



**International
Standard**

ISO 37153

**Smart community infrastructures —
Maturity model for assessment and
improvement**

*Infrastructures communautaires intelligentes — Modèle de
maturité pour l'évaluation et l'amélioration*

**Second edition
2024-08**

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Published in Switzerland

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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 document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation 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 268, *Sustainable cities and communities*, Subcommittee SC 1, *Smart community infrastructures*.

This second edition cancels and replaces the first edition (ISO 37153:2017), which has been technically revised.

The main changes are as follows:

- [Annexes B, C, and D](#) replaced [Annexes A, B, and C](#) to the first edition.

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 United Nations (UN) sustainable development agenda, “Transforming Our World: The 2030 Agenda for Sustainable Development”, adopted in 2015, aims to end poverty, promote prosperity and well-being, while reducing environmental impact by 2030. It includes 17 Sustainable Development Goals (SDGs), of which Goal 11 focuses on “Make cities inclusive, safe, resilient and sustainable”. As cities and communities grow, they face challenges in meeting the needs of citizens in an equitable and sustainable way. The demand for community infrastructure(s) such as energy, water, transportation, waste and information and communication technology (ICT) will increase with the growth of urban populations and urbanization. Appropriate development of community infrastructure(s) is crucial to support the operations and activities of communities to overcome urban challenges and make progress towards achieving the SDGs. It also needs to be economically efficient and aims to reduce the environmental impact of urban activities.

For the efficient development of community infrastructure(s) and continuous performance improvement, communities can benefit from a tool that measures the current level of maturity of the community infrastructure(s) relative to the desired future improvements. In this context, a maturity model is widely recognized as an efficient and effective tool. This model describes the necessary practices and processes at each level to achieve the desired level of performance in a reliable and sustainable manner. For example, the capability maturity model (CMM) presented in the ISO/IEC 15504 series provides this function in software development. Documents such as ISO 18091 and ISO 37101 also promote a CMM-like framework for local governments or communities.

This document provides the basis, requirements and guidance for assessment and improvement of community infrastructure(s) using a community infrastructure maturity model (CIMM). The CIMM assesses the level of performance, process and interoperability of the community infrastructure(s) as well as its contribution to the community. It also helps stakeholders set improvement targets to guide investment by identifying gaps in the current level of community infrastructure.

The CIMM can be expressed conceptually as a series of levels, each building on the previous one as shown in [Figure 1](#). See [Clauses 4](#) and [5](#) for more information.

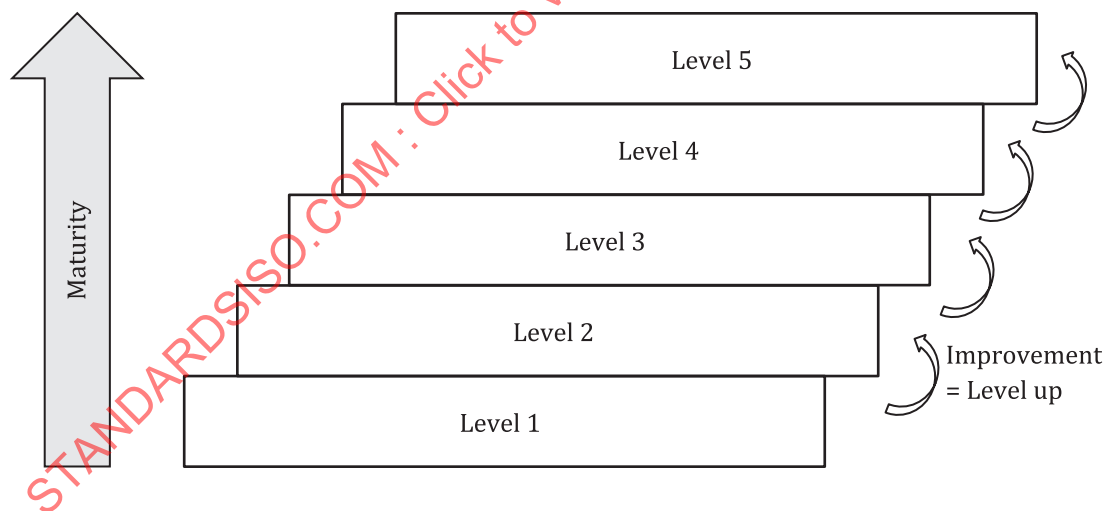


Figure 1 — Conceptual expression of CIMM

Decisions are made on the basis of a systematic overall picture of the characteristics of the community infrastructure in order to promote continuous improvement. The CIMM is a systematic assessment framework that includes the five reference levels of maturity for each of the community infrastructure characteristics.

An assessment using the CIMM can be used to compare different communities, but can also be used to compare the current and future state of infrastructure in a single community by defining the object and scope of the assessment. For example, see [Annex A](#) for an overview of the “Plan-Do-Check-Action (PDCA)” cycle for developing community infrastructure(s), where this document is particularly helpful in the “Plan”

and “Check” phases. This document can help users assess current levels of performance, process and interoperability, and to monitor progress towards achieving desired improvements.

More specifically, this document supports the following stakeholders:

- citizens:
 - to improve their quality of life;
 - to make community infrastructure accessible for a wide range of people, regardless of their individual language, disability, etc.;
- owners of community infrastructure:
 - to identify which performance characteristics of the infrastructure should be prioritized;
 - to identify what technical performance aspects should be prioritized for improvement;
- suppliers of community infrastructure:
 - to determine which community infrastructure products meet the specified requirements;
 - to identify a direction for the development of future community infrastructure products and services;
- operators of community infrastructure:
 - to determine the current level of performance of the community infrastructure they operate;
 - to determine the appropriate processes to improve performance;
- investors:
 - to determine which types of infrastructure investment will best achieve the desired level of performance;
- city planners or government decision makers:
 - to assess city planning and identify infrastructure priorities;
- all stakeholders:
 - to ensure that investment in community infrastructure maximizes performance and minimizes life cycle costs;
 - to promote the harmonization of the needs of residents, community managers and the environment;
 - to promote the sustainable development and community resilience.

