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# DELIVERABLE

## *D4.4.2 – Boundary constraints and best practices for certification programs*

**Project Acronym: ESPRESSO**

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| ***Dissemination Level*** | | |
| P | Public | **X** |
| C | Confidential, only for members of the consortium and the Commission Services | |

# 1. Revision history and statement of originality

## 1.1. Revision history

| Rev | Date | Author | Organization | Description |
|---|---|---|---|---|
| **0.1** | 30.01.2017 | Thomas Batz | Fraunhofer IOSB | Initial TOC (v. 0) |
| **0.2** | 17.03.2017 | Kym Watson | Fraunhofer IOSB | First draft |
| **0.3** | 23.03.2017 | Bart De Lathouwer | OGCE | Final draft |
| **1.0** | 31.03.2017 | Kym Watson | Fraunhofer IOSB | Final editing |
| **1.1** | 31.03.2017 | Irene Facchin | TRILOGIS | Quality Check |
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## 1.2. Statement of originality

*This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.*

## 2. List of References


| Number | Full Reference |
|---|---|
| **[1]** | CITYkeys 2017: Handbook for Cities on Performance Measurement, available on http://www.citykeys-project.eu/ or at bit.ly/2lepPfO |
| **[2]** | CITYkeys 2016: D1.4 Smart city KPIs and related methodology, available on http://www.citykeys-project.eu/ |
| **[3]** | ESPRESSO 2016: D4.3 ESPRESSO Smart City indicator platform |
| **[4]** | ESPRESSO 2017 Definition of Smart City reference architecture |
| **[5]** | OGC Compliance Interoperability Testing and Evaluation (CITE) program, https://portal.opengeospatial.org/files/?artifact_id=55234 |

# 3. Table of Acronyms

| Acronym | Description |
|---|---|
| **ESPRESSO** | systEmic Standardisation apPRoach to Empower Smart citieS and cOmmunities – project of which this document forms a deliverable |
| **OGC** | Open Geospatial Consortium |
| | |

# 4. Executive Abstract

This document is the output report of **Task 4.4 Definition Smart City certification mechanism** for the ESPRESSO Project (systEmic Standardisation apPRoach to Empower Smart citieS and cOmmunities). It proposes a certification mechanism for smart cities based on a KPI framework that is assumed to be evolving in time. It does not address the definition and selection of KPIs as such, but does adopt the CITYkeys approach to KPI definition. CITYkeys advocates city and project related KPIs. ESPRESSO supplements these KPIs with two general KPIs relating to the overall strategy and the usage of a reference architecture. The result of the KPI evaluation is expressed as a Smart City Vector describing the performance of a city at the level of subthemes. ESPRESSO proposes a clear organizational structure for certification to ensure independent assessments of whether a city can call itself a Smart City. The certification process is subject to regular review to take new developments into account (technological, economic, environmental and societal, etc.).

# 5. Table of Content

# 6. Table of Figures



# 7. Table of Tables

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# 8. Introduction

The term "Smart City" is very much a hype expression and of course no city wants to be called not smart or even "dumb". This calls for an independent and transparent way of certifying a city as being smart.

The objective of this document is to propose a general mechanism for certifying smart cities based on a set of indicators. The actual definition and selection of indicators of smartness is intentionally not within the scope. Rather the document describes boundary constraints on the selection, management and evaluation of such indicators under the premise that indicators will evolve over time, that indicators may be dropped or new indicators adopted.

As agreed in ESPRESSO, we reference and build on the CITYkeys KPI (Key Performance Indicators) and the CITYkeys experience in defining "reasonable" KPIs [1, 2]. By reasonable we mean indicators that can be determined as objectively as possible with an acceptable level of effort and cost. The KPIs shall be important to a city, be trustworthy and provide a fair assessment of the city's performance in a given area. They should help to guide future investments and policy making involving citizens and other stakeholders in a transparent way. A city will generally have to prioritize its development projects and should ideally have a strategic roadmap of projects and measures to improve its performance. For more details on the possible benefits of a KPI measurement framework, see [1].

