful for a specific purpose or objective

Note 1 to entry: Quantitative data can originate from *data sources* (3.2.2) that provide either *primary data* (3.1.5) or *secondary data* (3.1.6).

3.1.5
primary data
data obtained from known direct measurement or from implicitly or explicitly defined calculations based on data originating from such direct measurements

3.1.6
secondary data
data obtained in other ways than *primary data* (3.1.5)

3.1.7
metadata
data that provides information about other data

EXAMPLE The date when the data was originally measured, or a description of the *system* (3.2.4) that the data are intended to represent or information about how the data was obtained.

3.1.8
foreground data
data representing *property* (3.2.3) of a *foreground system* (3.2.6)

3.1.9
background data
data representing *property* (3.2.3) of the *system* (3.2.4) that lies outside the *foreground system* (3.2.6)

3.2 Managing information

3.2.1
metrology
science of measurement, embracing both experimental and theoretical determinations at any level of *uncertainty* (3.3.3) in any field of science and technology

Note 1 to entry: For details about metrology, refer to JCGM 200:2012.

Note 2 to entry: Metrology includes all theoretical and practical characteristics of measurement, whatever the measurement uncertainty and field of application.

3.2.2
data source
origin of data

Note 1 to entry: A data source might consist of *primary data* (3.1.5) or *secondary data* (3.1.6)

EXAMPLE Literature, databases, human resources, instruments.

3.2.3
property
aspect or quality of something that can be determined by measurement

[SOURCE: ISO/TS 15926-6:2013, 3.1.12, modified — The preferred term "physical quantity" and the Note 1 to entry have been removed.]

3.2.4
system
group or groups of independent and interrelated objects or processes

3.2.5
systems analysis
methodology for identifying and analysing properties of a *system* (3.2.4) by studying its internal constituents and their dependencies and relations

3.2.6
foreground system
subsystem of focus of a *systems analysis* (3.2.5)

3.3 Characteristics of information

3.3.1
data quality
characteristics of data that relate to their ability to satisfy stated requirements

Note 1 to entry: In this document, "stated requirements" refers to "requirements of the objective" and "ability to satisfy stated requirements" refers to "meeting the objective" according to Clause 6.

[SOURCE: ISO 14044:2006, 3.19, modified — Note 1 to entry has been added.]

3.3.2
transparency
open, comprehensive and understandable presentation of information

[SOURCE: ISO 14044:2006, 3.7]

3.3.3
uncertainty
variability due to random or systematic causes

Note 1 to entry: Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood.

4 Use of quantitative environmental information

4.1 General

Quantitative environmental information is used for environmental measurements, calculations, assessments, comparisons, reporting and communication about systems. This document supports any such use or application of quantitative environmental information throughout International Standards on environmental management. Examples are environmental performance indicators, environmental

communication, environmental declarations, life cycle assessment, greenhouse gas emission reporting, climate change mitigation, climate change adaptation, carbon footprint, water footprint, eco-efficiency, reporting to authorities, sustainability reporting, social responsibility reporting, environmental technology verification (ETV) reporting, material flow cost accounting and monetary valuation.

The role that the application of environmental quantitative information has in relation to this document is shown in Figures 1, 2 and 3. The application sets requirements on different characteristics of the quantitative environmental information that in turn implies how the data and information is acquired and provided. The application also specifies the intended use and the requirements or expectations concerning credibility, accuracy and transparency. This document provides specific guidelines when the application implies a comparison between quantitative environmental information about different products, processes or systems.

4.2 Internal use of quantitative environmental information

This document gives guidelines for the acquisition and provision of quantitative environmental information for internal applications. Typical applications are as follows:

— monitoring of environmental performance indicators: acquisition and provision routines for repeated information handling tasks as required for documentation and for supporting the continual improvement of the environmental management system;

— environmental risk assessment: quantified environmental information about identified risk factors and possible impacts as intended or accidental;

— life cycle assessment studies of products and services (LCA): data acquisition procedures for the acquisition and provision of life cycle inventory (LCI) data for internal use;

— material flow cost accounting (MFCA): quantitative information on material and energy flows on the process level of an organization that are acquired and provided to improve the resource efficiency of production systems;

— business intelligence: quantitative methods and routines for the assessment of environmental performance and specified requirements for the general market;

— establishing mid- and long-term environmental goals connected or integrated with financial data;

— automatically optimizing production performance to minimize the risk for environmental impact from the production facility.