Smart community infrastructures — Maturity model for assessment and improvement

1 Scope

This document provides the basis, requirements and guidance for assessing the level of performance, process and interoperability of community infrastructure(s) as well as its contribution to the community using a CIMM. It also helps stakeholders set targets for improvement that will guide investment by identifying gaps in the current level of community infrastructure.

This document is applicable to:

- a) all types of community infrastructure, including, but not limited to, energy, water, transportation, waste and ICT;
- b) single types of community infrastructure or multiple types of community infrastructure;
- c) all types of communities, regardless of geographical location, size, economic structure, or stage of economic development;
- d) all applicable stages of the infrastructure life cycle (e.g. planning, design, construction, operation and decommissioning).

NOTE The use of natural systems, such as green infrastructure, is considered a type of infrastructure.

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 37151, *Smart community infrastructures — Principles and requirements for performance metrics*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 maturity model

model derived from one or more specified assessment model(s), that identifies the set of phased development or progress levels showing the assessment categories for community infrastructure(s)

3.2 maturity level

point on an ordinal scale of community infrastructure maturity that characterizes the maturity of the community infrastructure assessed within the scope of the maturity model used

3.3

impact

change to the economy, environment and other community issues, either adverse or beneficial, resulting from community infrastructure(s)

3.4

achievement criteria table

ACT

table populated with predefined requirements for characteristics to be achieved at each maturity level, as specified in the community infrastructure maturity model (CIMM)

3.5

community infrastructure maturity model

CIMM

maturity model applied to community infrastructure, which defines maturity levels in order to assess the level of maturity of community infrastructure

3.6

performance

measurable result

Note 1 to entry: Performance can relate to either quantitative or qualitative findings.

Note 2 to entry: Performance can relate to the management of activities, processes, products (including strategies, programmes, projects, plans and services), systems or organizations.

[SOURCE: ISO 37101:2016, 3.29]

3.7

process

series of actions or events taking place in a defined manner leading to the accomplishment of an expected result

Note 1 to entry: "Defined" in this context does not necessarily mean documented. A defined process includes, but is not limited to, adaptive means.

[SOURCE: ISO/IEC 15944-1:2011, 3.53, modified — Note 1 to entry has been added.]

3.8

interoperability

ability of systems to provide services to and accept services from other systems and to use the services so exchanged to enable them to operate effectively together

Note 1 to entry: "Systems" in this context means community infrastructures.

Note 2 to entry: "Services" in this context includes information such as data and knowledge.

[SOURCE: ISO 21007-1:2005, 2.30, modified — Notes 1 and 2 to entry have been added.]

3.9

community

group of people with an arrangement of responsibilities, activities and relationships

Note 1 to entry: In many, but not all, contexts, a community has a defined geographical boundary.

Note 2 to entry: A city is a type of community.

[SOURCE: ISO 37100:2016, 3.2.2]

3.10

community infrastructure

system of facilities, equipment and services that support the operations and activities of communities

Note 1 to entry: Such community infrastructures include, but are not limited to, energy, water, transportation, waste and information and communication technologies (ICT).

[SOURCE: ISO 37100:2016, 3.6.1]

3.11

smart community infrastructure

community infrastructure with enhanced technological performance that is designed, operated, and maintained to contribute to sustainable development and resilience of the community

[SOURCE: ISO 37151:2024, 3.3]

3.12

sustainable development

development that meets the environmental, social and economic needs of the present without compromising the ability of future generations to meet their own needs

Note 1 to entry: Derived from the Brundtland Report.

[SOURCE: ISO Guide 82:2019, 3.2]

3.13

life cycle

consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal

[SOURCE: ISO 14044:2006, 3.1]

3.14

metric

defined measurement method and the measurement scale

[SOURCE: ISO 37100:2016, 3.5.2]

3.15

characteristic

distinguishing feature

[SOURCE: ISO 17566:2011, 2.2]

4 Basis of community infrastructure maturity model

4.1 Outline

This document provides requirements and guidance for the development of a methodology to assess the performance, process and interoperability of community infrastructure(s) and their contribution to community-wide priorities in relation to five maturity levels based on the CIMM. This methodology is also used to identify improvement points for the levels.

For this purpose, an achievement criteria table (ACT) shall be developed and utilized.

[Clause 4](#) provides an overview of the whole methodology, including definitions and requirements. [Clause 5](#) specifies how to develop the ACT. [Clause 6](#) specifies how to utilize the table for assessment and improvement.

4.2 Achievement criteria table

The ACT comprises:

- characteristics to assess their attributes, i.e., performance, process and interoperability of the community infrastructure(s) or their contribution to the community;
- objectives justifying the inclusion of each characteristic;
- five levels of maturity for each characteristic;
- descriptions or definitions of the criteria for the characteristics that define each level.

The CIMM provides reference maturity levels for the community infrastructure(s). See [4.5](#) and [5.4.3](#) for details.

[Table 1](#) outlines the basic structure of an ACT. Note that this basic structure can be customized to meet the needs of each assessment. An example of a customized ACT structure for the assessment of community infrastructure(s) is provided in [Annex C](#). [Annex D](#) then provides an example of an assessment trial using the ACT structure from [Annex C](#).

