
**Security and resilience — Guidelines
for complexity assessment process**

*Sécurité et résilience — Lignes directrices relatives au processus
d'évaluation de la complexité*

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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).

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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 292, *Security and resilience*.

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

Complexity is a fundamental property of many systems. An appropriate level of complexity is required for systems operation, but a high degree of complexity can weaken the system, particularly during turbulent times. High system complexity could be an obstacle to the security, resilience, effectiveness and efficiency of all organizations. As organizational systems, products, processes, technologies, organizational structures and contracts become more complex, organizations may fail to pay sufficient attention to the introduction and proliferation of more complex and less secure systems that then become unsustainable and lose their integrity. [Figure 1](#) explains where the introduction of complexity can improve performance, but where, after it reaches certain point, it will degrade performance. Point A is the best ratio between performance and complexity.

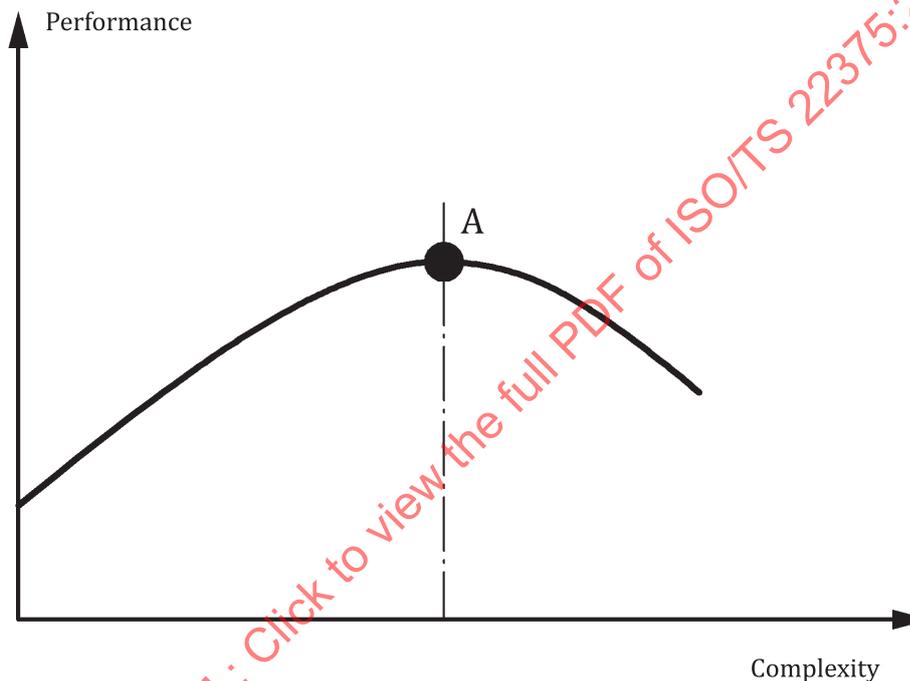


Figure 1 — The impact of complexity against performance

Organizational complexity cannot be increased indefinitely, however. If complexity exceeds a manageable level, e.g. interdependencies expand to the degree that all elements are connected with one another, the system behaviour turns chaotic. Hence, the relationship between organizational complexity and performance is hypothesized to be inversely u-shaped, as shown in [Figure 1](#)^[16].

The complexity of an organization's system is influenced by external and internal factors, often linked to direct or indirect actions carried out by different parties.

Day-to-day managerial decisions about the organization's activities tend to generate complexity.

For large companies with decentralized decision-making, decisions tend to be made without the assessment of complexity cost and benefit trade-offs.

These decisions could add complexity without creating customer or competitive benefits and could increase the organization's vulnerability.

Moreover, the decisions taken by customers, competitors and suppliers, as well as the enactment of new regulations, induce the organizations to adapt themselves to new scenarios. Increasing the complexity of the external environment may induce the organization to increase the number of functional units and this could increase functional and structural complexity of the organization.

Functional complexity is characterized by its management system and its business processes set out in directives, procedures and reports.

Structural complexity deals with the variety of elements and relationships among the people, products and services, and assets of the organization.

To assess the complexity of an organization's system, it is necessary to take into account a large number of parameters where the interactions change and develop dynamically and in a non-linear laws.

This is particularly true in the context of a turbulent and interdependent global economy, punctuated by shocks and instabilities of increasing intensity and frequency, which can undermine the performance and survival of any system.

High complexity is an important source of a new form of risk called "complexity-related risk" that organizations have to address and manage if the security and resilience of its system are to be sustained.

This document aims to stimulate organizations to take into account the threat created by an excess of complexity and to consider complexity assessment as an integral part of their plan for security management.

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Security and resilience — Guidelines for complexity assessment process

1 Scope

This document gives guidelines for the application of principles and a process for a complexity assessment of an organization's systems to improve security and resilience. A complexity assessment process allows an organization to identify potential hidden vulnerabilities of its system and to provide an early indication of risk resulting from complexity.

This document is generic and applicable to all sizes and types of organization systems, such as critical assets, strategic networks, supply chains, industrial plants, community infrastructures, banks and business companies.

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 22300, *Security and resilience — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22300 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

complexity

condition of an organizational system with many diverse and autonomous but interrelated and interdependent components or parts where those parts interact with each other and with external elements in multiple end non-linear ways

Note 1 to entry: Complexity is the characteristic of a system where behaviour cannot be determined only as the sum of individual variables behaviours.

3.2

parameter

specific value describing the measurable or theoretical features of the elements of a system

4 Principles

To carry out complexity assessment process effectively, an organization should adopt and apply the principles below.

- a) Complexity is a fundamental property of many organization's systems. An appropriate level of complexity is required for systems operations.