To establish consistency of data used in different applications and to maximize the usability of data, one common set of guidelines and routines for data acquisition and provision might be useful.

4.3 External use of quantitative environmental information

This document also gives guidelines for the acquisition and provision of quantitative environmental information for external applications, such as the following:

— greenhouse gas (GHG) trading scheme and GHG emission reporting;

— corporate environmental and sustainability reporting;

— governmental reporting;

— external communication, such as eco-labelling, environmental product declarations and other public life cycle assessments, by providing guidelines on how to specify requirements on transparency, accuracy and other characteristics that are important when communicating results of complex studies externally;

— environmental performance reporting, such as setting the quantitative specifications for the reporting of the eco-efficiency of products and services of a company;

— environmental technology verification (ETV) reporting based on new environmental technology verified in its claimed performance;

— communication with financial stakeholders, such as sustainability reports or financial databases;

— information that enables product users to manually or automatically optimize their product handling, use or waste treatment to minimize the risk for environmental impacts due to the product;

— information for suppliers of goods and services that enables them to manually or automatically optimize their supply to minimize the risk for environmental impacts during the supply.

External communication of quantitative environmental information sets requirements on consistency, reliability and transparency. Meeting these requirements is facilitated by common guidelines that support review, verifiability and credibility of the data. Information that is acquired and provided in compliance with a common guideline can be more easily interpreted and therefore also more easily used in several applications.

4.4 Using quantitative environmental information for comparisons

This document gives specific guidelines when the quantitative environmental information is intended for comparisons, such as:

— carbon dioxide emissions from different production plants;

— eco-efficiency of different products;

— life cycle impact assessment of different functional units;

— electricity consumption by different production units.

When acquiring and providing data intended for comparison, it is important to consider not only the application at hand, but also that any decisions are generalizable and repeatable when acquiring the same or similar data for the other system(s) for comparison.

One of the objectives of quantitative data might be to carry out comparative studies, such as:

a) a system at two or more different time intervals;

b) the effect of changes in systems, areas and product lines;

c) different organizational and operational boundaries internally or externally.

5 Principles for generating and providing quantitative environmental information

5.1 General

These principles are fundamental for ensuring that quantitative environmental information provides a true and fair account and is used as a guideline for decisions relating to this document.

5.2 Relevance

The selected data sources, system boundaries, measurement methods and assessment methods meet the requirements of the interested parties and/or the application.

NOTE These requirements can vary for different interested parties and different applications.

5.3 Credibility

The quantitative environmental information provided is truthful, accurate and not misleading to interested parties.

5.4 Consistency

Compatible, coherent and not self-contradictory quantitative environmental data and information are developed using recognized and reproducible methods and indicators, which respect related integrity constraints.

5.5 Comparability

The quantitative environmental information is generated, selected and provided in a consistent way, with consistent measurement units, thereby allowing for comparisons.

EXAMPLE Comparison of environmental performance of an organization over time; comparison of environmental performance of different organizations or of similar organizations in different countries.

5.6 Transparency

The processes, procedures, methods, data sources and assumptions for providing and generating quantitative information are made available to all relevant interested parties.

NOTE This is done to ensure a proper interpretation of the results and to give explicit reasons for any extrapolations, simplifications or modelling performed, taking into account confidentiality of information, if required. In addition, any volatility or uncertainty is disclosed.

5.7 Completeness

All significant quantitative environmental information for the intended use is reflected in such a way that no other relevant information needs to be added.