Table 1 — Basic structure of an ACT

Characteristics	Objectives	Level				
		1	2	3	4	5
CH1	Objective of CH1	Def.	Def.	Def.	Def.	Def.
CH2	Objective of CH2	Def.	Def.	Def.	Def.	Def.
CH3	Objective of CH3	Def.	Def.	Def.	Def.	Def.
...	...	...	...	...	...	...
Key "CH1": characteristic 1. "CH2": characteristic 2. "CH3": characteristic 3. "Def.": definition. Represents a description of the criteria for the characteristics to be met at each level of the CIMM. These definitions can be expressed in quantitative, qualitative or descriptive measures.						

4.3 Assessment aspects of the community infrastructure

This document provides two aspects for the assessment of the community infrastructure(s).

- **Technical assessment:** Assessment of the performance, process and interoperability of the community infrastructure(s), e.g. the capacity of a power generation plant.
- **Contribution assessment:** Assessment of the contribution of the community infrastructure(s) to community-wide priorities, e.g. the unemployment rate of a community affected by a road construction project.

A technical assessment can be useful as an assessment tool for operators, supervisory authorities and community infrastructure vendors.

A contribution assessment can be useful as an assessment tool for government decision-makers and development agencies.

[Table 2](#) outlines the conceptual relationship between the two assessment aspects. It is a modified version of ISO 37151:2024, Table 1.

NOTE 1 For details of the relationship between community issues and community infrastructure performance, see ISO 37151:2024, 5.3.

NOTE 2 [Annex B](#) provides a detailed description of the technical assessment. Many stakeholders show more interest in the technical assessment than the contribution assessment. This is because a contribution assessment takes longer to measure complex causal relationships, which involves data collection and data analysis.

NOTE 3 Community issues are the challenges facing the community. The issues and their prioritization vary between different communities.

Table 2 — Relationship between the two assessment aspects

Technical assessment	Contribution assessment			
	Impact 1 (e.g. gross product of a community)	Impact 2 (e.g. unemployment rate of a community)	[...]	Impact N (any other impacts)
Characteristic A (e.g. capacity of services)	***	*		
Characteristic B (e.g. investment efficiency of services)	**	**		
[...]				
Characteristic N (any other characteristics)	*	***		
NOTE 1 The number of “*” indicates the degree of relationship between each characteristic listed in the row and impact listed in the column. “***” means largely relevant, “**” means relevant, “*” means slightly relevant, and a blank means not relevant.				
NOTE 2 The empty row and column marked with [...] indicate that there can be more characteristics and impacts up to any value of N.				

4.4 Overview of the methodology

The methodology involves the development of:

- an ACT;
- a procedure for assessing the target community infrastructure(s);
- a procedure for improving the maturity level of the target community infrastructure.

[Figure 2](#) provides an overview of the methodology (see [Clauses 5](#) and [6](#) for details). An assessment and improvement procedure is described in [Clause 6](#).

1 Target community infrastructure

Determine the purpose, assessment aspect (technical or contribution) and target community infrastructure(s)

2 Characteristics

Select characteristics that fit the purpose

3 Procedure

Develop an achievement criteria table in accordance with the CIMMs

4 ACT

Characteristics and their attributes		Objectives	L1	L2	L3	L4	L5
PF1	Performance	Objective of PF1	Def	Def	Def	Def	Def
PF2		Objective of PF2	Def	Def	Def	Def	Def
PF3		Objective of PF3	Def	Def	Def	Def	Def
PR1	Process	Objective of PR1	Def	Def	Def	Def	Def
PR2		Objective of PR2	Def	Def	Def	Def	Def
PR3		Objective of PR3	Def	Def	Def	Def	Def
IO1	Inter-operability	Objective of IO1	Def	Def	Def	Def	Def
IO2		Objective of IO2	Def	Def	Def	Def	Def
IO3		Objective of IO3	Def	Def	Def	Def	Def

5 Assessment and improvement

Current	Target	Measures
Level2	Level3	a
Level3	Level3	a
Level2	Level3	a
Level2	Level3	a
Level2	Level3	a
Level3	Level3	a
Level1	Level3	a
Level2	Level3	a
Level1	Level3	a

Key

a	Improvement measures for filling the gaps.	IO2	interoperability characteristic 2
PF1	performance characteristic 1	IO3	interoperability characteristic 3
PF2	performance characteristic 2	Def	definition, see Table 1
PF3	performance characteristic 3	L1	maturity level 1
PR1	process characteristic 1	L2	maturity level 2
PR2	process characteristic 2	L3	maturity level 3
PR3	process characteristic 3	L4	maturity level 4
IO1	interoperability characteristic 1	L5	maturity level 5

Figure 2 — Overview of the methodology**4.5 Community infrastructure maturity model**

The CIMM provides an overall picture of the maturity of the community infrastructure(s) with five reference levels. [Table 3](#) provides general definitions and descriptions of the maturity levels in the CIMM.

NOTE Each level assumes that the requirements of the lower levels have been fulfilled.

Table 3 — General definition of the CIMM

Level	Definition	Description
5	Sustainably optimizing	Continuously improving to satisfy future needs
4	Improving	Partially beginning to fulfil future needs
3	Fulfilled	Satisfies current needs in a defined manner
2	Partially fulfilled	Needs are identified but not satisfied
1	Initial	Not yet started

5 Requirements and guidance for developing an achievement criteria table

5.1 General

To develop an ACT, the following steps should be taken:

- determining the purpose, assessment aspect and target community infrastructure(s);
- selecting characteristics that fit the purpose (see 5.3 for details);
- defining the characteristics for each of the five maturity levels in accordance with the CIMMs (see 5.4 for details);
- organizing the characteristics and the maturity levels into a table.

Once the ACT has been developed, the table may be used for different assessment needs.

The selection of the target infrastructure(s) may range from a single infrastructure to multiple infrastructures.

5.2 Guidance for determining purpose

To determine the purpose of the assessment, the following steps should be taken:

- identifying the target community (e.g. city, state, nation or region);
- identifying and prioritizing the community issues in the target community (e.g. unemployment, poverty or congestion);
- identifying and analysing the relevant community infrastructure(s) and their impact on the prioritized community issues;
- defining the purpose of the assessment and the improvement of the community infrastructure(s) by addressing the community issues identified in b) in the community identified in a).