Following the CITYkeys approach [1, 2], we take into consideration not only the actual status of a city with "city indicators", but also the change which should be or has been reached by planned or completed projects with "project indicators". Project indicators are designed to assess the impact of a smart city project. For example, the reduction of carbon dioxide emissions is an indicator of the impact of a project to increase the number of electric vehicles. For more details, see [2]. Project indicators require typically additional qualitative information collected in interviews with the project participants. The availability of data for both indicator types varies from city to city depending on available statistical and open data sources. Some indicators require manual data collection. The automation of data collection is of course critical to an efficient and sustainable process. It is also closely related to on-going efforts of cities to increase their degree of digitalization.

CITYkeys derived its KPI based on 43 existing indicator frameworks. Further indicators and categories of indicators are presented in [3]. This fact in itself underlines the need for a sustainable, adaptable approach to smart city certification.

# 9. ESPRESSO Smart City certification mechanism

In this chapter we will describe the ESPRESSO Smart City certification mechanism starting with the basic subject of indicators. We describe the constraints on a certification scheme, introduce the dimensions of the certification scheme and suggest an organisational certification structure. We introduce the concept of the Smart City Vector as a basis for smart city certification.

The KPIs to assess the smartness of a city are manifold; as in CITYkeys we consider these indicators to be grouped in themes and subthemes (cf. Fig. 1). A single number is not sufficient to describe the smart city status. For example, a city may be excellent in the subtheme of employment, but poor in the subtheme of climate resilience. It is also not reasonable to attempt to assign weights to different subthemes as there is no objective basis for any particular choice. A city should endeavour to be smart and improve itself with respect to as many subthemes as possible. Hence we propose that a Smart City Vector be used to certify a smart city. In order to ensure that the Smart City Vector has a manageable number of dimensions that can be visualized easily, we propose that the KPIs within a subtheme be weighted to compute an index for each subtheme.

| People | Planet | Prosperity | Governance | Propagation |
|---|---|---|---|---|
| • Health<br>• Safety<br>• Access to (other) services<br>• Education<br>• Diversity and social cohesion<br>• Quality of housing and the built environment | • Energy and mitigation<br>• Materials, water and land<br>• Climate resilience<br>• Pollution and waste<br>• Ecosystems | • Employment<br>• Equity<br>• Green economy<br>• Economic performance<br>• Innovation<br>• Attractiveness and conpetitiveness | • Organisation<br>• Community involvement<br>• Multi-level governance | • Scalability<br>• Replicability |

**Figure 1: Classification of CITYkeys KPIs in themes and sub-themes. Source [1].**

## 9.1. Fundamental requirements on a certification mechanism

The following fundamental requirements are proposed as a framework of boundary conditions on a smart city certification mechanism:

- The assessment of a city for a possible certification should be described with a multi-dimensional vector of indicators and not merely with a single number. This allows differentiation of cities that are weak or strong in certain subthemes.
- The assessment should consider factors such as:
    - The initial situation of the city. Cities in a difficult economic or social area have a different starting position as compared to modern, wealthy cities that have been planned comprehensively from scratch on "green fields".

  - Size and population density of the city,
  - Climatic and geographical situation
  - Economic level
  - Technological maturity
- The assessment shall not be just a once-off process, but repeated at regular intervals. Cities should be encouraged to improve themselves and their assessment.
- The assessment should consider the impact of projects in the city to improve its status through suitable project indicators.
- The assessment criteria shall be reviewed and adapted at regular intervals (e.g. every 5 years). We refer to this as the *Certification Process Review* below. Over time the technologies available to a smart city will change and the general level of technology usage and "smartness" should increase. Also the expectations of citizens for their city will evolve, and possibly change radically due to events such as drastically increasing prices for fossil fuel.
- The certification mechanism shall include mandatory criteria that must be fulfilled for a city to be certified as smart. For example, a city with a poor performance in the subtheme "pollution and waste" could be deemed to be not smart regardless of its performance in the other subthemes.
- The assessment mechanism shall be generic in the sense that it shall work with different sets of KPIs. The KPIs will almost certainly not be static and will develop over time.
- The assessment result shall allow cities to be compared in a suitable way.
- KPIs shall be mapped onto a value scale from 0 to 5 as in [1]. The KPIs within a subtheme are weighted to compute an index for the subtheme in the range [0, 5]. In turn, this subtheme scale shall be mapped onto the traffic light colors: e.g. the value intervals [0, 2), [2, 4) and [4, 5] can be mapped to the colors red, yellow and green respectively. A vector represents the value in each indicator.
  - The mapping on to traffic light colors can depend on the subtheme.
  - The KPI weighting and color mapping can be adapted as part of the Certification Process Review.
  - Vectors are only comparable if they have the same version number for the weighting and mapping.
  - The themes and subthemes can be adapted in a Certification Process Review
  - A city requires an overarching strategy (concept) and a reference architecture to become smart in a sustainable way. [4] presents a Smart City reference architecture.

