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Analysing the Impact of Smart City Networks in Telecommunications Regulation and Standardization: the Spanish Case

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1. Abstract

Since its establishment in 2011, the Spanish Network of Smart Cities (RECI) has worked towards the ultimate objective of making Spanish cities an international reference within the global ‘smart’ panorama. This network, originally empowered by the individual experience of many Spanish cities with presence in international smart city projects for over 10 years, has adopted a powerful governance structure, including its own particular network coordination and management mechanisms. Overall, this environment can be considered a fast track to learning in matters of smart cities governance and project implementation and a powerful tool for collaborating with the remaining stakeholders. The final objective of this work focuses on providing a full picture of the impact of RECI on the Spanish smart cities and its influence in policy-making and standardization. The conclusions of this study show the important role that RECI has played in the recent development of Spain as an international reference in the field of smart cities. It also shows a positive correlation between RECI's influence on government and normalisation bodies to guarantee the success of RECI's participant strategies.

2. Introduction

The smart city wave is a world-wide movement which for some years has revolutionized the way cities operate. Energy, mobility, society, government, construction, and environment are just some of the main vertical sectors involved in a common venture for integrating all city services to make them more efficient, eco-friendly and citizen-oriented. Across all these verticals, the information and communications technologies (ICT) appear as the vertebral column for this overall smart holistic objective for cities. This smart city-ICT relationship forms a feed-back loop where ICT provides the necessary tools for cities to use in its services. At the same time, the cities are defining new needs and consequently ICT research paths to reach further horizons.

The massive surge in ICT field of application has rapidly impacted on national and international standardization and normalisation organizations. International examples of how these organizations have integrated smart cities in the committees or working groups can be seen in the following; Technical Committee 268 of the International Standardization Organization (ISO/TC 268)[1], the Systems Evaluation Group – Smart Cities of the International Electro technical Commission (IEC/SEG 1) or the CEN-CENELEC-ETSI Coordination Group ‘Smart and Sustainable Cities and Communities’ (SSCC-CG)[2]. At national level, the Spanish Telecommunication State Secretary (SETSI) and the Association of Standardization and

Normalisation (AENOR) created in 2012 the Normalisation Technical Committee 178 (CTN 178) for Smart Cities[3].

Taking the Spanish case as an example, SETSI & AENOR's CTN 178 illustrates how important close collaboration between the government, the normalisation organization and the cities are in order to align norms with necessities and experiences already learned. This article specifically focuses on the influence and impact the Spanish Network of Smart Cities has on normalisation, regulation and cities, as a promoter of the CTN 178. Originally established by 20 Spanish cities in 2012, RECI currently includes over 65 cities, some of which have a historical presence in international R+D+I smart city projects. Within the five normalisation sub-committees that form CTN 178, four of them are chaired by RECI's municipalities. Among these five sub-committees, SC1 – Infrastructures which deals with ICT normalisation has by far been the most active and innovative committee with 13 norms already published and another 18 currently being developed.

As previously outlined, this article will analyse the influence of RECI's organization and activities on the Spanish ICT normalisation and its implementation in local government. Comparisons will also be made between national and international smart city cases. In Section 3, this article reviews the mode of operation of the RECI and its collaboration with other networks. Following, in Section 4, the impact of the network in the normalisation scenario is described in depth. Finally, some conclusions are extracted from the previous sections outcomes.

3. RECI, the Spanish Network of Smart Cities

RECI, created in June 2011 with the signing of the 'Manifest for the Smart Cities' Innovation for Progress', is an initiative sponsored by elected councillors in Spain who are committed to create an open network which promotes the economic, social and business advantages of RECI. The elected councillors actively seek to progress smart cities initiatives through innovation and knowledge-sharing which is based on ICT's feedback. RECI positions itself as an association of local territories whose entities, which are part of the network, are representative of their geographical/ local area. Each represented area leads innovation initiatives in their own sphere, by promoting their own local network of agents, related to research and innovation.

The final objective of RECI is based on the exchange of information and experiences. It is an interlinked communicative venture which aims to develop a sustainable city management model. Its primary aim is to create a model which improves the quality of life of its citizens. In order to achieve this, the association promotes the automatic and efficient management of urban infrastructures and services. These smart city projects seek to reduce public spending and improve the quality of service, whilst, continuing to focus on aspects such as energy saving, sustainable mobility, e-Government, social care and security. These objectives are the foundation of the four main pillars adopted by RECI to support local level development, as shown in Figure 1.