In order to prioritize community issues, depending on the target community, the following may be referred to:

- for a nation, the SDGs or a specific national development plan;
- for a region, the SDGs or a specific regional development plan;
- for a city, the SDGs or a specific urban development plan.

5.3 Requirements and guidance for identifying characteristics

5.3.1 General

The characteristics of the community infrastructure(s) shall be selected in accordance with the purpose of the assessment and the aspect to be assessed.

For a technical assessment of the community infrastructure(s), technical characteristics shall be selected in accordance with the requirements given in ISO 37151.

For a contribution assessment, community-wide characteristics (preferably indicators or metrics) with societal benefits shall be selected, taking into account the overall functioning of multiple community infrastructures.

For such characteristics, the SDGs or the national development goals of each nation should be consulted.

Additional characteristics can be derived from regulations, industry standards and specifications.

[Table 4](#) outlines an example of how to identify the characteristics.

Table 4 — Example of how to identify characteristics

Purpose	Key stakeholders	Key stakeholders' categories of needs	Characteristics	Objectives of characteristics
Assessment and improvement of maturity of the target community infrastructures (e.g. energy, water, transportation, waste, and ICT)	Citizens (e.g. residents), owners, sponsors, planners, operators, and suppliers	Availability, accessibility, affordability, economic efficiency, maintainability, resilience, mitigation of climate change, and, conservation of ecosystem	Characteristic 1	Objective 1
			Characteristic 2	Objective 2
			...	...

5.3.2 Additional recommendation for characteristics

In order to assist users in selecting appropriate characteristics to define the maturity level classification, a characteristic should:

- be a metric, i.e. measurable through monitoring, surveying or some other type of assessment method;
- be easy to use for scoring ("YES/NO" or other "either/or" classifications should be avoided as they are difficult to place on a five-level scale);
- allow for the ability to obtain accurate and precise results.

NOTE Reviewing and revising the selected characteristics on the basis of practical verification can help users continuously improve characteristics, which can then better meet their needs.

5.4 Guidance for defining criteria

5.4.1 General

Descriptions of the criteria for the five different maturity levels should be developed for each identified characteristic in accordance with the general descriptions given in the following subclauses. These descriptions should be compiled in the ACT.

To define the maturity levels, the following steps should be taken:

- classifying each identified characteristic into one of three attributes: performance, process or interoperability (see [5.4.2](#) for details);

NOTE 1 It can be inappropriate to develop characteristics for all three attributes.

- developing the five-level criteria for each characteristic based on the reference CIMM for each classification (see [5.4.3](#) for details).

NOTE 2 The classification of the attributes depends on the identified community issues (see [5.2](#)), such as the interoperability of water infrastructure.

5.4.2 Attribute of characteristics

When developing an ACT for community infrastructure(s), maturity levels should be defined according to the characteristics of their attributes, i.e., performance, process and interoperability.

Performance characteristics are those used to assess the performance of the community infrastructure(s), for example:

- the level of maturity of the community infrastructure service;
- the effect on the environment or other aspects of the community directly attributable to the operation of the infrastructure.

Process characteristics are those used to assess, for example:

- the levels of maturity of process for the community infrastructure such as introduction, maintenance and operation carried out by community managers, administrators, or operators;
- the activities for planning, managing and monitoring community infrastructure services.

Interoperability characteristics are those used to assess how well different infrastructure elements can work together or support each other, for example:

- the cooperation, alignment and harmonization of multiple community infrastructures;
- the cooperation, alignment and harmonization of infrastructure services, as well as the various services and issues within a community;
- relationships with other communities.

5.4.3 Definition of the criteria

5.4.3.1 General

The five-level criteria of maturity levels should be defined for each characteristic, depending on its attribute (see [5.4.3.2](#) for details).

In addition, this guidance should be used in developing the characteristics for all attributes:

- If it is difficult to describe a criterion with a single constant value, variables should be utilized.
- If a characteristic is not clearly classifiable as either performance, process or interoperability, it should be designated to the classification most appropriate to the purpose of the assessment.

5.4.3.2 Maturity levels by attributes of characteristics

Depending on the attribute, the five-level criteria for each characteristic should be developed on the basis of the CIMM given in [Tables 5](#), [6](#) and [7](#) for each attribute.

[Tables 5](#), [6](#) and [7](#) correspond to the CIMM for performance, process and interoperability characteristics, respectively. In these tables, “needs” includes both the technical and the contribution assessment aspects.

NOTE [Annex C](#) provides examples of practical criteria for the description of the five reference levels, focusing on the technical assessment, which are developed on the basis of [Tables 5](#), [6](#), and [7](#), and insights gained from some assessment trials.

The CIMM for performance characteristics is defined in [Table 5](#), which is derived from the general CIMM in [Table 3](#).

Table 5 — CIMM for performance characteristics

Level	Definition	Description
5	Sustainably optimizing	Satisfies quality and capacity for future needs
4	Improving	Under development to satisfy future needs
3	Fulfilled	Satisfies quality and capacity for current needs
2	Partially fulfilled	Physically functioning but does not satisfy current needs
1	Initial	No functioning infrastructure

The CIMM for process characteristics is defined in [Table 6](#), which is derived from the general CIMM in [Table 3](#).

Table 6 — CIMM for process characteristics

Level	Definition	Description
5	Sustainably optimizing	Procedures for continuous improvement of processes are implemented with appropriate resources (e.g. human, financial and natural resources)
4	Improving	Processes are implemented quantitatively
3	Defined	Processes are defined and implemented
2	Managed	Process needs are identified but processes are not defined
1	Initial	No established processes

The CIMM for interoperability characteristics is defined in [Table 7](#), which is derived from the general CIMM in [Table 3](#).