## 9.2. Elements taken into consideration

The Certification Scheme has three dimensions (cf. Fig. 2):

- the desired results – in our case the Smart City Vector,
- the process to be conducted to reach the result and
- the involved organisations.

We now describe all three dimensions, starting with the Smart City Vector as result, followed by the involved organisations and then the process.

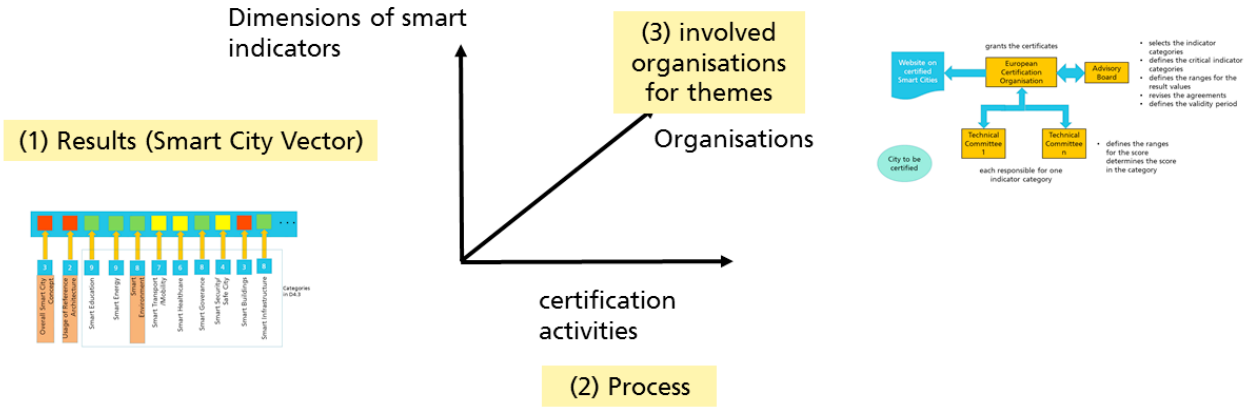


**Figure 2: Dimensions of the Certification Scheme.**

## 9.3. Smart City Vector

An example for a smart city vector is shown in Figure 3. The subthemes are grouped in the five CITYkeys themes for KPIs as in Fig. 1. Moreover, we add indicators for the:

- Overall Smart City Concept,
- Usage of a Reference Architecture.

The orange indicators are mandatory, i.e. they must be achieved at least with a yellow level. This minimum level could be raised to green. The legend for the meaning of the project impact KPIs is shown in Fig. 4.