5.8 Validity

Systematic errors and associated uncertainties are minimized as far as practicable and tendencies towards a particular perspective or bias are eliminated.

5.9 Appropriateness

Quantitative environmental information is made relevant and fully understandable to interested parties, by using formats, language and media that meet their expectations and needs.

5.10 Materiality

The focus is kept where it really matters and where the application of the quantitative environmental information could influence the intended user's decisions and work efficiently with the acquisition and provision of quantitative environmental information.

NOTE The concept of materiality is used to identify information that, if omitted or misstated, would significantly misrepresent a compilation of quantitative environmental information to its intended application, thereby creating confusion or misunderstanding. Acceptable materiality is determined by the application.

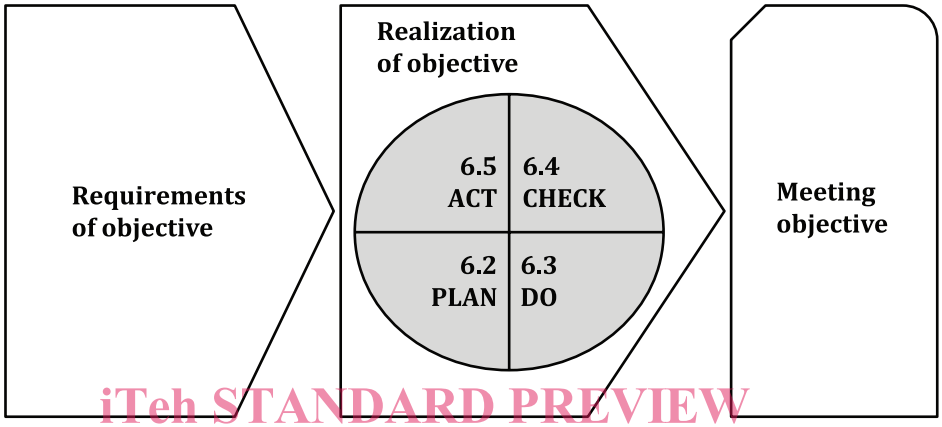
6 Guidelines

6.1 General

6.1.1 Plan-Do-Check-Act approach

The guidelines in this document are based on the continual improvement loop of Plan-Do-Check-Act (PDCA), as illustrated in Figure 2. The guidelines are organized into a consistent framework, described in this clause, and illustrated by Figures 1, 2 and 3.

To the extent necessary, all steps and outcomes of the PDCA should be sufficiently documented.