Table 7 — CIMM for interoperability characteristics

Level	Definition	Description
5	Sustainably optimizing	Continuous improvement of interoperability is in place
4	Improving	Common platform for achieving interoperability is established
3	Fulfilled	Connection and collaboration needs are defined and established across community infrastructures
2	Assessed	Connection and collaboration needs are assessed but not defined across community infrastructures
1	Initial	Infrastructures are operated independently

6 Guidance for assessment and improvement

6.1 General

This clause provides guidance on assessing the maturity of the target community infrastructure(s) with an ACT, as well as improving the performance, process and interoperability of community infrastructure(s) and their contribution to community-wide priorities.

6.2 Guidance for assessment

For assessment, the following procedures should be taken at a minimum:

- preparing necessary document(s), e.g. an analysis of policies relevant to the target community infrastructure(s) or records of the current situation of the target community infrastructure(s);
- selecting an appropriate ACT in accordance with [Clause 5](#) or the target infrastructure(s);

- c) assessing the target community infrastructure(s) according to each characteristic in the ACT and categorizing them into the appropriate assessment level;
- d) recording the results of the assessment.

If no ACTs exist, an appropriate ACT should be created in accordance with [Clause 5](#).

6.3 Guidance for improvement

6.3.1 Analysis for improvement

For improvement, the following procedures should be taken:

- a) setting a target level for each characteristic desired to be improved;
- b) identifying and analysing the gaps between the target level and the assessed current situation;
- c) developing a plan or measures to close the gaps and achieve the target level.

Procedures based on the PDCA cycle described in [Annex A](#) should be implemented periodically.

NOTE The same ACT is used for assessment and improvement. The metric that indicates the target for improvement can be the whole indicator, a part of an indicator or a group of indicators. This depends on the future vision of the community infrastructure(s).

In developing an improvement plan, the feasibility, operability and effect of the plan should be evaluated. A benchmark to judge if the plan has been successfully implemented should also be included in the plan. The effect should be compared to the cost of the plan.

6.3.2 Implementation of improvement

There are various means for implementing the improvement plans, such as:

- improving the performance characteristics by either replacing or repairing the hardware or physical equipment;
- improving the process characteristics by implementing an advanced maintenance activity based on the data monitoring, which serves to extend the life cycle of community infrastructure(s);
- improving the interoperability characteristics by enhancing data sharing and practical use between different types of infrastructure.

After the implementation of the improvement plan, an evaluation should be carried out to verify that the desired effect has been achieved.

Documents detailing the improvement plan at each assessment stage should be retained for future analysis.

NOTE [Annex A](#) provides a basic example of practical implementation for continuous improvement of community infrastructure(s).

Annex A (informative)

Continuous improvement of community infrastructure

A.1 General

This annex provides a basic overview of the practical implementation of continuous improvement of community infrastructure(s), which consists of two methodologies.

- a) CIMM: A tool to determine the current level and the target level of the community infrastructure(s), i.e. used to define “AS-IS” and “TO-BE”.
- b) PDCA cycle: A tool for continuous improvement from the current maturity level to the target maturity level, i.e. used to show “HOW-TO”.

Understanding the relationship between the CIMM and the PDCA cycle helps users to implement the continuous improvement activities effectively and efficiently.

A.2 The PDCA cycle and the community infrastructure maturity model

A.2.1 PDCA cycle

ISO 9001, a quality management standard, defines the PDCA cycle. This cycle can be described as the following steps when applied to the community infrastructure(s) for a continuous improvement activity:

- **Plan:** Establishing objectives and making a plan for delivering results in accordance with the desired performance of the community infrastructure(s).
- **Do:** Carrying out the activities defined in the plan.
- **Check:** Monitoring and measuring processes against the performance of the community infrastructure(s) and verifying that the process has achieved the desired results.
- **Act:** Extracting key points for improving the performance of the infrastructure(s) and taking action.

The PDCA cycle can be used to continuously improve the suitability, adequacy and effectiveness of the community infrastructure(s) and, ultimately, to upgrade the maturity level of the infrastructure(s).

A.2.2 Community infrastructure maturity model

A CIMM is usually designed as a tool to serve three purposes.

- Descriptive purpose: Used to assess the current maturity level of the community infrastructure.
- Prescriptive purpose: Indicates how to identify the desired maturity level for the community infrastructure.
- Comparative purpose: Based on benchmark results.