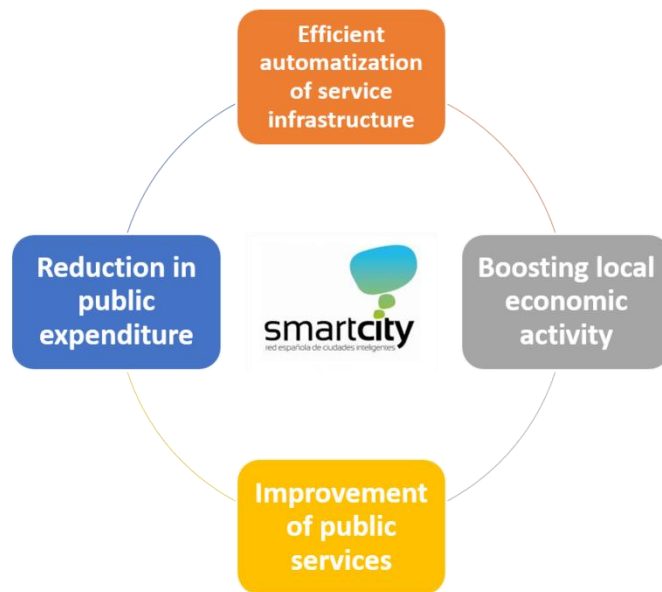


Figure 1: RECI's foundation pillars.

All 65 cities which currently make up this network, share the motivation that a smart city is one which knows how to make the most of possibilities offered by the ICT. The revived use of local knowledge has transformed the 65 isolated cities into an effective, efficient and continuous network of knowledge sharing.

RECI's ongoing work is developed under five working groups (WG), where one or two cities act as leaders for each group. These five groups are: Social Innovation; Energy, Environment, Infrastructures and Livability; Urban Mobility; and Governance, Economy and Business. These groups, together with their related activities and leading cities are shown in Table 1.

Table 1: RECI's working groups

Working Group	Areas
WG 1 Social Innovation	Accessibility, Culture and Sports, Citizen Involvement, e-Health Emergency and Security management, Tourism, Education and Open Data
WG 2 Energy	Energy Efficiency Dissemination Municipal Facilities: smart buildings, efficiency in public lighting, renewable energy installations
WG 3 Environment, Infrastructures and Livability	Environmental Quality, Sustainable Buildings, Building Control Automation, Management of Public Infrastructures and Urban Facilities, Parks and Public Gardens Management, Livability, Urban Parameters Measurement, Waste Collection and Treatment, Urban Planning
WG 4 Urban mobility	Electric vehicle (EV), Intelligent Transport Systems (ITS)
WG 5 Governance Economy and Businesses	eGovernment, New Business Models, Employment, e-Commerce and NFP Payment Platforms, Cloud Computing, Virtual Data Centres.

Due to this working groups division, the smart city policies promoted by RECI are mainly sectorial policies. Member cities choose based on their own individual needs and motivations which groups they would like to participate in. Each group is comprised of several cities

working together to analyse the needs of the working group and subsequently design and agree on related strategies. The agreed strategies are guided by the city councillors and the local technical staff involved. In each working group, RECI offers local politicians and local technical staff the possibility to frame engagement and co-creation processes, throughout multiple phases of the workflow.

Therefore, RECI's work can be positioned at the crossroad of the areas of e-government and the digital transformation of democratic process. Concretely, for the city members of RECI, the main focus seems to be on the role of ICT infrastructure.

International collaboration with other networks

Despite the fact that RECI's work is mainly focused on the evolution of Spanish cities towards a smart future, RECI is one of the first city networks of its kind in the world. RECI has raised much interest from other countries regarding its operational model and activities. This has created a different dimension of cooperation at an international level. From this perspective, RECI has had expressions of interest from European countries such as Portugal, France and Italy; Latin American countries such as Peru, Chile, Argentina, Bolivia, Brazil or Colombia; North America, with cities from the United States and Mexico; and other countries such as Egypt and Israel. These are shown in Figure 2.

Portugal has a very similar city network based on the RECI's model, RENER (Rede Portuguesa de Cidades Inteligentes, or Portuguese Network of Smart Cities), which was established in 2013[4]. Similar to RECI, RENER is empowered by a private non-profit organisation, INTELI, organised as a public-private cooperation to promote research and innovation in the smart cities field. Currently there is an agreement for mutual collaboration between RECI and RENER.

