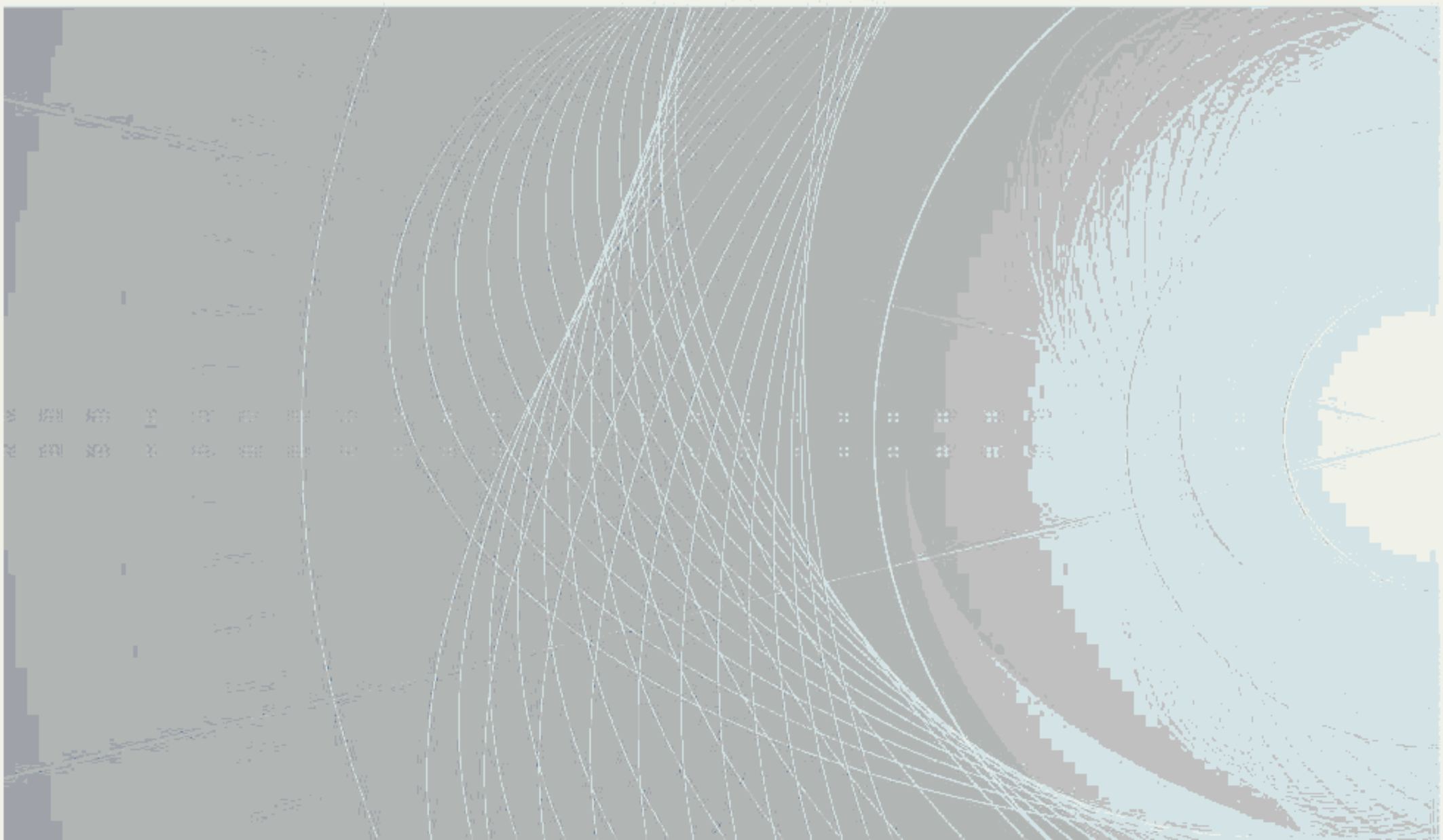
IEC SRD 63235

Edition 1.0 2021-03

SYSTEMS REFERENCE DELIVERABLE

Smart city system – Methodology for concepts building



IEC SRD 63235:2021-03(en)

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Smart city system – Methodology for concepts building

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 01.040.01

ISBN 978-2-8322-9388-1

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SMART CITY SYSTEM – METHODOLOGY FOR CONCEPTS BUILDING

FOREWORD

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IEC SRD 63235, which is a Systems Reference Deliverable, has been prepared by IEC systems committee Smart Cities.