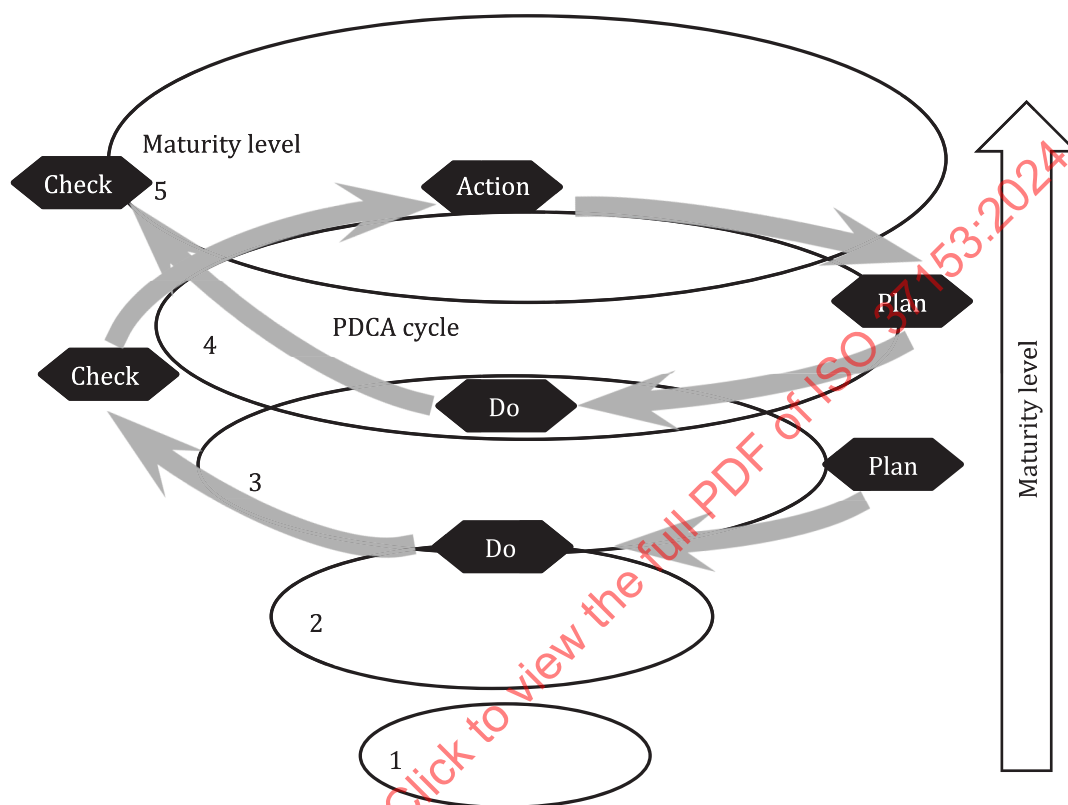
A.2.3 Relationship between the PDCA cycle and the community infrastructure maturity model

The relationship between the PDCA cycle and the CIMM can be described as follows:

- The PDCA cycle is an iterative, four-step, performance improvement method to increase maturity levels.

- A CIMM is an assessment tool which is used to assess community infrastructure(s) based on five maturity levels. It can be used to set the right target level, identify the gap and decide how much the metrics should be improved.
- Repeating the PDCA cycle leads to continuous improvement and upgrading of the maturity level of the community infrastructure(s).

[Figure A.1](#) shows an example of how to use the PDCA cycle to improve the maturity level of the community infrastructure(s).



Key

Plan E.g. determine the well-suited maturity level for the target infrastructure(s).

E.g. help identify the minimum resources needed to get the maximum results for the desired maturity level.

Do E.g. construction and rebuilding of infrastructure(s).

Check	E.g. check if the improved infrastructure(s) has reached the desired maturity level by monitoring and measurement.
-------	--

E.g. help detect the weakness in the infrastructure(s).

Action	E.g. improvement action including updating equipment, conducting repairs, introducing advanced maintenance technologies, and providing human training.
--------	--

NOTE Each ellipse represents one level of maturity.

Figure A.1 — PDCA cycle for improvement activities

A.3 How to use the PDCA cycle for improvement activities

A.3.1 Procedures

The following is a general procedure for using the PDCA cycle to improve activities for community infrastructure(s):

- a) identifying the weaknesses of the target infrastructure(s) based on an ACT;

- b) identifying which infrastructure(s) performance needs to be improved based on the ACT;
- c) defining what changes will lead to effective improvement for users' needs;
- d) modifying actions to facilitate improvement;
- e) verifying if the actions are appropriate.

A.3.2 Implementation of the PDCA cycle

A.3.2.1 Focus on the changes

All improvement requires change. The ability to develop, test and implement change is necessary for performance improvement.

The following actions can be taken when implementing the PDCA cycle for change:

- using substitution;
- finding and removing bottlenecks;
- using automation;
- using proper measurements;
- focusing on the core processes and purposes;
- coaching operators to improve their operational ability;
- optimizing maintenance;
- improving predictions.

A.3.2.2 Data collection

A better understanding of the objectives of data collection makes it easier to reach consensus among stakeholders.

Data collection consists of the following:

- developing a collection strategy, methods and tools prior to data collection;
- developing a plan with detailed steps for collecting each data element;
- validating the data involves:
 - data elements are collected in exactly the same way over time to ensure accurate and credible data;
 - data checking and correction mechanisms to deal with missing data;
- using support tools, such as data aggregation systems, to enable stakeholders to easily and effectively understand the progress from the initial stage to the consensus on the target;
- recording the results of selected data over time for the whole PDCA cycle.

A.3.2.3 Monitoring and measurement

The "check" stage of the PDCA cycle involves monitoring and measurement. Tracking the results of monitoring and measurement at each maturity level helps users accurately assess the current level of performance. The following should be taken into account when monitoring and measuring:

- identifying methods for monitoring and measurement to ensure valid results;

- identifying the timing of monitoring and measurement action;
- identifying the timing of analysis and assessment of results from monitoring and measurement.

[Table A.1](#) shows an example sheet for improvement activities based on the PDCA cycle.

Table A.1 — Example sheet for improvement activities

Target characteristics for improvement					
Name	Characteristics (metric)	Unit (if any)	Current level	Target level	Gap
Improvement activities (Based on PDCA cycle)					
(PLAN)			(DO)		
(CHECK)			(ACTION)		

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Annex B (informative)

Mechanism of the attributes of characteristics in technical assessment

B.1 General

This document provides two types of assessment of community infrastructure: technical assessment and contribution assessment. In general, technical assessment covers the direct effects of activities related to the community infrastructure(s), e.g. development, maintenance and operational management, such as planning and monitoring. In contrast, contribution assessment measures broader, community-wide effects. Many stakeholders show more interest in the technical assessment than the contribution assessment. This annex describes the mechanism of the three attributes of characteristics in the technical assessment, which are performance, process and interoperability.

Furthermore, in the CIMM for performance, two types of needs are considered in the five reference levels: current needs and future needs. This annex also describes the relationship between the two types of needs in the five reference levels.