- b) High complexity could be a source of a new form of risk called “complexity-related risk”. Complexity is often an important cause of vulnerability and should be managed.
- c) The complexity assessment process should inform the security management process and the risks management process. It helps the organization to enhance the security and resilience of its system.
- d) A complex system has numerous components and interconnections, interactions or interdependences that may be difficult to describe, understand, predict, manage, design and change. The complexity assessment process aims to identify the most important process/parameters that contribute to making the system vulnerable.
- e) A complexity assessment process enhances an organization’s resilience and creates strategic and tactical advantages. It assists the organization to decide how to reduce the variability/volatility of the parameters to achieve these benefits.

5 Preliminary assessment process

5.1 General

The preliminary assessment process for the complexity assessment process provides the foundations, structures and capabilities that enable the process to be applied and to ensure its consistent application.

5.2 Mandate and commitment

Top management should provide evidence of its commitment to the development and implementation of the complexity assessment process and to continually improving its effectiveness by:

- a) defining and endorsing the organization’s policy for managing the complexity assessment process;
- b) determining the objectives consistent with the organization’s policy;
- c) ensuring the availability of sufficient resources and reliable data sources;
- d) assigning roles, accountabilities and responsibilities at appropriate levels within the organization;
- e) establishing an awareness programme to communicate the benefits of the complexity assessment process to relevant interested parties;
- f) ensuring legal and regulatory compliance.

5.3 Needs and expectations of interested parties

The organization should identify all interested parties relevant to managing the complexity assessment process and should determine their requirements based on their needs and expectations.

The organization should ensure that the requirements of interested parties are considered.

5.4 Embedding competence and awareness

The organization should make the complexity assessment process a core value of the organization and should ensure the required competence is maintained.

The organization should ensure that any person(s) is (are) competent on the basis of appropriate education, training or experience, and should retain associated records to provide evidence of the training.

The organization should identify training needs associated with its security management plan. It should provide training or take other action to meet these needs, and should retain associated records.

6 Planning the assessment process

6.1 General

The complexity assessment process should be an integral part of the security management process and should be tailored to the objectives of the organization.

6.2 Defining the scope

6.2.1 The organization should define the scope of the complexity assessment process that is appropriate to:

- a) its size and nature;
- b) its requirements, considering its mission, goals, legal responsibilities, and internal and external obligations;
- c) its operational objectives, products and services, activities and resources.

6.2.2 The scope should include:

- a) the goals and objectives of the process;
- b) the frequency, depth and breadth of measurement;
- c) specific inclusions and exclusions;
- d) the complexity assessment structure and methodologies.

6.3 Determining the objectives

6.3.1 The organization should define the objectives of the complexity assessment process in accordance with the security management process.

6.3.2 The process could be addressed to identify, at least:

- a) the structural complexity of the organization;
- b) the functional complexity of the organization;
- c) the interdependencies between organizational process and functional units;
- d) the main parameters connected with the complexity of the system.

6.3.3 These objectives should:

- a) be consistent with the scope and policy;
- b) be retained as documented information;
- c) be clearly stated;
- d) have time frames for their achievement;
- e) enable opportunities to maintain or improve performance;
- f) be monitored and updated as appropriate.

6.4 Establishing the external context

The organization should identify those areas of the external environment in which it seeks to achieve its objectives. The external context can include, but is not limited to:

- a) the social, cultural, political, legal, regulatory, financial, technological, economic, natural and competitive environment, whether international, national, regional or local;
- b) the external infrastructure on which the organization depends, including the market, utilities, suppliers, logistics and related processes;
- c) key external drivers and trends that impact on the objectives of the organization.

6.5 Establishing the internal context

The organization should identify the factors of the internal environment in which it seeks to achieve its objectives. The internal context can include, but is not limited to:

- a) governance arrangements, including policies, structures, roles and accountabilities, and the decision-making processes (both formal and informal);
- b) personnel and related capabilities;
- c) physical assets, technologies and internal infrastructure;
- d) capital, financial arrangements and income streams;
- e) information systems, reporting and other information flows.

6.6 Establishing resource requirements

6.6.1 General

The organization should allocate sufficient resources to managing each step of the complexity assessment process. The allocation should consider:

- a) funding;
- b) trained and competent personnel with the appropriate knowledge, skills and experience;
- c) procedures, methods and supporting infrastructure;
- d) communication and documentation.

6.6.2 Personnel

6.6.2.1 The organization should:

- a) appoint one or more management representatives who, irrespective of other responsibilities, should have defined roles, responsibilities and authority for ensuring the effectiveness of the complexity assessment process;
- b) identify the skills and knowledge required by those involved in the complexity assessment process;

6.6.2.2 Knowledge requirements include:

- a) analytic systems, business intelligence, etc.;
- b) organizational processes and functional units of the organization;
- c) corporate enterprise resource planning (ERP) or business warehouse systems, and protocols, etc.

6.6.3 Procedure

The organization should define a specific, flexible and focused procedure to manage the implementation of the complexity assessment process.

This procedure should define:

- a) how the assessment is to be clearly targeted to the organization's system;
- b) the frequency within which assessments are conducted and the intervals between assessments that are considered to be appropriate by the organization;
- c) how the changes since the last assessment are to be determined.

The complexity assessment process may be performed by self-review or on-site review by an external organization or a combination of both.

6.6.4 Method

The organization should:

- a) identify suitable assessment methodologies and/or techniques to identify, analyse and evaluate the complexity;
- b) choose the appropriate qualitative and/or quantitative analytic approach based on the type, size, or nature of the organization and resource and skill constraints.

NOTE A qualitative approach uses the answers to questionnaires to identify the main causes of increases in the complexity of the organization's system.

A quantitative approach uses algorithms to measure the parameters within the ERP to highlight the critical points of the system or the organization.

6.6.5 Communication

The organization should have effective communication and consultation procedures for the exchange of information of the complexity assessment process with interested parties.