The text of this Systems Reference Deliverable is based on the following documents:

Draft SRD	Report on voting
SyCSmartCities/135/DTS	SyCSmartCities/153/RVDTS

Full information on the voting for the approval of this Systems Reference Deliverable can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This document provides methodologies being performed and to be continually performed in the sustainable development of a future part of IEC 60050 [1] on smart city systems.

The methodology in this document provides system approaches to coordination, cooperation and connectivity of the terminology sources including IEC, ISO and ITU. The methodology fosters a multi-dimensional system of systems view on smart city systems across dimensions, domains and layers along the lifecycle of a smart city system, scenarios and use cases, supporting the sustainable development of smart city system arrangements, activities and artefacts, convergence of people, process and productivity globally.

1 Planned as IEC 60050-831, *International Electrotechnical Vocabulary (IEV) – Smart city systems*.

SMART CITY SYSTEM – METHODOLOGY FOR CONCEPTS BUILDING

1 Scope

This document, which is a Systems Reference Deliverable, provides a holistic system of systems approach to provide views, methodology framework, principles, processes, rules, and evaluation criteria for smart city system concepts building.

The methodology is applicable to continual improvement of a future part of IEC 60050 on smart city systems, but is not limited to it.

NOTE It is planned that smart city systems will form the subject of IEC 60050-831.

This document does not specify the definitions of a smart city system.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

3.1
characteristic
abstraction of a property (3.5)

Note 1 to entry: Characteristics are used for describing concepts (3.2).

[SOURCE: ISO 1087:2019, 3.2.1, modified – The EXAMPLE has been deleted.]

3.2
concept
unit of knowledge created by a unique combination of **characteristics** (3.1)

Note 1 to entry: Concepts are not necessarily bound to particular natural languages. They are, however, influenced by the social or cultural background, which often leads to different categorizations.

Note 2 to entry: This is the concept "concept" as used and designated by the term "concept" in terminology work. It is a very different concept from that designated by other domains such as industrial automation or marketing.

[SOURCE: ISO 1087:2019, 3.2.7]

3.3
concept system
system of concepts
set of concepts (3.2) structured in one or more related domains (3.4) according to the concept relations among its concepts (3.2)

[SOURCE: ISO 1087:2019, 3.2.28]

3.4
domain
subject field
field of special knowledge

Note 1 to entry: The borderlines and granularity of a domain are determined from a purpose-related point of view. If a domain is subdivided, the result is again a domain.

[SOURCE: ISO 1087:2019, 3.1.4]

3.5
property
feature of an object

Note 1 to entry: One or more objects can have the same property.

[SOURCE: ISO 1087:2019, 3.1.3, modified – The EXAMPLES have been deleted.]

3.6
term
designation that represents a general concept by linguistic means

[SOURCE: ISO 1087:2019, 3.4.2, modified – The EXAMPLE and Note 1 to entry have been deleted.]

4 Methodology for smart city system concepts building

4.1 General

Methodology refers to a coherent, integrated set of methods from which a coherent sub-set can be selected for particular applications. A methodology for building smart city system concepts should contain at least six components:

a) a system of systems view with common concerns and interests of multiple stakeholders (see 4.2);
b) a methodology framework of constructs essential to the problem (see 4.3);
c) a set of principles guiding the scopes of concept and taxonomy of a smart city system (see 4.4);
d) a set of procedures suggesting the direction and order to proceed (see 4.5);
e) a series of rules identifying things to be avoided (see 4.6); and
f) a collection of evaluative criteria for assessing the quality of the product (see 4.7).

NOTE Adapted from the definition of methodology in ISO/IEC 16500-8:1999, 3.14.

4.2 A system of systems view

A system of systems view (see Figure 1) considers the smart city as a complex system, made up of many vertical domains such as transport, health, education, and employment. These vertical domains are interconnected by three cross-cutting systems that include views of social system, digital system and physical system of a city and system approach, which work together as a complementary whole in responding to the concerns and interests of different stakeholders (ISO/IEC 30182:2017, 2.14). Each of these cross-cutting systems, in turn, can be subdivided into other horizontal, cross-cutting domains.

Taking this system of systems view enables the total capability of a city to be enhanced in a way and to an extent that none of the constituent systems can accomplish on its own. Each constituent system is a useful system by itself, having its own management, goals and resources, but when coordinated within the smart city system (SCS) contributes to providing the unique capability of the SCS.

The social system provides a multi-dimensional governance framework (ISO/IEC TR 38502:2017, 3.1) for coordinating arrangements of strategies, policies, decision-making structures and accountabilities to multiple stakeholders' concerns in social space and convergence.