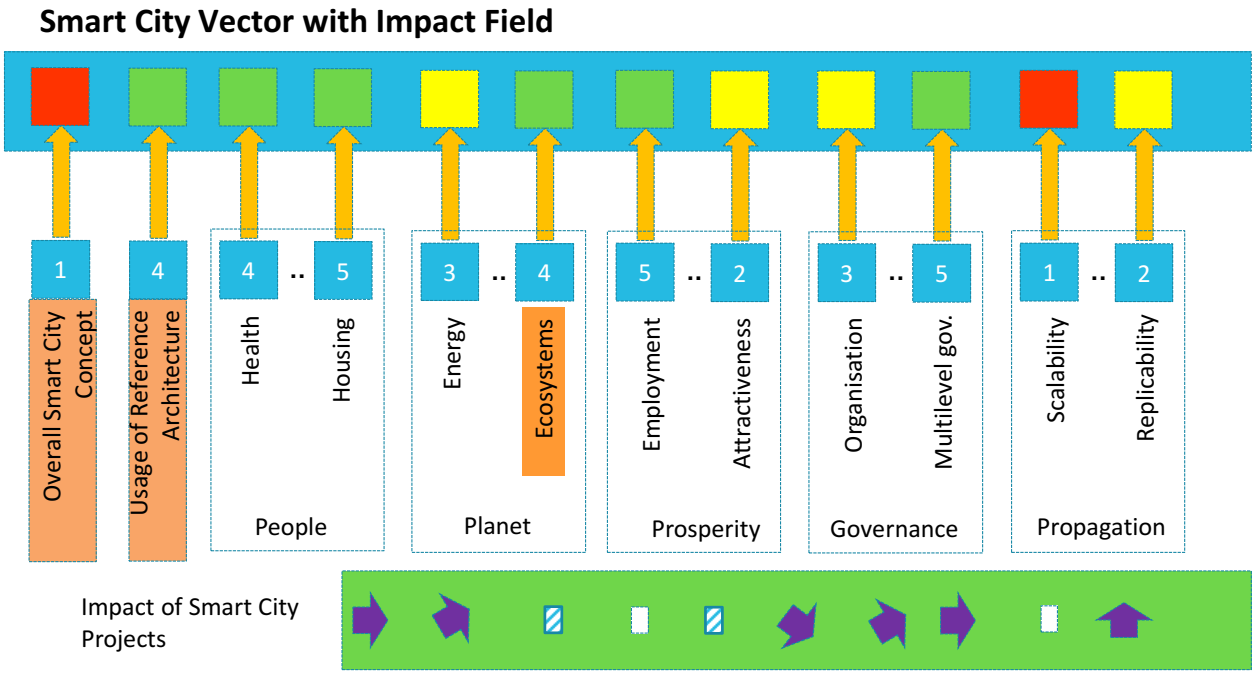


**Figure 3: Smart City Vector (Example).**

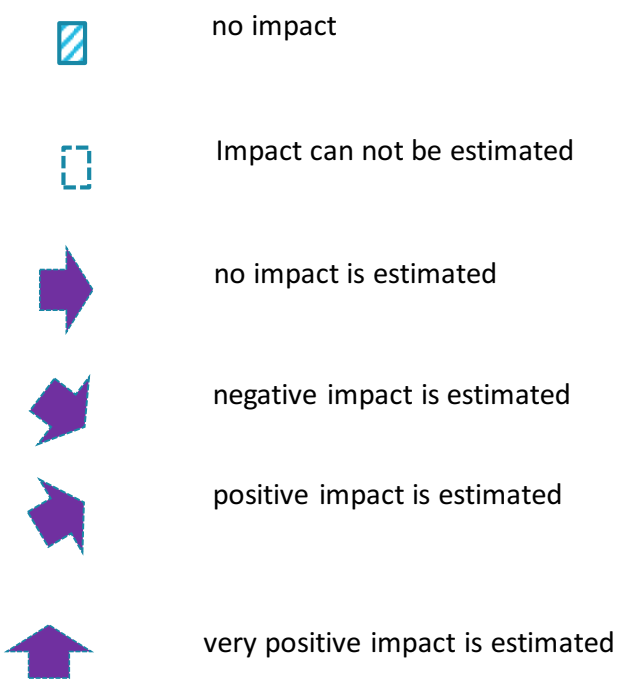


**Figure 4: Legend of project impact.**

## 9.4. Involved Organisations

The organizational structure proposed in Fig. 5 ensures a clear separation of responsibilities and roles. A European Certification Organisation grants the certificates and publishes the result vectors in a register on a public web site. The Advisory Board

- selects the KPI subthemes (categories) to be included
- defines the mandatory KPI which have to be fulfilled by each applicant city
- defines the ranges for the three result values (red, yellow, green)
- defines the validity period of the certification (e.g. 6 years)
- proposes revisions to the certification process at regular intervals (e.g. 5 every years)

The scores in the various indicator categories are determined by technical committees (1 for each indicator theme or subtheme), consisting of technical experts in the respective theme / subtheme. The technical committees

- define the data to be collected from the cities and organize its evaluation
- define the weights of the KPIs within a subtheme.