B.2 Mechanism of the attributes of characteristics in technical assessment

The effectiveness and efficiency of the activities, e.g. development, maintenance and operational management, for the community infrastructure(s) are continuously improved by utilizing the attributes of characteristics in the technical assessment while promoting cooperation among the community infrastructure(s). [Figure B.1](#) shows the mechanism of the three attributes of characteristics for improvement and cooperation. In this case, residents, environments and city managers are selected as main stakeholders. Performance applies to the residents, while process and interoperability apply to the environments and the city managers in general. Note that [Figure B.1](#) shows a simplified mechanism. Therefore, although collaboration by stakeholders and participation by residents are important, they are not shown.

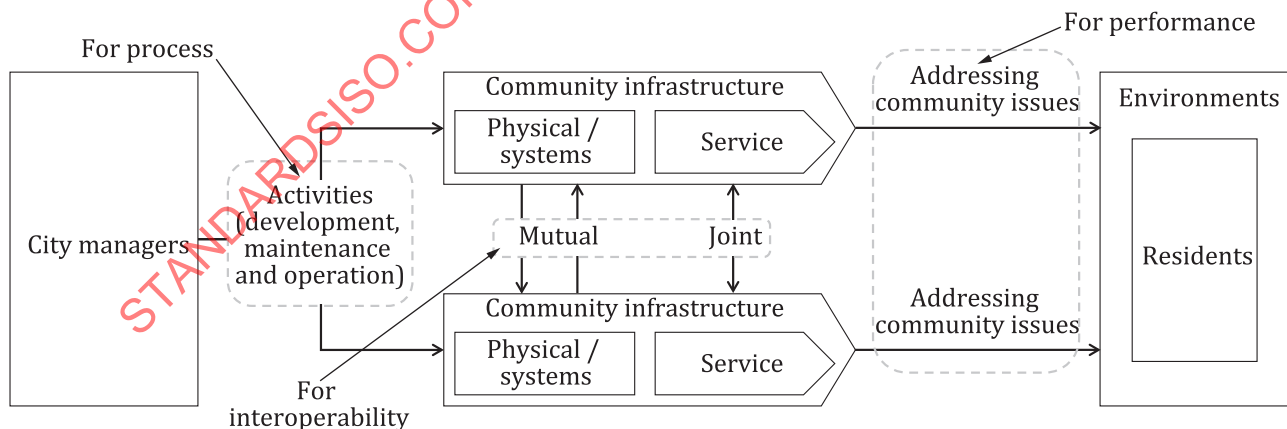


Figure B.1 — Mechanism of the attributes of characteristics in technical assessment

B.3 Supplementary explanation of CIMM for performance

In general, the activities related to community infrastructure(s) and their assessment take a long time and require an understanding of the achievement criteria and identification of discrepancies or gaps between

the current state and the future goal at each phase. CIMM provides an appropriate assessment method for community infrastructure(s), with the five reference levels for the attributes of the characteristics.

During the time that it takes to carry out the activities related to the improvement of the community infrastructure(s), the needs of the stakeholders can change along with the socio-economic conditions and technologies. Therefore, the five reference levels for performance take into account current and future needs, as shown in Table 5 in 5.4.3.2.

Taking public transportation as an example, Figure B.2 shows how performance can be used in relation to current needs and future needs with the five reference levels. Responding to the changing needs of residents from mass transportation to convenient mobility, where user-friendliness is more focused and digital technologies are more developed, public transportation has shifted from rail transportation such as undergrounds or light rail transit (LRT) to mobility as a service (MaaS), which combines various transportation means such as rail, bus, and taxi. Figure B.2 shows the change from current needs to future needs in response to the discontinuous shift in needs from mass transit to convenient mobility. To reflect the change, appropriate metrics can be set at each level.

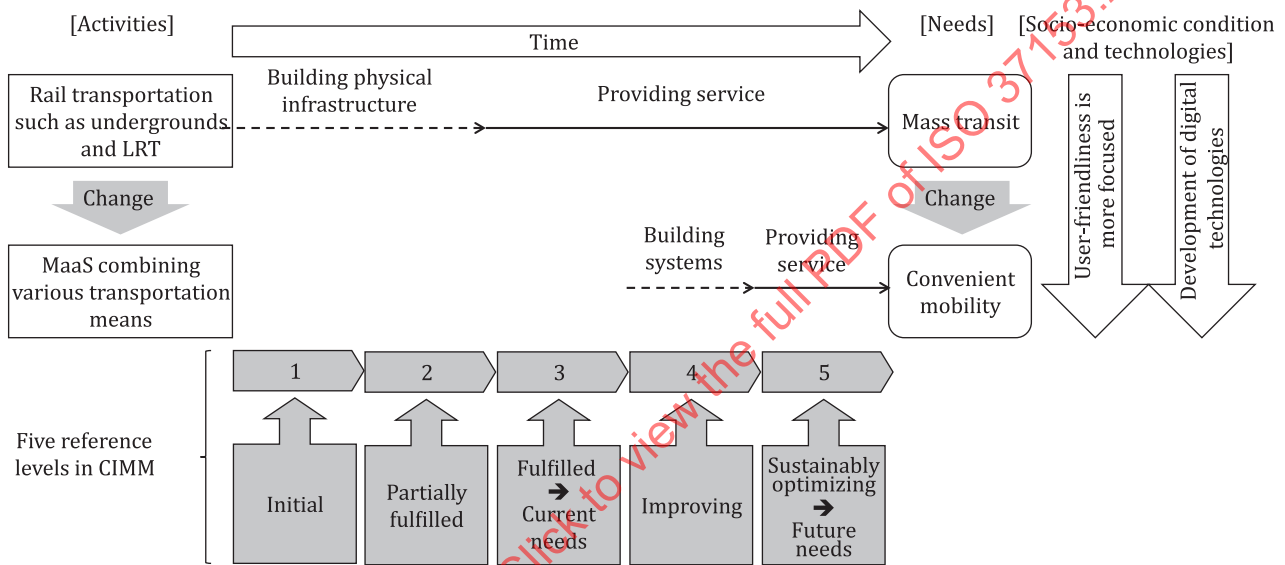


Figure B.2 — Relationship of current needs and future needs for public transportation

Annex C (informative)

Achievement criteria table for technical assessment

C.1 General

In the assessment of the community infrastructure(s), an ACT is the key output when appropriate levels are selected from the five reference levels in the CIMM and the issues and improvements in activities related to the community infrastructure(s) are identified. This annex outlines a general procedure for making a practical ACT and assessment for improvement, based on some assessment trials. Note that the focus of this annex is on the technical assessment as described in [Clause 4.3](#).