A digital system provides a multi-domain architecture framework (ISO/IEC/IEEE 24748-1:2018, 3.7) for cooperating activities of conventions, principles and practices for individual domain architecture and enabling digital transformation.

A physical system provides a multi-layer application framework (ISO/IEC/IEEE 24765:2017, 3.177) to connect artefacts in each subsystem and enable interfaces between systems in physical space to support all necessary interactions.

An integration of the three systems supports the convergence of multi-dimensional, multi-domain and multi-layer concerns and interests of multiple stakeholders as well as enhancing the adaptive capacity of a city as an ecosystem to deliver a sustainable, prosperous and inclusive future for its citizens.

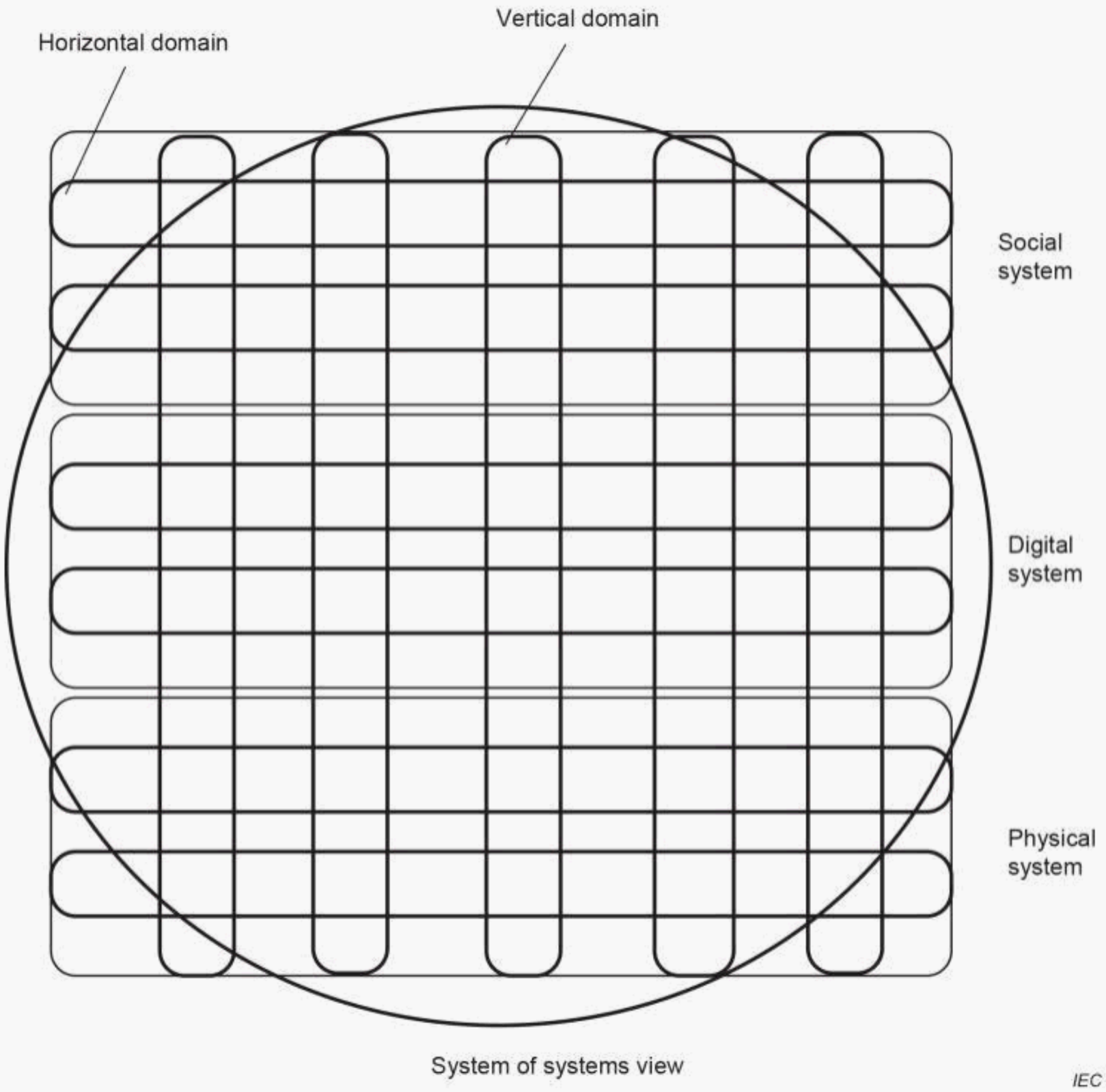

Figure 1 – Concept views of smart city systems

4.3 A methodology framework

A methodology framework refers to a way, or structure, that supports a number of different methods and languages to be used together when developing a system.