These should include:

- a) internal communication among interested parties, including employees within the organization;
- b) external communication with customers, partners and other interested parties, including the media;
- c) receiving, documenting and responding to communication from all interested parties.

6.6.6 Documentation

The complexity assessment process documentation should include:

- a) policy, scope and objectives;
- b) complexity assessment process options;
- c) awareness programme;
- d) training programme;
- e) procedures for implementing the complexity assessment process.

7 Implementing the assessment process

7.1 General

The main source of complexity in an organizational system is the unpredictable variability of its most important and interdependent parameters.

These parameters could be identified inside these main fields:

- a) size and diversity of products and services;
- b) management hierarchy and behaviours;
- c) amount of directives, procedures and reports;
- d) relationships among the people of functional units;
- e) interactions among the operative, support and control processes.

A list of potential parameters that drive complexity is provided in [Annex A](#).

7.2 Assessment process

The complexity assessment process should be managed at three different levels.

- a) LEVEL 1: Define complexity environment.

At this level, the organization can identify only the framework of the organizational system in terms of external and internal complexity fields.

- b) LEVEL 2: Qualitative complexity assessment.

If the organization recognizes that the complexity of its organizational system could generate a risk, it should use methodologies and/or techniques for a qualitative complexity assessment.

The assessment is performed with questionnaires, which should be filled in during suitable surveys and workshop. Through a set of internal and external parameters, it is possible to compare the interrelationships among the organizational elements (process, product, organization, performance, resources, mission etc.) and identify the related complexity fields.

- c) LEVEL 3: Quantitative complexity assessment.

If the organization wishes to thoroughly investigate its complexity, it should pass to a quantitative methodology. It should use algorithms that highlight the critical issues of the organizational system through the measurement of parameters inside the ERP.

The output is the ranking of each parameter based on its contribution to overall system complexity.

[Annex B](#) provides some examples of how to carry out the complexity assessment process.

8 Monitoring and review

8.1 The organization should develop procedures for the systematic monitoring and review of the performance of the complexity assessment process on a regular basis and at planned intervals.

8.2 Monitoring procedures should:

- a) determine the extent to which the organization's complexity assessment process, objectives and targets are met and how they impact system performance over the expected range of operating situations;

- b) assess the performance of the complexity assessment process and procedures after its implementation;
- c) record the data and results of monitoring and measurement to facilitate corrective actions.

8.3 The organization should:

- a) review the complexity assessment process at planned intervals to ensure its continuing suitability, adequacy and effectiveness;
- b) use the information obtained from the review to address the need for changes to the scope, policy and objectives of the complexity assessment process;
- c) evaluate the resource allocations of personnel, including employees and contractors, data sources, procedures and tools;
- d) identify changes in the activities, functions and risks that will affect the organizational system, including changes to:
 - 1) the organization and its processes;
 - 2) suppliers and the supply chain;
 - 3) technology;
 - 4) systems and application software;
 - 5) legal and regulatory requirements;
 - 6) the market sector and the local, national and global economy;
- e) consider the lessons learned and the issues identified during the implementation of the complexity assessment process.

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Annex A (informative)

List of potential parameters that drive complexity

A.1 General

To assess the complexity of an organization’s system, it is necessary to take into account a large number of parameters, where interactions change and develop dynamically and in a non-linear ways.

A bibliographic analysis of work on complexity assessment carried out by several authors has identified a list of potential parameters.

These parameters are divided in two parts: internal and external, depending on whether they belong to inside or outside the organization.

Subsequently, the parameters have been categorized in accordance with their main reference area.

For more information, see Reference [1].

A.2 Internal parameters

Table A.1 — Internal parameters — Primary processes

| Purchasing process | Sales process | Production process |
|---|-------------------------|---|
| Quality of bulk materials | Number of deliverables | Variety of the product components |
| Material price escalation | Combined transportation | Interdependence between the components of the product |
| Early purchase order | Commercial burdens | Number of product groups at production site |
| Unfamiliar procurement | | Productivity |
| Number of suppliers, subcontractors, contractors | | Number of production facilities |
| Quality of suppliers, subcontractors, contractors | | |
| Combined transportation | | |
| Commercial burdens | | |

Table A.2 — Internal parameters — Planning

| Strategic | Organizational | Operative |
|---|---|---|
| Number of decisions to be made | Number of decisions to be made | Number of decisions to be made |
| Number of objectives | Number of objectives | Number of objectives |
| Interdependence of objectives | Interdependence of objectives | Interdependence of objectives |
| Largeness of scope (number of components, etc.) | Number of structures/groups/teams to be coordinated | Dependencies between schedules |
| Scope for development | Number of hierarchical levels | Peak number of FTE ^a participants on the project management team (PMT) during the detailed engineering/design phase of the project |
| Impact of required approvals from external stakeholders | Staff quantity | Production volume at the production site |
| Number of total permits (internal) | Variety of hierarchical levels within the organization | Number of direct FTEs at the production site |
| Number of total permits (external) | Variety of organizational interdependencies | Number of indirect FTEs at the production site |
| Level of difficulty in obtaining permits (internal) | Variety of organizational skills needed | Impact of required inspection by external agencies |
| Level of difficulty in obtaining permits (external) | Interdependence between sites, departments and companies | Impact of external agencies on the project execution plan |
| Clarity level of change management process | Team cooperation and communication | Peak number of FTEs on the PMT during the design phase |
| Timely decision making | Number of executive oversight entities above the PMT who have decision-making authority over the project execution plan | Peak number of FTEs on the PMT during the procurement phase |
| Clarity of business objectives | Span of leadership at the production site | Impact of project location on the project execution plan |
| Clarity of scope definition | Number of hierarchy levels at the production site | Percentage of craft labour turnover |
| Cost targets | Executive oversight entities above the PMT limit | Impact of the project location on the project execution plan |
| Number of stakeholders | Number of times a change order needs to go above the PMT | |
| Number of companies/projects sharing their resources | Difficulty in obtaining design approvals | |
| Number of investors | Percentage of PMT staff who work on the project versus planned staff | |
| Geographic location of the stakeholders | Flexibility in work arrangement | |
| Variety of the stakeholders status | Level of authorizing approvals and duration of receiving proposals | |
| Stakeholders interrelations | Dynamic and evolving team structure | |
| Number of joint-venture partners | | |
| Level of stakeholder cohesion | | |

^a Full-time equivalent (FTE) is a unit that indicates the workload of an employed person.