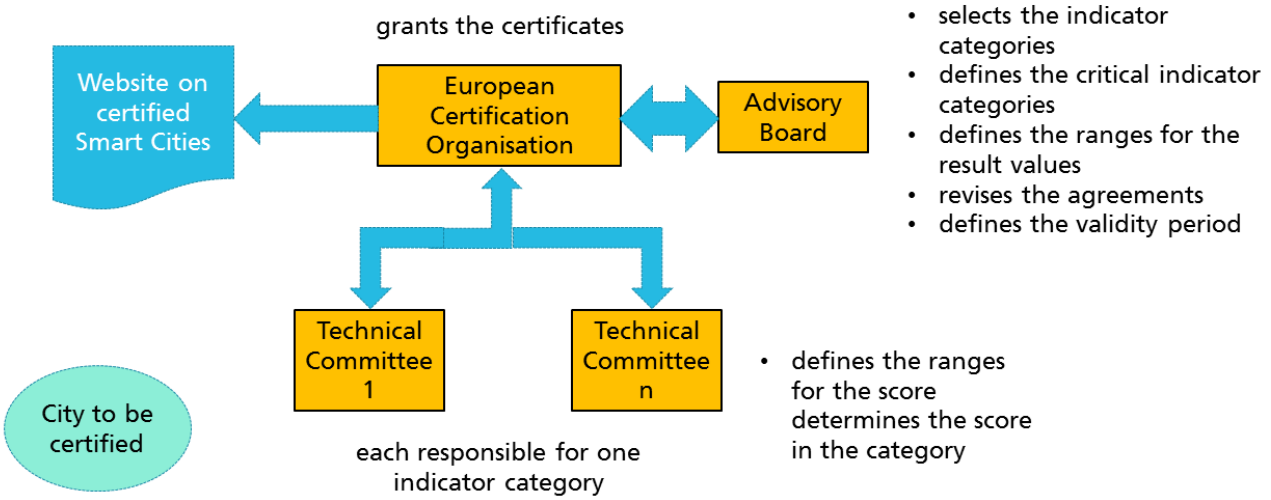


**Figure 5: Involved Organisations.**

This structure requires an initialization group within European standards organizations as shown in Fig. 6 to:

- appoint the European Certification Organisation
- establish the Technical Committees for a set of themes, subthemes
- appoint members to the Advisory Board
- define the (initial) certification scheme and rules, the list of indicator themes

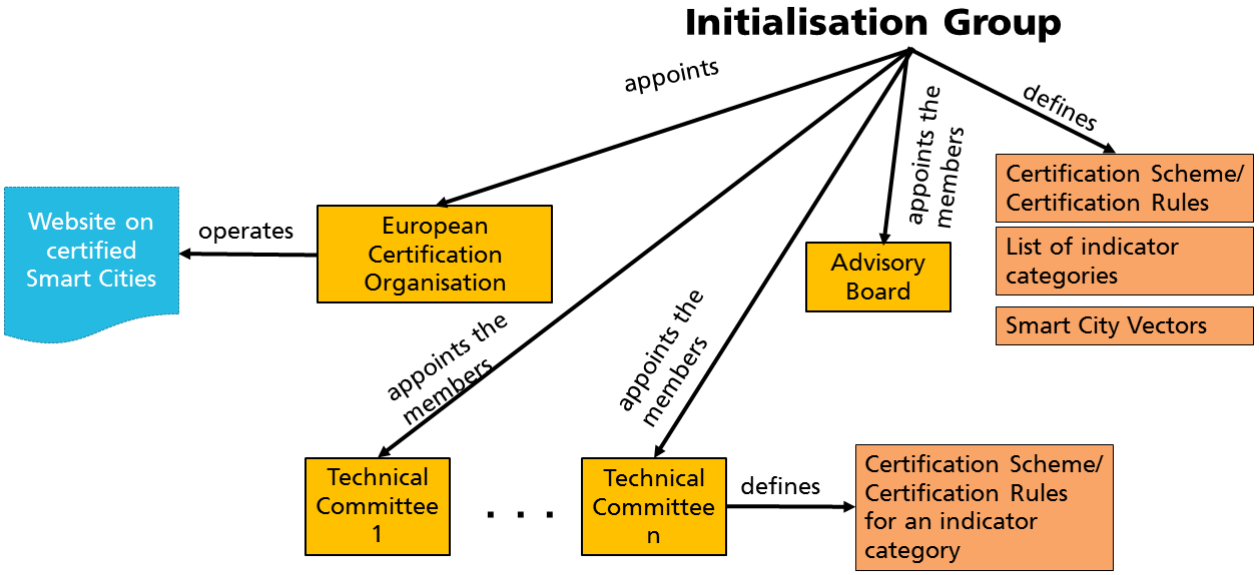


**Figure 6: Initialising of the Certification Process.**

## 9.5. Certification process

Figs. 7 and 8 shows the actual certification process from the external and internal viewpoints respectively. A self-certification shall not be possible.