NOTE This definition of methodology framework is adapted from ISO/IEC 16500-8:1999, 3.15.

The methodology framework for a smart city system concept system refers to a system of systems way of thinking that supports multi-dimensional, multi-domain and multi-layer, lifecycle and use case analysis approaches to be used together as a complementary whole in developing a smart city system, as shown in Figure 2.

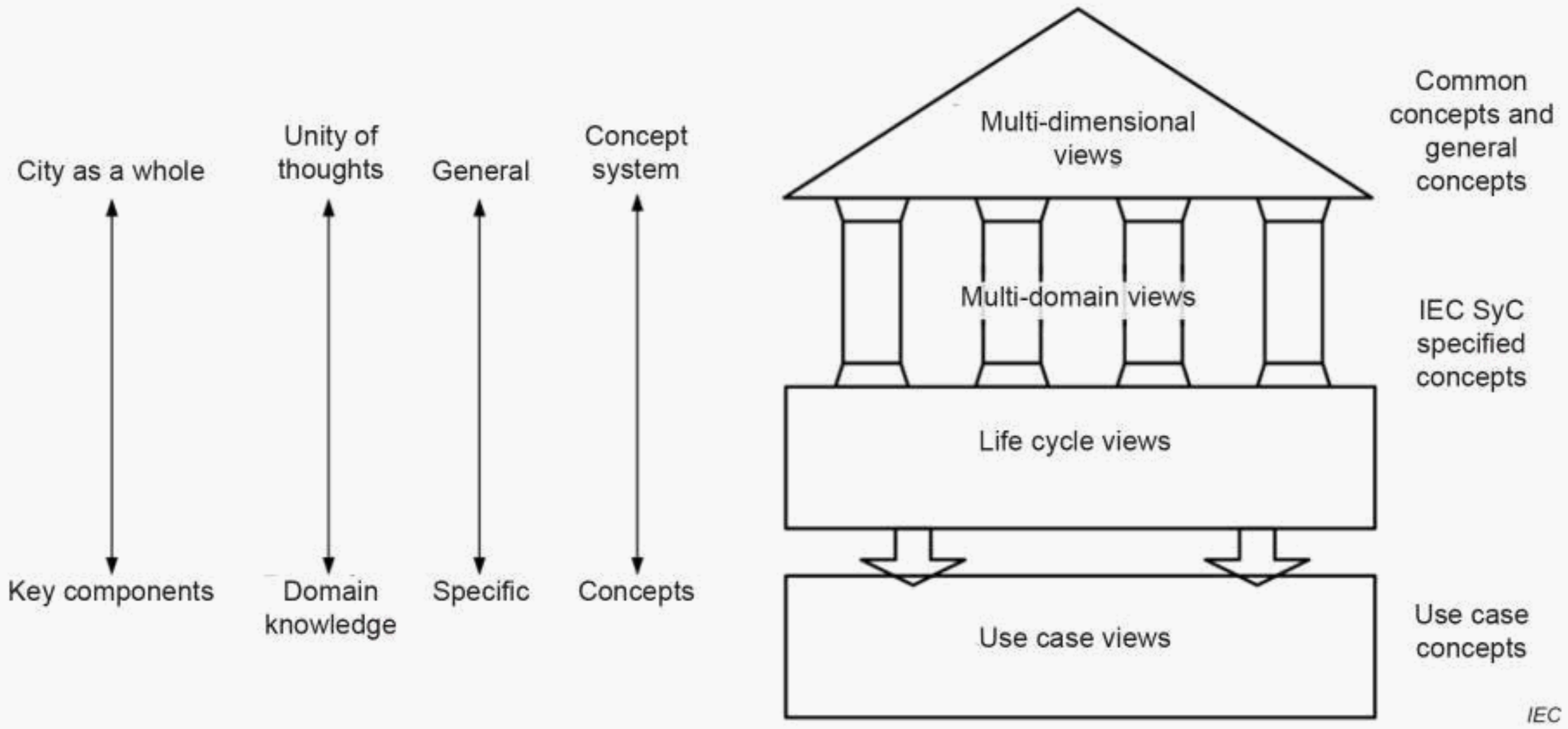

Figure 2 – A methodology framework for building smart city system concept

A methodology framework for smart city system concept building would have the following considerations.

a) At the high-level, seeing the city as an organic whole to build a multi-dimensional smart city coordination framework supporting people-interdependent and shared visions.

b) At the intermediate-level, setting up a multi-domain smart city cooperation framework to support communication within each specific system to enable solutions and processes to be compared, harmonized and aligned, as well as working together towards shared goals in the management of other critical infrastructure.

c) At the low-level, establishing a lifecycle connectivity framework to bring alternatives and complementary approaches together towards productivity-oriented shared solutions.