Table A.3 — Internal parameters — Projects management

| Projects management |
|--|
| Duration of the project |
| Variety of project management methods and tools applied |
| Number of interfaces in the project organization |
| Impact of the magnitude of change orders on project execution |
| Impact of the timing of change orders on project execution |
| Influence of this project on the organization's overall success |
| Project type |
| Project location |
| Project size |
| Number of distinct disciplines, methods or approaches involved in performing the project |
| Magnitude of legal, social or environmental implications from performing the project |
| Overall expected financial impact (positive or negative) on the project's stakeholders |
| Strategic importance of the project to the organization or organizations involved |
| Stakeholder cohesion regarding the characteristics of the product of the project |
| Number and variety of interfaces between the project and other organizational entities |
| Social and political influences surrounding the project location |
| Interfaces within the project |
| Strategic importance of the project |
| Variety of the technologies used during the project |
| Impact of required approvals from external stakeholders on the original project execution plan |
| Target project funding against industry/internal benchmarks |
| Difficulties in securing project funding |
| Quality issues of skilled field craft labour during the project |
| Total number of joint-venture partners in the project |

Table A.4 — Internal parameters — Resource management

| Financial | Human |
|---------------------------------|--|
| Largeness of capital investment | Diversity of staff (experience, social span, etc.) |
| Variety of financial resources | Company's degree of familiarity with technologies that will be involved in the detailed engineering/design project phase |
| Number of funding phases | Company's familiarity with technologies in the design phase |
| | Company's familiarity with technologies in the operating phase |
| | Quality issues of skilled field craft labour |
| | Percentage of craft labour sourced locally |
| | Human skill and behaviour |
| | Team experience |

Table A.5 — Internal parameters — Innovation and technology management

| Innovation | Technology |
|-------------------------------------|---|
| Organizational degree of innovation | Variety of information systems to be combined |
| Technological degree of innovation | Number of information systems |
| | Variety of technological dependencies |
| | Variety of the technological skills needed |
| | Interdependence of information systems |
| | Technological processes dependencies |

A.3 External parameters**Table A.6 — External parameters**

| Creativity | Cultural aspects | Environment | Legal aspects |
|----------------------|------------------------------------|--|---|
| Demand of creativity | Cultural configuration and variety | Rate of change of the external environment with which the system interacts | New laws and regulations |
| | | Project location | Local laws and regulations |
| | | remoteness level | Requirements for government authorities |
| | | Level of infrastructure existing at the site | Permitting and regulatory requirements |
| | | Extreme weather events | |
| | | Economic fluctuation | |
| | | Climate | |

Annex B (informative)

Examples of how to carry out the complexity assessment process

B.1 Overview

This annex provides examples of how to carry out the complexity assessment process for each level. The methodologies have been developed by several authors listed in the Bibliography and represent an adaptation of their work.

More examples can be found in References [14] and [16].

B.2 Method for a systematic evaluation of advanced complexity management maturity

NOTE This subclause has been adapted from Reference [11].

B.2.1 General

The trend of increasing digitalization and current developments towards the so-called fourth industrial revolution show that, in the near future, organizations will be need to be very flexible and adaptable.

The corresponding significant increase of complexity has already been perceived by industrial companies worldwide.

Complexity can be subdivided into external and internal complexity.

External complexity describes the market perspective, which is characterized by changeability and flexibility drivers (e.g. population growth and demographic change, increasing consumption of resources, digitalization).

Internal complexity describes the company perspective, which is characterized by the complexity fields and the occurrence of complexity dimensions.

B.2.2 Internal complexity and its dimensions

The first step to identify internal complexity and to improve its transparency is the systematic subdivision into complexity fields (process, product and organization) and subfields in which complexity arises (e.g. technologies, order processing and IT-systems). See [Figure B.1](#).

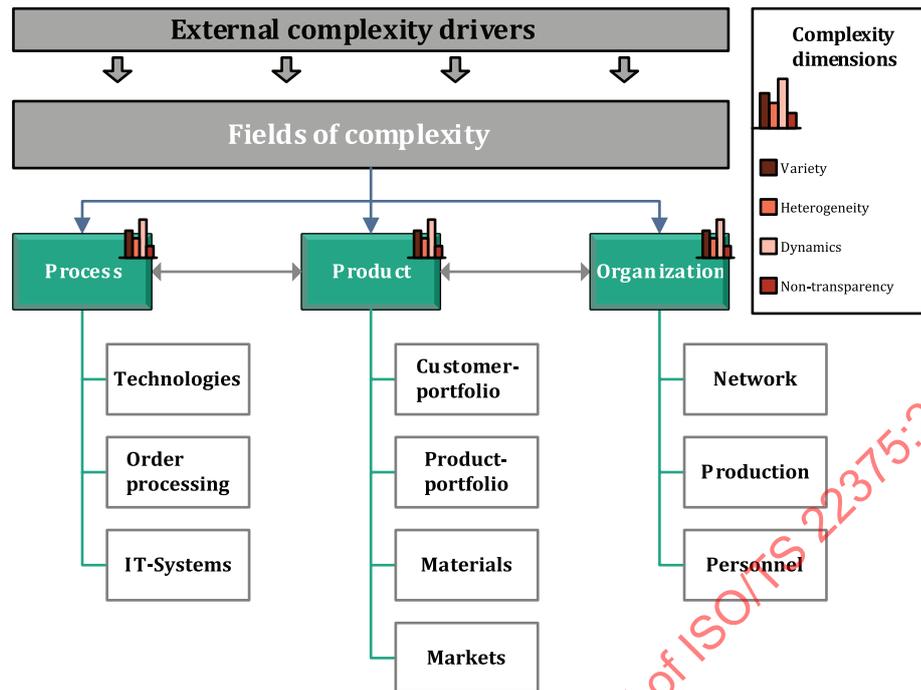


Figure B.1

Each field can be generally described by the four dimensions of complexity and their interrelations.