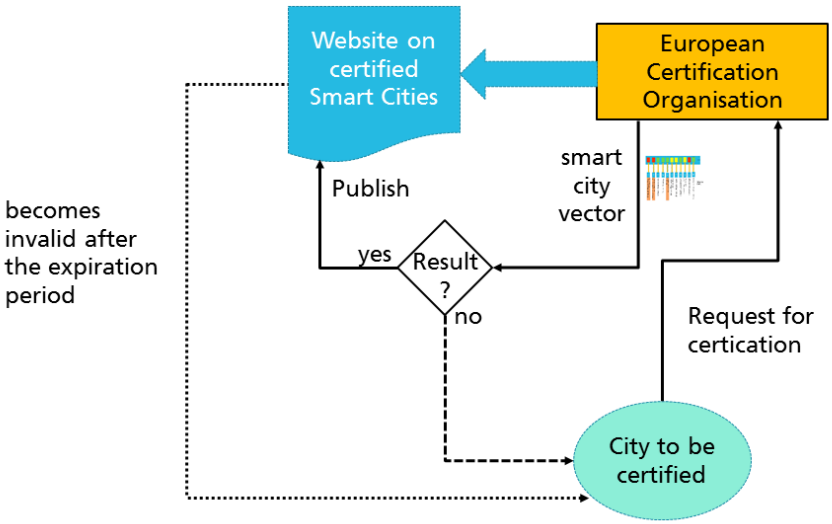


**Figure 7: Certification Process (external view).**

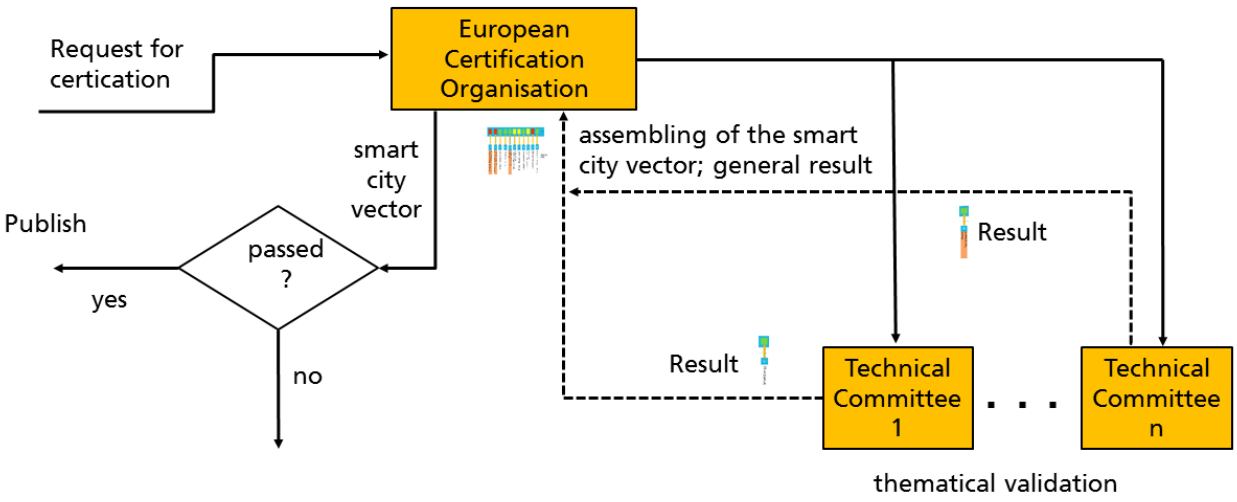


**Figure 8: Certification Process (internal view).**

The Certification Process Review is illustrated in Fig. 9.