These all form integrated parts of the organic whole, operating as a multi-layer application framework having a reusable architecture for all or part of a system, thus supporting shared solutions.

4.4 Principles

The terms included need to be:

a) highly relevant and pertinent to the smart city system domain;

b) highly relevant to reaching clarity and consensus in the smart city system domain;

c) highly relevant to electrotechnical, digital or system domain scoping and positioning, where there is a need for clarity and consensus on a coordinated lifecycle governance and cross-domain and cross-object continuity service for setting frameworks and applications;

d) in frequent use and applicable throughout all current and future documents of the International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), and Telecommunication Standardization Sector of the International Telecommunication Union (ITU-T);

e) highly relevant to the social system, e.g. the interests of citizens, city governance and management, and industry and where there is a need for clarity and consensus;

f) highly relevant to the digital system and physical system, e.g. electrotechnical, digital or system domain scoping and positioning;

g) highly relevant to interests and needs in a particular setting; for example, documents developed for SyC Smart Cities such as city needs matrix and smart city linking stakeholders and concerns validation, where there is a need for clarity and consensus, e.g. "safety", "security", "risk".

h) If a definition of a concept is controversial, but it is vital for scope and objective, it should be included.

Terms should not be included that:

1) are not pertinent to the smart city/smart city system domain, and which are unlikely to be relevant in the future;
2) are not in frequent use;
3) have different interpretations, where there is no consensus, and which are therefore likely to cause confusion or conflicts, contradictions or inconsistency;

In considering definitions for the key terms identified, the first step will be to review existing definitions of those terms within ISO, IEC or ITU and either adopt or adapt them. In general, preference will be given to terms and definitions from coordinated working across different standards organization developers and across different systems committees. A new definition will be given only if there are no existing relevant definitions to draw on or if the existing relevant definitions cannot apply to the current and future practice.

4.5 Processes

Where there are existing generic definitions that, in general, are applicable to the work of IEC SyC Smart Cities, then the normal approach would be to use these and, where necessary, to add notes clarifying how they should be applied in the smart city system context. The only exceptions to this would be where the term is central to the work of IEC SyC Smart Cities. In this case, it might be more appropriate to develop a new definition, based on the generic one, but written in a way to specifically address the smart city or electrotechnical context. The following processes would be undertaken to ensure the effectiveness of concept and taxonomy building.

a) Use the principles given in 4.4 to develop a list of terms for which clear definitions are needed by IEC SyC Smart Cities.
b) Review whether those terms have already been defined by IEC, ISO or ITU and other Standards Development Organizations (SDOs).
c) If they have already been defined, we consider whether those definitions are relevant and appropriate to IEC SyC Smart Cities.
d) If there are definitions that are more or less appropriate and simply need to be modified to meet the needs of IEC SyC Smart Cities, then the preferred option would be to add extra notes to the existing definition. Should more fundamental changes be required, then coordination of this process with the relevant committee would be recommended, with the aim of developing a definition that is suitable for all, or developing a new definition, based on the generic one, but explicitly focused on smart city, electrotechnology, or the systems approach.
e) If there are no definitions that are relevant or appropriate, then a new definition would be created.
f) Where there are terms that might be useful for other IEC systems committees or other SDOs, coordination with the ISO-IEC-ITU Joint Smart Cities Task Force (JSC TF) would be beneficial to allow terms to be defined in a way that they can be used across all the IEC systems work and across all the smart city domains.

Definitions are available from the IEC, ISO, ITU terminology databases and other SDOs. Examples are given below.