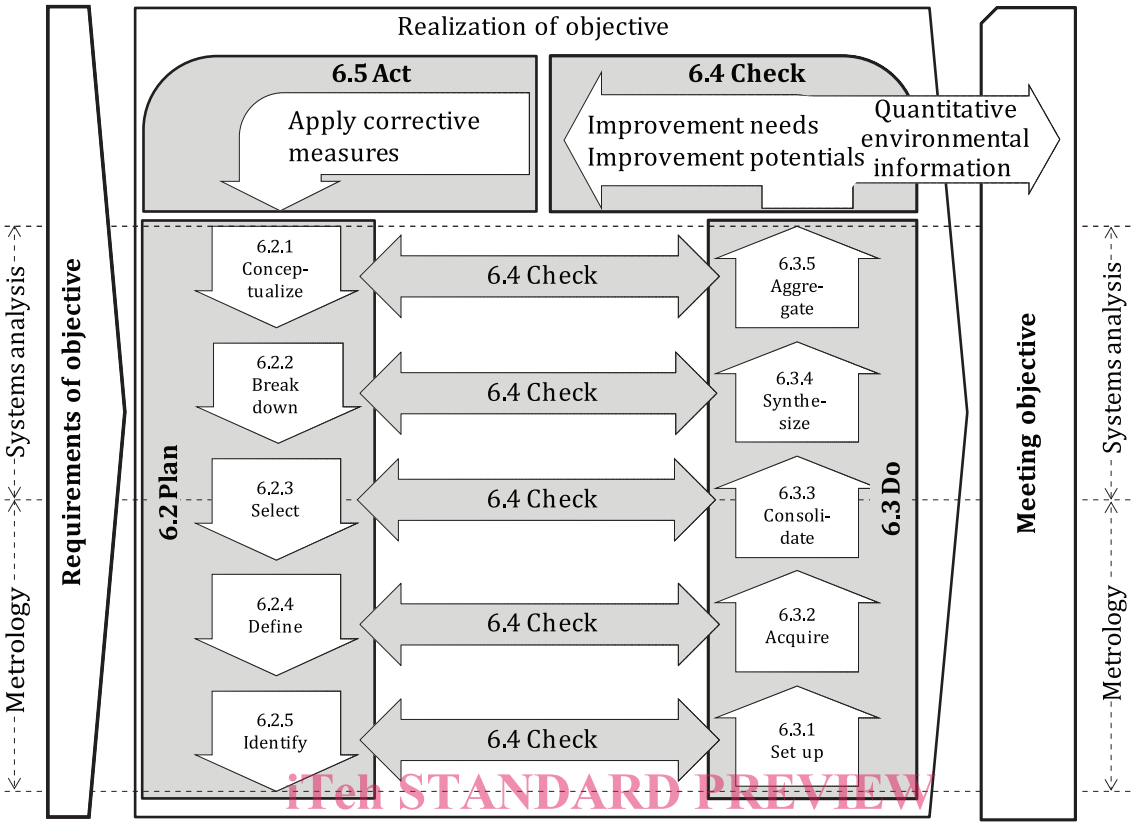


NOTE 1 The numbers in the figure refer to clauses and subclauses in this document.

NOTE 2 Due to the design of the framework (see Figure 2), the PDCA loop in Figure 1 is traversed counter-clockwise.

Figure 1 — The overall process model of the framework

The framework is based on a process model. The input to the process is the requirements of the objective, set by the actual application of the quantitative information. The requirements of the objective and judgement of whether the objective has been met is outside of the scope of this document but is set by the application. The application itself lies outside of the framework. The output from the process is the meeting objective. The focus of the framework is the process of the realization of objective. The PDCA work process starts with 6.2 “Plan”. Figure 2 shows the realization of the objective in detail.



NOTE The numbers in the figure refer to clauses and subclauses in this document.

Figure 2 — Guidelines for acquiring and providing quantitative environmental information with PDCA

The emphasis of the guidelines lies in tasks which belong to Plan, Do and Check. Act is also part of the framework, but with lesser emphasis. In these steps, the quantitative environmental information is prepared and delivered according to the requirements of the objective. Each task of Plan corresponds to a task in Do. This covers the handling of specific issues down through the planning and data acquisition, up to the provision of the quantitative environmental information. Check is the evaluation of the actual correspondence between the tasks of Plan and Do, and of the overall meeting of the requirements of the objective.

The guidelines, as described in Figures 1 and 2, support a process view. The guidelines distinguish the three consecutive phases:

— requirements of the objective;

— realization of the objective;

— meeting the objective.

In Figure 2, the upper half of tasks are labelled as systems analysis (see 6.2.1 to 6.2.3 and 6.3.3 to 6.3.5), and the lower tasks are labelled as metrology (see 6.2.3 to 6.2.5 and 6.3.1 to 6.3.3). Tasks 6.2.3 and 6.3.3 belong to both those labels. This indicates that the acquisition of quantitative data rests on applicable sciences, standards and methods of metrology, and that the quantification of the system relies on the sciences, standards and methodologies of systems analysis. It also means that the selection of parameters (see 6.2.3) and the consolidation of parameters (see 6.3.3) is where this framework combines these two different fields to quantify environmental information.

The framework provides systematic approaches to check of quantitative environmental information. Check might be, for example, in the form of peer data quality check, peer review or third-party review.

Two different forms of support for review and check are described in 6.4.2.1 and 6.4.2.2: consecutive check and check of resulting quantitative information.