- Variety:** describes the number of distinguishable states and configurations, distinguishable elements and relations of a system.
- Heterogeneity:** describes the diversity of the system elements and the divergence of their interrelations.
- Dynamics:** describes changeability over time and possible turbulence effects of the system.
- Non-transparency:** is characterized by knowledge about the system and its interdependencies in terms of lack of definition or fuzziness.

B.2.3 Overall maturity-based approach for the evaluation of complexity management systems

This approach is based on the assumption that predictable patterns exist in the development of complexity skills. These development patterns are conceptualized as evolutionary stages or levels and represent the mutually defined maturity levels.

Maturity implies evolutionary progress in demonstrating specific skills or achieving targets, from an initial state, where few skills regarding complexity management are considered, to a final state, which is complete, optimizing the company resources to achieve the goals of harmonizing internal and external complexity. Each level describes different degrees of maturity regarding the complexity management system, as shown by [Figure B.2](#).

Each maturity level is defined by specific characteristics and predefined requirements that are necessary to achieve the next level of maturity. In general, it can be assumed that a higher degree of maturity shows a better expression of the rated processes and thus the underlying complexity management capabilities.

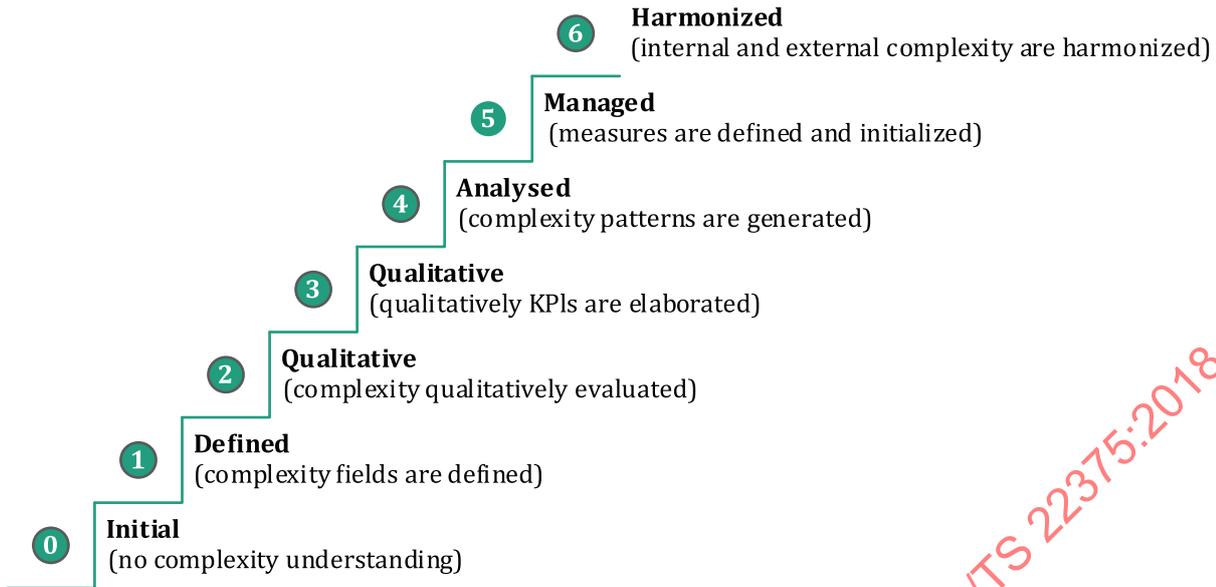


Figure B.2

The levels are as follows.

- 0) Initial: No understanding of complexity. The company has not yet been concerned by or recognized any complexity problems or strategies.
- 1) Defined: Complexity fields are defined. The company has identified external complexity drivers and has defined the internal complexity fields.
- 2) Qualitative: Complexity is qualitatively evaluated. The company uses methods to evaluate existing complexity within the different complexity fields in a qualitative way.
- 3) Quantitative: Quantitative KPIs are elaborated. The company has elaborated specified key performance indicators (KPIs) to quantify the existing complexity in terms of the four complexity dimensions.
- 4) Analysed: Complexity patterns are generated. The company has analysed the existing internal complexity and generated complexity patterns by detailed analysis of the complexity fields and dimensions based on the correlation of specific, selected indicators.
- 5) Managed: Measures are defined and initialized. The company has defined and initialized specific complexity cultivation strategies to adapt or master the existing internal complexity.
- 6) Harmonized: Internal and external complexity are harmonized. The company has optimized their internal complexity according to the external complexity on the market and is able to dynamically adapt and adjust it permanently.

B.2.4 Conclusions

Each defined maturity level in advanced complexity management addresses deficits in existing complexity management approaches.

General complexity fields are known, but not defined in more depth and formulated in detail. Various evaluation approaches exist, but are generally related to product complexity.

B.3 Developing a method for complexity assessment

NOTE This subclause has been adapted from Reference [1].

B.3.1 General

Business processes have a cross-cutting effect on the organizational structure since they require the contribution of different organizational units (OUs). Business processes can cover both internal and external activities.