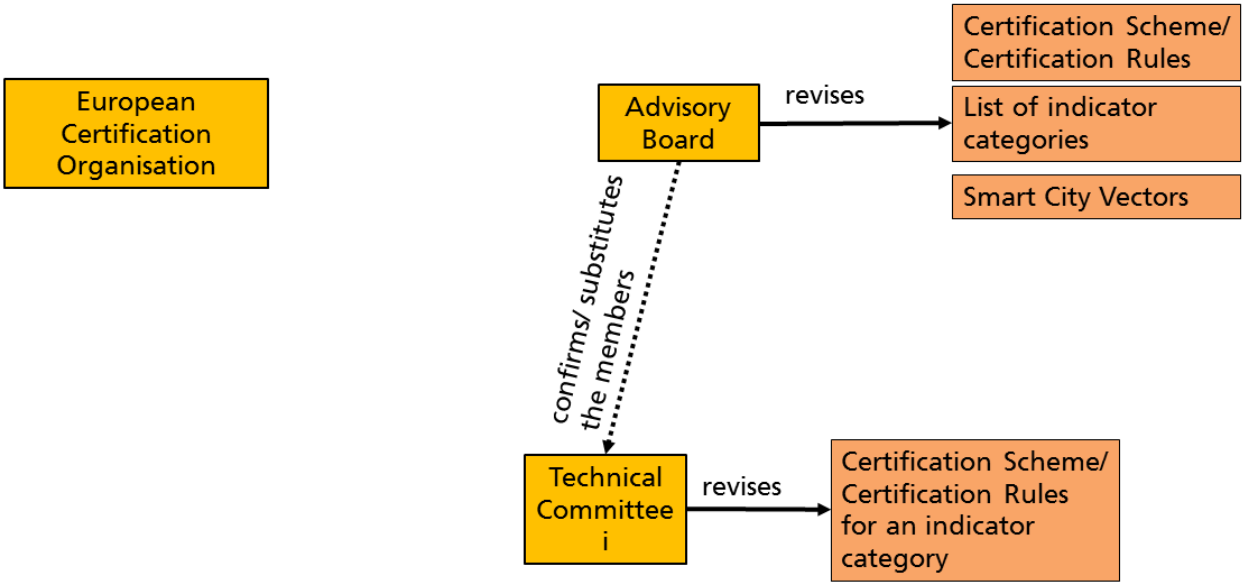


**Figure 9: Updating of the Certification Process.**

# 10. Conclusions and Future Steps

Similar to the next steps in the Standards harmonisation and development priorities, Smart City Certification cannot be handled by a single SDO, except maybe for ISO - but there is no prior work done for certification of Smart Cities.

Smart City is a popular topic with cities, governments (federal and local), industry, citizens and standards developing organisations (formal and informal, national and international). Each SDO has either directly or indirectly working groups that relate to Smart City standards - yet, the term Smart City is not a domain by itself, but a container word for Smart initiatives on the scale of a city or area, that theoretically has an impact on the lives of the citizens. Smart City initiatives touch on about every aspect of Information Technology (very wide), but also very deep as it potentially touches on all aspects of the OSI 7 layers stack. This explains why all the SDOs have initiatives going on under the banner of Smart Cities.

A Smart City Certification mechanism would need to constitute a New Work Item Proposal (terminology and usage in ISO) that originates from a National Committee (this could be done through DIN) within scope of an existing committee, submitted to the secretariat of the parent technical committee (taken from the ISO rules). The ISO/IEC JTC1 WG11 could be the proposing committee.

Alternatively, or additionally, Standard Developing organisations need to engage in a strategic collaboration and dialogue to manage the depth and spread of the Smart City domain and topics - and set priorities in the domain for certification.

Most SDOs have some sort of Smart City work going on - either to organise the members around a common philosophy or to define concrete KPIs. The KPIs under consideration have only an indirect link to IT. IT can be an enabler and is in some cases very necessary, but is typically not sufficient for a good score in a given KPI. SDOs have established certification schemes in the IT domain. For instance, for geospatial standards OGC has its Compliance Interoperability Testing and Evaluation (CITE) program that has been in operation for over 10 years [5]. IT standards and IT certification alone are therefore not sufficient for Smart City certification. The experience gained by SDOs in managing IT certification schemes can feed into future Smart City certification mechanisms.