In an ACT, descriptions of the criteria for the five reference levels are important for appropriate assessment. This annex also provides examples of the practical criteria for describing the five reference levels of the attributes of the characteristics in the technical assessment. These are based on [Tables 5, 6, and 7](#) in [5.4.3.2](#), and insights gained from some assessment trials.

C.2 General procedure for a practical ACT and assessment for improvement

The following steps 1 to 4 provide a general procedure for the development of a practical ACT and steps 5 and 6 provide a general procedure for the assessment of improvements:

- Step 1. Target sectors are identified.

Important sectors are identified as target sectors with reference to policies and plans for the development of the community infrastructure(s).

- Step 2. Target activities are set.

Taking into account the objectives, important activities related to the community infrastructure(s) are set as target activities, e.g. development, maintenance, and operational management such as planning and monitoring.

- Step 3. Metrics (characteristics) are selected.

Metrics are selected with appropriate attributes of characteristics to measure the degree of achievement of the objectives for the target activities, with reference to ISO 37151. Note that where possible and applicable, metrics should be quantitative, possibly taking into account specific weights, rather than qualitative for objective assessment.

The metrics are classified into the categories of needs defined in ISO 37151 and the attributes of characteristics.

- Step 4. Criteria of the five reference levels are described.

Taking into account the policies and plans, the criteria of the five reference levels for the metrics are described based on [Tables 5 to 7](#) in [5.4.3.2](#), as well as [Table C.2](#). The descriptions of the criteria of the five reference levels are set for the attributes of the characteristics to measure the degree of achievement of the objectives.

- Step 5. Data is collected for the metrics and the appropriate level is determined.

Data is collected for the metrics and the appropriate level is determined from the five reference levels by matching the results of the data analysis with the descriptions of the criteria of the levels.

- Step 6. Issues are identified and improvement plans are implemented.

Issues are identified in the targeted activities and improvement plans are implemented to raise the levels.

[Table C.1](#) shows an ACT structure for practical use developed in accordance with the general procedure described in [Clause C.2](#). Appropriate metrics can be selected at each level.

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Table C.1 — ACT structure for practical use

Target sectors	Target activities (considering objectives)	Metrics ^a	Classification		Levels					Appropriate level ^b	Issues and improvements
			Categories of needs as defined in ISO 37151	Attributes of characteristics		1	2	3	4	5	
***	***	***	***		Description	***	***	***	***	***	***
					Result			***			
	***	***	***		Description	***	***	***	***	***	***
					Result			***			
		***	***		Description	***	***	***	***	***	***
					Result			***			
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^a Metrics are selected with appropriate attributes of characteristics to measure the degree of achievement of the objectives.											
^b Appropriate level is determined by analysis that matches the descriptions of the criteria for each level.											

C.3 Practical criteria for describing the five reference levels

As indicated in [Clause 4.3](#), the technical assessment generally attracts more interest from many stakeholders. The technical assessment covers the attributes of the characteristics. [Table C.2](#) provides the practical criteria for describing the five reference levels of the attributes of the characteristics in the technical assessment.

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Table C.2 — Practical criteria for describing the five reference levels

Attributes of characteristics	Key elements	Five reference levels				
		Level 1 (initial)	Level 2 (partially fulfilled)	Level 3 (fulfilled)	Level 4 (improving)	Level 5 (sustainably optimizing)
Performance	Functioning situation	No functioning infrastructure	Physically functioning	Stably functioning, with no critical issues	Stably functioning and improving, with no critical issues	Stably functioning and optimizing, without any issues, using state-of-art technologies
	Service requirements	No services	Partially satisfies current quality, capacity and coverage needs	Fully satisfies current quality, capacity and coverage needs	Partially satisfies future quality, capacity and coverage needs	Fully satisfies future quality, capacity and coverage needs
Process	Management and operation	Needs are not identified, and management plans are not formulated	Needs are identified, and the management and operation plans are formulated but not fully implemented	Management and operation plans are established, at least configuration, work, risk and maintenance management plans	Management and operation based on quantitative analyses are effectively established and improvements based on the analyses are promoted	Optimal management and operation based on the evaluation of efficiency and effectiveness are established and an efficient optimum process utilizing advanced technologies is implemented
	Servicing	Needs for servicing are not identified	Needs for servicing are identified, but not fully implemented	Servicing is defined and implemented	Servicing is monitored and analysed	Servicing is continuously boosting its value creations
Interoperability	Management and operation	No cooperation	Cooperation across infrastructures and/or communities is assessed, but individually implemented	Cooperation across either infrastructures or communities, of both, is defined and established	Integrated management and services across either infrastructure(s) or communities, or both, are established	Integrated management and services across either infrastructure(s) or communities, or both, are continuously improving
	Closeness and scale	Information is not shared	Information is shared between infrastructure(s) and/or communities by means of data exchange	Operation based on shared data and process is established	Operation based on shared systems is established	Operation based on shared systems is continuously improving with state-of-the-art technologies