– ISO Online browsing platform, available at: http://www.iso.org/obp
– IEC Electropedia, available at: http://www.electropedia.org/
– ITU Terms and Definitions, available at: http://www.itu.int/net/ITU-R/index.asp?redirect=true&category=information&rlink=terminology-database&lang=en#lang=en

- UNBIS terms at: https://lib-thesaurus.un.org/DPI/DHL/DHLUNBISThesaurus.nsf?Open
- ISO/IEC/IEEE software and systems engineering vocabulary terms, available at: https://pascal.computer.org/sev_display/index.action
- Sector Forum for Smart and Sustainable Cities and Communities Standards Specifications and Reports relevant to Smart Cites
- https://www.etsi.org/standards/types-of-standards
- IEC/ISO/ITU Smart city Coordination Task Group: 2019 Draft White Paper: Suggested Priority Terms in Need of Common Definitions to Support Standards Activities for Smart city, Barcelona, World Smart City Forum, April 17, 2019

4.6 Rules

The selection of terms and the wording of definitions aims, as far as possible, to follow established usage. However, the context of usage (including application, cultural, and linguistic factors) can lead to apparent contradictions. Terms with broadly inconsistent usage are indicated as such; where consensus is not possible a majority solution is sought. Where contradictory usages reflect established practice, appropriate notes are recorded (ISO 10241-1:2011, 4.5; ISO/IEC 2382-36:2019).

"Technical terms appearing in a definition should be defined either in the IEV, or in another authoritative publication. Where reference is made to the concept, if there is more than one term for a concept, the entry term shall be used to refer to the concept …".

[SOURCE: ISO/IEC Directives, Part 1 and IEC Supplement:2020, SK.3.1.4.3]

"For the creation of new terms (or for the revision of existing terminologies), the following principles should be followed (more information is given in ISO 704:2009, 7.4).

- The term is a label used to designate the concept (as described by the definition) in a concise and unambiguous (i.e. avoiding as far as possible homographs) manner: it should of course evoke the concept, but is not intended to replace the definition.
- Consistency: the terminology in any subject field should not be an arbitrary collection of terms, but rather a coherent terminological system corresponding to the concept system.
- Appropriateness: the terms proposed should adhere to familiar and established patterns of meaning within a language community; term formation that causes confusion shall be avoided; terms shall be as neutral as possible and avoid connotations, especially negative ones.
- Derivability: terms that allow for the formation of derivatives should be favoured.
- Linguistic correctness vis-à-vis the language shall be considered.
- Preference should be given to terms in native language rather than to terms borrowed from other languages.

In addition, it is to be noted that the terms in the various languages should not be word-for-word translations of the term in the initial language in which a specific terminological entry was prepared. The right process for the formation of the term in a given language is to start from the concept, as described by the definition, and then to choose (or to form) the most appropriate term in this language.

In the case of creation of a new term (neologism), it is recommended that the technical experts consult with linguistic experts in the country concerned."

[SOURCE: ISO/IEC Directives, Part 1 and IEC Supplement:2020, SK.3.1.3.2].

4.7 Evaluation criteria for assessment of the concept and domain relevance

4.7.1 General considerations

Concepts and the vocabulary should be relevant to domain relevance assessment (4.7.2), stakeholder relevance assessment (4.7.3) and domain and stakeholders matrix relevance assessment (4.7.4), in accordance with the principles given in 4.4.

In addition, characteristics of well-organized smart city system concepts shall address the following concerns:

– system of systems view for the integration, interoperability and effectiveness of terms and vocabularies in the smart city system domain;

– many diverse stakeholders' concerns with respect to multi-dimensional understanding of cities;

– synergy between uniformity and diversity;

– commonly-agreed multidisciplinary concept system to enable all the stakeholders to use the same "language";

– clear technical descriptions; and

– a coherent and harmonized vocabulary that is easily understandable by all potential users.

Concepts are not independent of one another, and an analysis of the relationships between concepts within the smart city system domain and the arrangement of them into concept systems shall be a prerequisite of a coherent and consistent vocabulary.

Discussions and consensus among experts from different WGs of IEC SyC Smart Cities to get consensus on concept system building shall be a prerequisite for co-governance of terminology work, co-creation, co-sharing and co-win of terminology documents and services of IEC SyC Smart Cities.

Such a coordination process is important for the effective development of the vocabulary standards. See Annex A for an example of a smart city concept system building from different SDOs.

4.7.2 Domain relevance assessment

The assessment criteria are electrotechnology domain relevance to help the integration, interoperability and effectiveness of city systems. The aspect of the city needs shall have the following three elements.

– Domain criterion 1 (DC1): has an electrotechnical or mechanical component.

– Domain criterion 2 (DC2): has a system element as part of a smart city system.

– Domain criterion 3 (DC3): has a digital element as part of digital repeatable systems.

4.7.3 Stakeholders relevance assessment

The assessment criteria are relevant to stakeholders. The use case needs to be relevant to three types of specific city stakeholders as follows.