The framework is intended to be used either or both iteratively and recursively, for different purposes and in different ways.

The iterative use of the PDCA loop is straightforward. At each iteration, it serves to gradually Plan and Do differently to more effectively and efficiently satisfy the requirements of the objective. It also serves to adapt Plan and Do to any changing requirements of the objectives, such as increased demands in data transparency, needs of additional parameters or other changing requirements.

Recursive use of the framework is schematically represented in Figure 3. If the data source results from the quantification of a transparent system model, the framework can be applied an arbitrary number of levels for practical reasons of work division or to satisfy the requirements of the objective.

Figure 3 shows a schematic representation of how the framework might be used recursively during break down or aggregation of a system to identify or set up data sources, in the figure exemplified as measurements, literature and expert data sources.

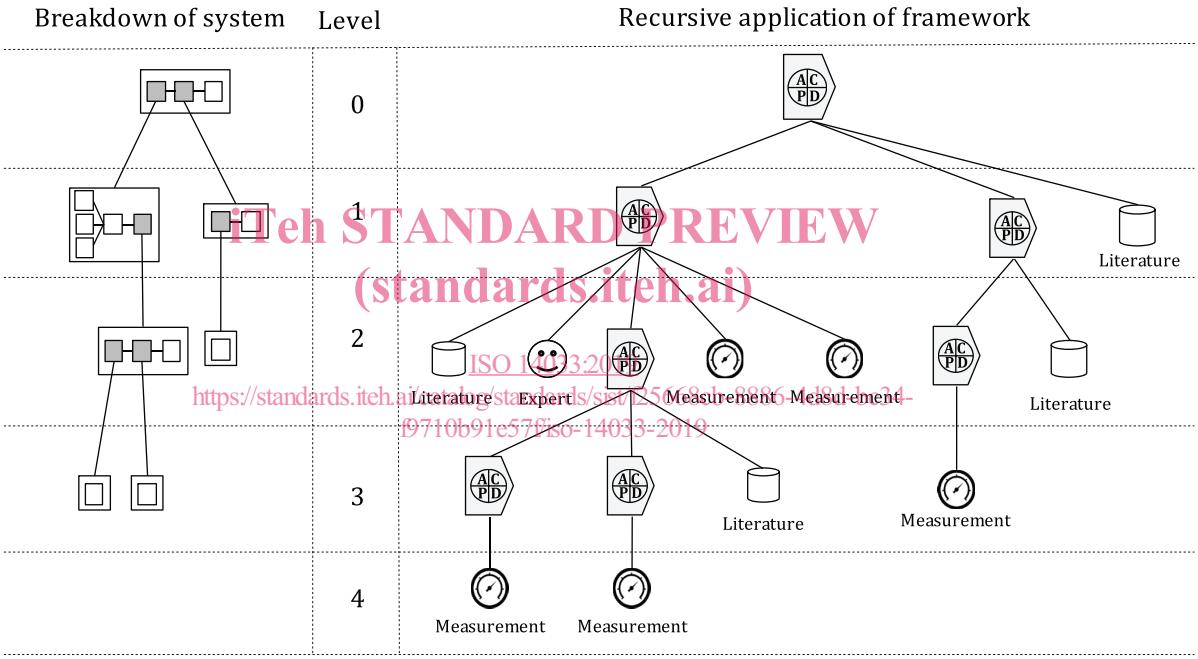


Figure 3 — Recursive use of the framework

The framework provides guidance from three viewpoints, as follows:

a) top down, as a detailed and stepwise guideline for specifying quantitative environmental information for one or several defined applications, i.e. Plan (see 6.2);

b) bottom up, as stepwise guidelines for how to compile basic data into quantitative environmental information intended for given applications, i.e. Do (see 6.3);

c) what and how to check, review and verify a specific compilation of quantitative environmental information, i.e. Check (see 6.4).

In 6.2 to 6.5, the guidelines are presented top down, starting with Plan. Supplementary illustrative examples and general examples on the application of the guidelines are given in Annexes A and B.