A qualitative assessment methodology is one that identifies complexity through the interaction of the processes of an organization with its OUs.

B.3.2 Assessing internal influence

First, it is necessary to define a list of potential internal parameters that are categorized in processes and macro-processes as shown in [Table B.1](#).

Table B.1

| Acronym | Process | Macro-processes |
|----------|-------------------------|---------------------------|
| ACQ | Purchasing process | Primary processes |
| VEN | Sales process | |
| P-PROD | Production process | |
| PLAN-ST | Strategic planning | Planning |
| PLAN-ORG | Organizational planning | |
| PLAN-OP | Operative planning | |
| PROJ | Projects management | Projects |
| RF | Financial resources | Resources |
| RU | Human resources | |
| T | Technology management | Innovation and technology |
| INN | Innovation management | |

The method starts by analysing all the possible relationships among processes through a matrix, as shown in [Table B.2](#).

Starting from the first row, an "X" is inserted if the process can in some way affect another process, while an empty space indicates no influence. A process will affect another process if a variation in its parameters will cause a change in the other process.

Table B.2

| | ACQ | VEN | PLAN-ST | PLAN-ORG | PLAN-OP | P-PROD | PROJ | RF | RU | T | INN |
|----------|-----|-----|---------|----------|---------|--------|------|----|----|---|-----|
| ACQ | | | | | | | | | | | |
| VEN | | | | | | | | | | | |
| PLAN-ST | | | | | | | | | | | |
| PLAN-ORG | | | | | | | | | | | |
| PLAN-OP | | | | | | | | | | | |
| P-PROD | | | | | | | | | | | |
| PROJ | | | | | | | | | | | |
| RF | | | | | | | | | | | |
| RU | | | | | | | | | | | |
| T | | | | | | | | | | | |
| INN | | | | | | | | | | | |

To better visualize the relationships shown by [Table B.2](#), the process on the row is called “node” (k) and the related affected process on the column is the “sector” (j). See [Figure B.3](#).

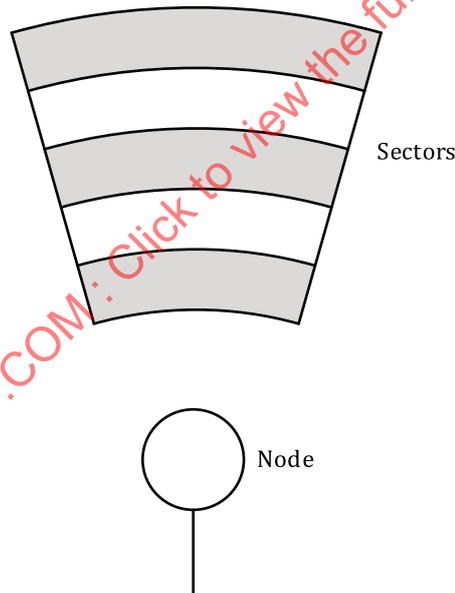


Figure B.3

Therefore, the relationship matrix can be represented by the graph of [Figure B.4](#).

When a cell of the matrix is empty, the related sector is disabled. Nodes and sectors are ordered following their macro-process grouping.