– Stakeholders criterion 1 (SC1): the citizen.

– Stakeholders criterion 2 (SC2): the city administration.

– Stakeholders criterion 3 (SC3): the industry and local business.

4.7.4 Domain and stakeholders matrix relevance assessment

The assessment criteria are the relevance of use case or use stories to domain and stakeholders identified above and the priority concern about the beneficiary.

The level of relevance can be identified according to the relationships of use case with domain and stakeholders of a city system, and can include system, risk, decision and activity and facility domain. Moreover, it can be assessed according to the concerns about the beneficiary of a city system, and can include interests, rights, needs and expectations of stakeholders that can be affected or perceived to be affected by use case. The domain and stakeholders matrix relevance assessment is shown in Table 1.

– Matrix criterion 1(MC1): highly relevant, above 50 % relevance.
– Matrix criterion 2 (MC2): relevant, below 50 % relevance.
– Matrix criterion 3 (MC3): neutral, 0 relevance.
– Matrix criterion 4 (MC4): relevance not known.

Table 1 can be used for the domain and stakeholders matrix relevance assessment.

Table 1 – Domain and stakeholders matrix relevance assessment

Concerns and interests	Highly relevant MC1	Relevant MC2	Neutral MC3	Unknown MC4
Electrotechnical (DC1)				
Systems standard (DC2)				
Digital (smart) (DC3)				
Value for citizen (SC1)				
Value for city administration (SC2)				
Value for industry and local business (SC3)				

Annex A
(informative)

Example of a smart city concept system building from three SDOs

A.1 Concepts relating to smart city

Table A.1 shows key terms that have been used in existing definitions from IEC, ISO and ITU −T, which are either generic or specific concepts relating to smart city. The following 20 key terms are identified as concepts for complementary understanding about smart city from four definitions of the three SDOs (D1 to D4):

1) built environment (D2);
2) competitiveness (D3);
3) citizen (D1D2D4);
4) city (D1D3D4);
5) city system (D1);
6) communication technology (D3);
7) data/information (D1D3D4);
8) digital system (D2);
9) environment (D1D2D3D4);
10) inclusive (D2D4);
11) integration (D2);
12) leadership (D1);
13) natural environment (D1);
14) resilience (D1);
15) service (D1D3D4);
16) sustainability (D1D2D3D4);
17) system (D1D2D4);
18) physical system (D2);
19) transformative (D1D4);
20) productivity (D3).

Table A.1 – Definitions of smart city from different SDOs and the key terms

Code	Definition	Properties of smart city and the key terms	Source
D1	a Smart City should be described as one that … dramatically increases the pace at which it improves its sustainability and resilience … by fundamentally improving how it engages society, how it applies collaborative leadership methods, how it works across disciplines and city systems, and how it uses data and integrated technologies … in order to transform services and quality of life to those in and involved with the city (residents, businesses, visitors), now and for the foreseeable future, without unfair disadvantage of others or degradation of the natural environment.	Properties of city: sustainability, resilience, collaborative leadership Key terms: data, integrated technologies, city system, services, quality of life, city, environment	ISO/IEC JTC 1 Smart cities: Preliminary Report 2014, 2.1.2
D2 D3	"effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens"	Properties of city: sustainable, prosperous, inclusive, effective integration Key terms: physical systems, digital systems, human systems, built environment, citizen	ISO/IEC 30182:2017, 2.14
	"A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects. NOTE – City competitiveness refers to policies, institutions, strategies and processes that determine the city's sustainable productivity."	Properties of city: innovative, economic, social, environmental, cultural aspects, competitiveness Key terms: city, information, communication technology, quality of life, urban operation, urban service, needs of present future generations	Rec. ITU-T Y.4900 (06/2016), 3.2.2 (definition for smart sustainable city)
D4	A city that exploits the transformative power of data and technology to better serve the people who live and work there, and the interests of future generations. A city that systematically delivers sustainable, prosperous and inclusive social place for people who live and work there, and for future generations Note 1 to entry: The effective use of the transformational power of digital, bio and social technologies and methodologies is a necessary requirement to achieving these outcomes.	Property of city: Transformative, sustainable, prosperous, inclusive, effective use of transformational power Key terms: city, data, technology, people, future generation	Xiaomi An, Michael Mulquin and Yi Song, Existing definitions of smart city from ISO, ITU-T and IEC: Investigation and an analysis from pluralistic and interdisciplinary perspective for harmonization, Research report submitted for SyC Smart Cities WG1 on August 29, 2017.