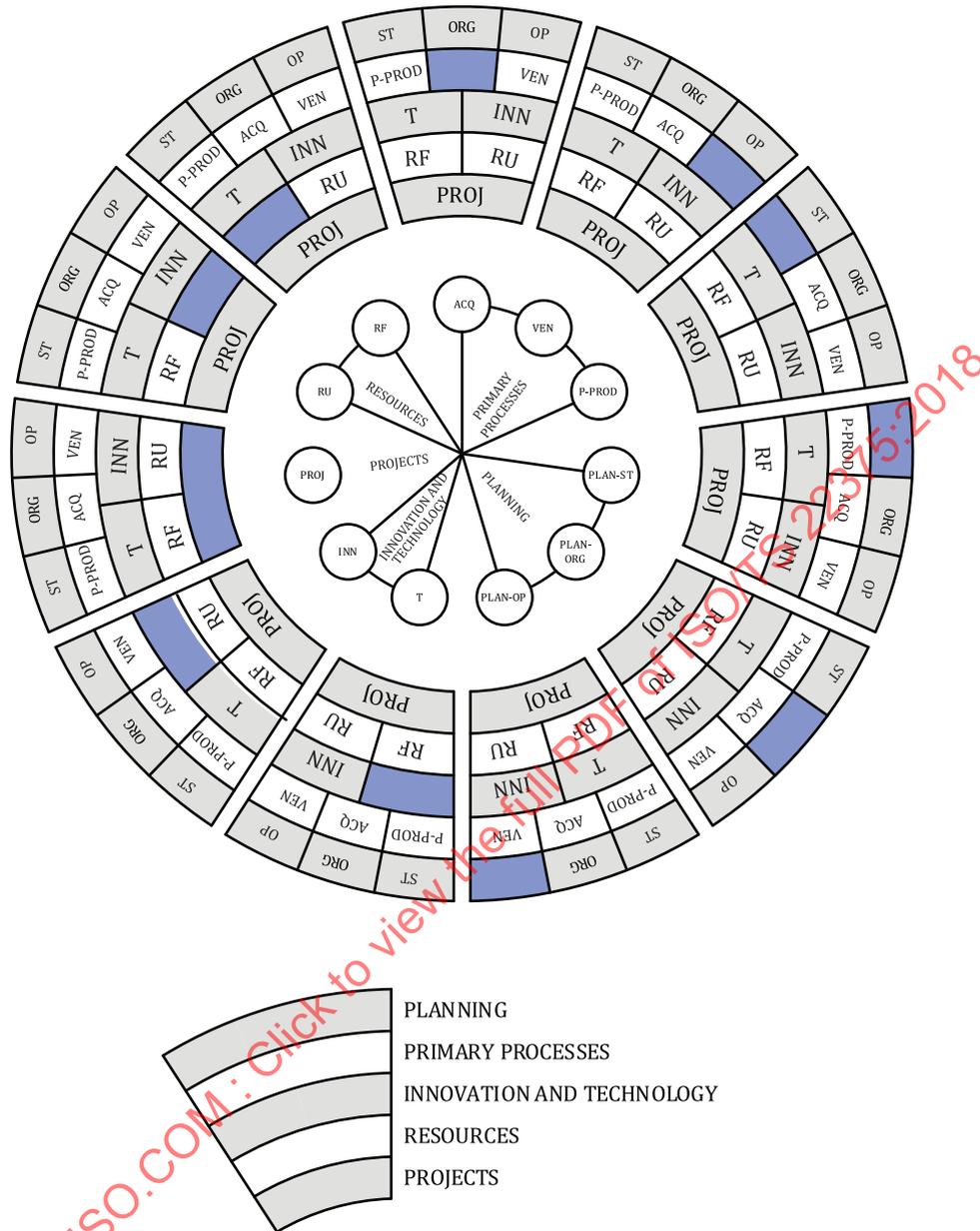


Figure B.4

At this stage of the method, the nodes are considered and how much the parameters of a node affect the other sectors is quantified. This operation is done for each node on the sectors to which it is linked.

Each node is formed by a certain number of parameters. First, it is necessary to establish the weight of each parameter within the node.

Once the weight, a_t , is established, it is possible to evaluate how much each parameter affects a particular sector. The rating of evaluation, v_t , ranges from 1 to 10. See [Table B.3](#).

Table B.3

| Parameter weight (a_i) | Parameter | Evaluation (v_i) | $a_i * v_i$ |
|----------------------------|-----------|----------------------|-------------|
| a_1 | 1 | v_1 | $a_1 * v_1$ |
| a_2 | 2 | v_2 | $a_2 * v_2$ |
| — | — | — | — |
| a_n | n | v_n | $a_n * v_n$ |
| Total = 1 | — | — | X_{kj} |

X_{kj} represents the degree of influence created by the k node on the j sector, which is subsequently divided by 10, obtaining a percentage of influence.

$$X_{kj} = \sum_{i=1}^n a_i * v_i$$

$$X'_{kj} = \frac{X_{kj}}{10}$$

where $k, j = 1, \dots, m$.

The achieved results are then encoded with colours, according to the legend shown in [Table B.4](#).

Table B.4

| | | |
|---|--------------------------|-----------------------|
|  | Disabled sector | $X'_j = 0$ |
|  | Weak activated sector | $0 < X'_j \leq 0,3$ |
|  | Average activated sector | $0,3 < X'_j \leq 0,6$ |
|  | Strong activated sector | $X'_j = 0,6$ |

B.3.3 Assessing external influence

The same procedure can also be applied considering the influence that processes of the external context may have on those of the internal context. Here, the nodes represent the processes of external context. See [Table B.5](#).

Table B.5

| Acronym | Process |
|---------|------------------|
| EN | Environment |
| CUL | Cultural aspects |
| LAW | Legal aspects |
| CREA | Creativity |

Sectors are the internal processes.

This phase of the method might identify some criticalities due to the influence of the external context on the internal context. See the graphical representation in [Figure B.5](#).

For each OU, according to the nodes that pass through it, SGC is calculated by the summation of complexity degree.

$$\text{Summation of complexity degrees (SGC)} = \sum \text{Complexity degrees}$$

$$\% \text{ on total complexity (SGC\%)} = \frac{\text{Summation of complexity degrees}}{\text{Maximum achievable complexity degree}}$$

The results are synthesized in [Table B.7](#).

Table B.7 — Results

| Organization | | | |
|--------------|-----------|--------------------------------------|------------------------------|
| OUs | Process | Summation of complexity degree (SGC) | % on total complexity (SGC%) |
| OU 1 | Process 1 | | |
| | — | | |
| | Process m | | |
| — | — | | |
| OU N | Process 1 | | |
| | — | | |
| | Process m | | |

This stage is graphically represented in [Figure B.6](#).

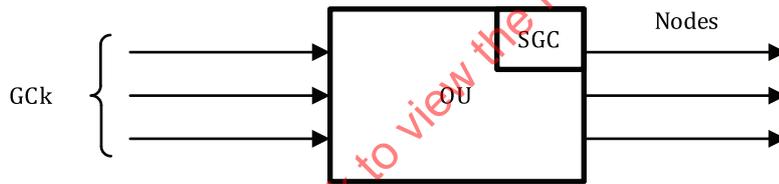


Figure B.6

Using the previously set thresholds, a colour can be assigned to each OU, as shown in [Table B.4](#), according to the SGC% value. See [Figure B.7](#).

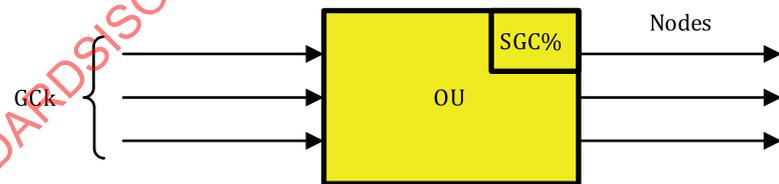


Figure B.7

The output is a map of OUs with different SGC% values.

Starting from the OU with the highest SGC%, it is possible to verify if each OU has a sustainable complexity or not.

B.3.5 Identifying external complexity in organizational units

The same procedure can also be applied to an evaluation method for external complexity.

A following phase of complexity assessment takes into account both the effects of internal and external complexity.

B.4 The complexity dilemma assessment methodology

NOTE This subclause has been adapted from Reference [5].