A.2 Relationships of concepts relating to smart city

A social–digital–physical three-dimensional view is justified as being effective for harmonization of existing definitions of smart city and reflecting the relationships of the concepts as shown in Figure A.1.

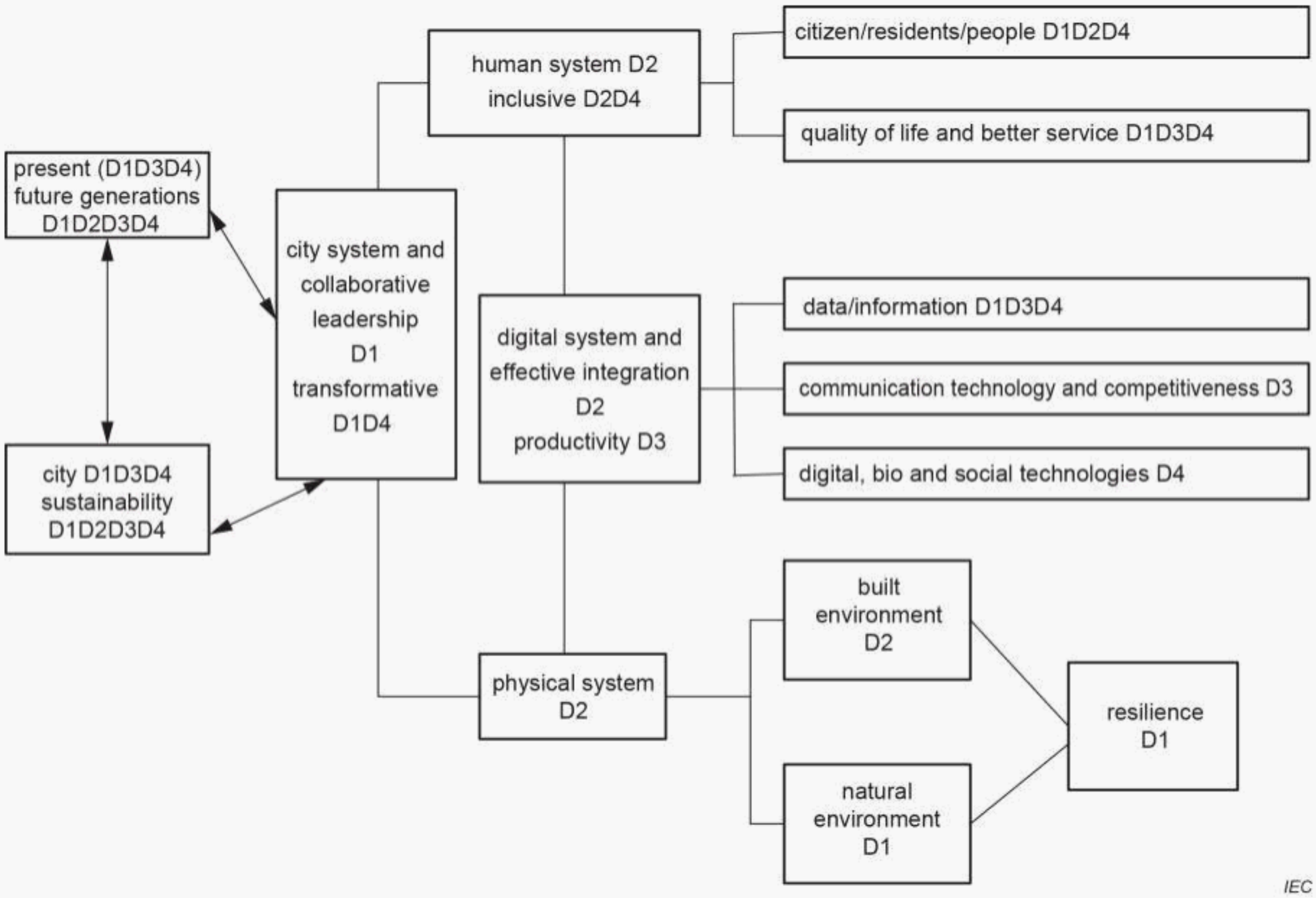

Figure A.1 – Concepts relating to smart city and their relationships

[SOURCE: Xiaomi An, Michael Mulquin and Yi Song, Existing definitions of smart city from ISO, ITU-T and IEC: Investigation and an analysis from pluralistic and interdisciplinary perspective for harmonization, Research report submitted for SyC Smart Cities WG1 on August 29, 2017]

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