B.4.1 General

Every organization faces a given level of external complexity, generated by factors such as the markets in which it is present, i.e. by consumer demand, competitors, etc.

Each organization should make an appropriate selection of this external complexity (“complexity reduction”) and, once selected, should prepare and provide dimensions for a consistent level of internal complexity in accordance with Ashby’s Law, i.e. developing products, updating technologies, processes, etc.

Finally, each organization should establish organizational capabilities designed to manage such internal complexity.

The last dimension to keep under control is the performance.

The complexity dilemma assessment methodology correlates the four dimensions: internal complexity (CI), external complexity (CE), organizational capabilities (CAP) and performance (P), through the following three relationships:

- coherence between internal and external complexity;
- coherence between organizational capabilities and internal complexity;
- coherence between organizational capabilities, internal complexity, external complexity and performance.

These three relationships are illustrated in [Figure B.8](#).

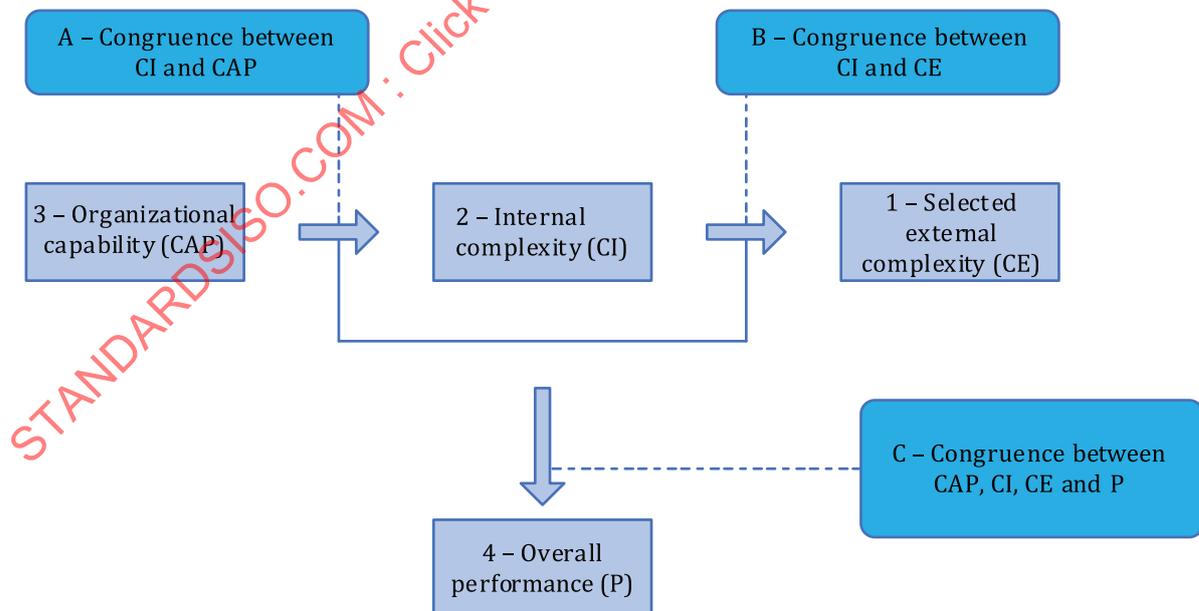


Figure B.8 — The complexity dilemma assessment methodology

B.4.2 The four dimensions

B.4.2.1 Internal complexity and external complexity

Both the concept of statistical complexity (number of the system elements, number of connections between the system elements and the type of functional relationships between the elements) and the concept of dynamical complexity (variability of the behaviour and the structure of the system over time) lead to the definition of four dimensions of complexity. These four dimensions represent the families of indicators that are measured to calculate both the level of internal complexity and the level of external complexity. See [Table B.8](#).

Table B.8 — The family of indicators

| | | | Point of view | |
|-----------------------|------------------------|---------------------|--|--|
| | | | Internal complexity | External complexity |
| Complexity dimensions | Statistical complexity | (1) Diversity | Number, heterogeneity and variety of elements and subsystems of the system | Number, heterogeneity and variety of elements of the part of the environment with which the system interacts |
| | | (2) Uncertainty | Degree of unpredictability and ambiguity of elements and relations within the system | Degree of unpredictability and ambiguity of external environment with which the system interacts |
| | | (3) Interdependence | Degree of interactions and connections between elements and subsystems of the system | Degree of interactions and connections between system and external environment |
| | Dynamical complexity | (4) Dynamicity | Internal rate of change of the system | Rate of change of external environment with which the system interacts |

B.4.2.2 Organizational capabilities

Organizational capabilities are the abilities that an organization should have or develop in order to effectively manage its complexity.

For the purpose of measuring the level of organizational capabilities, a set of capabilities shall be used. These are divided into four families called macro-capabilities. Organizational capabilities are not individual but concern the organization as a whole. See [Table B.9](#).

Table B.9 — Organizational capabilities

| Organizational macro-capabilities | Capabilities |
|-----------------------------------|--|
| (1) Interconnection | (1.1) Openness, (1.2) Networking, (1.3) Cooperation, (1.4) Integration, (1.5) Customer orientation |
| (2) Redundancy | (2.1) Learning, (2.2) Informative redundancy, (2.3) Relational redundancy, (2.4) Cognitive redundancy, (2.5) Functional redundancy |
| (3) Sharing | (3.1) Organizational leadership, (3.2) Trust, (3.3) Values sharing, (3.4) Strategy sharing, (3.5) Organizational sharing, (3.6) Knowledge sharing |
| (4) Reconfiguration | (4.1) Innovation, (4.2) Speed, (4.3) Knowledge recombination, (4.4) Acuity, (4.5) Entrepreneurship, (4.6) Co-evolution, (4.7) Operative flexibility, (4.8) Strategic flexibility |