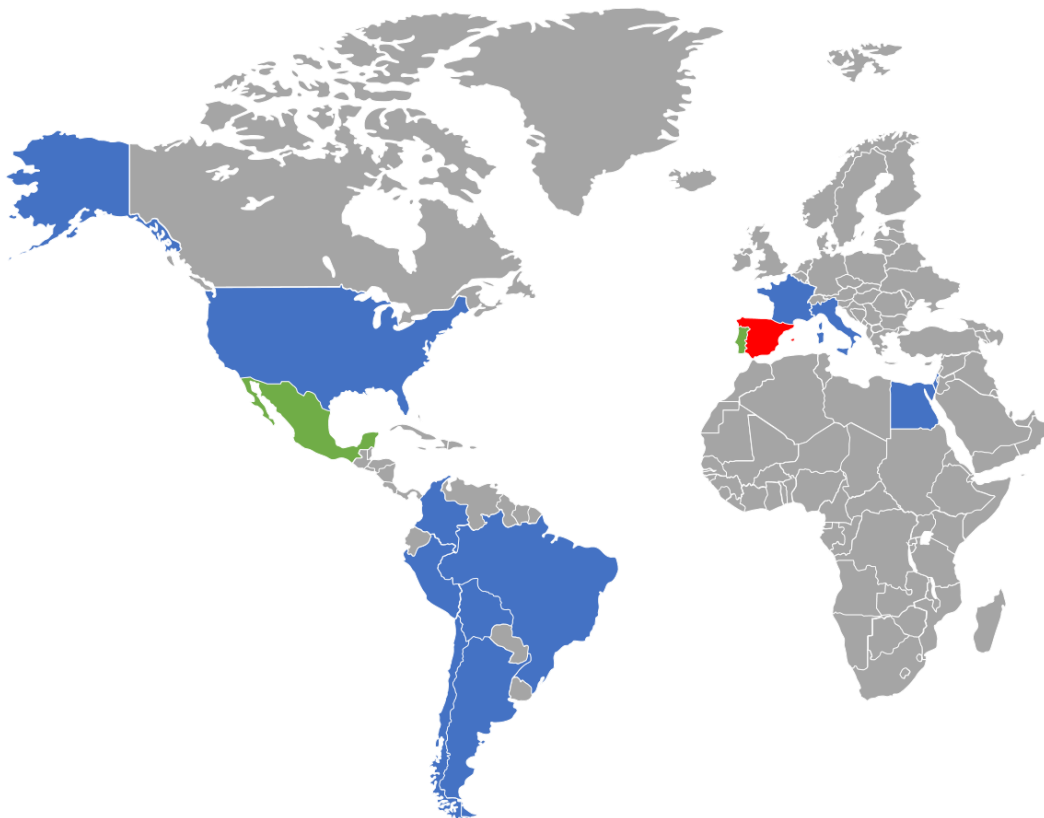


Figure 2: Countries directly influenced by RECI

Aside from RECI's activities and international display, the international interest has in many cases, emerged from the attention that several Spanish cities have received from their active role in international projects and organisations. These activities date back more than ten years, with some cities like Barcelona having participated in European projects related to smart cities, back in 2002. These projects have mainly been related to European Union Research and Innovation Programmes, such as CIVITAS (2002 - 2016), Framework Programme 6 or FP6 (2002 – 2006), FP7 (2007-2013), and the most recent Horizon2020 framework programme (2014 2020). These projects, initially oriented towards energy efficiency and clean transport, have evolved towards smart city projects with a global scope where several Spanish cities act as European models or *lighthouse cities*. As a result of the participation of these cities and many Spanish companies, university and research institutes; Spain now tops the participation rank in terms of European smart city projects.

Also at European level, many RECI members are active participants or coordinators in other initiatives such as the Covenant of Mayors, which seeks a reduction of 20% in CO₂ emissions in European cities by 2020. RECI also partakes in the European Innovation Partnership for Smart and Sustainable Cities (EIP-SSC), which was conceived as a marketplace for cities, universities, companies and other smart city stakeholders who wish to collaborate in different smart city initiatives, under the umbrella of the six different working groups. In the Covenant of Mayors, Spain ranks second after Italy in terms of the number of participant cities, with 1,454 signatory cities representing 27,101,765 citizens (63% of the Spanish population).

A direct consequence of this remarkable European level participation is the important contribution made by RECI's members as they become more influential and continue to share knowledge. This model constantly benefits other Spanish and international cities who continue to seek advice from the further advanced smart city participants.

RECI as a knowledge and best practice sharing platform – a normalisation preamble

Smart city development is intrinsically related to new paradigms such as 'Internet of Things' (IoT), Cloud Computing and Services, and Big Data Analytics. Despite the fact that these emerging technologies are in their early developmental stages, the expectations about how they can empower smart cities are rising on a daily basis. However, taking the current IoT market as an example, there exists an already formed, complex environmental structure which is cluttered by the many levels of stakeholders, from platform developers to applications, as it is shown in Figure 3. The complexity of this structure sets the stage for a difficult starting point, for any city trying to decide which IoT to choose from. Each city is tasked with making this risky decision which many impact their medium-to-long term goals. Poorly made decisions early on can limit the growth of the ICT city architecture due to lack of standardisation and compatibility known as 'silo technologies'. Previous studies carried out research on the cost of making the wrong IoT decision [5]. Its main conclusion was aspiring smart cities and their technology partners could squander \$341 billion by 2025, if they adopted a fragmented strategy as opposed to a 'standardized' approach to IoT solution deployment.

(APIs), shared among RECI cities, to replicate and adapt software applications locally –such as those linked to tourism. Two examples for consideration are Palma de Mallorca’s developments on tourist grounds and Madrid’s development on public traffic management. In the CMS all the documents shared are classified by type (i.e. document created for/by RECI, city success case, document shared by a city or company) and level of replicability (i.e. high, medium and low replicability). Currently, the CMS document count is at 275 documents (by April 2016), which are classified as shown in Figure 4.

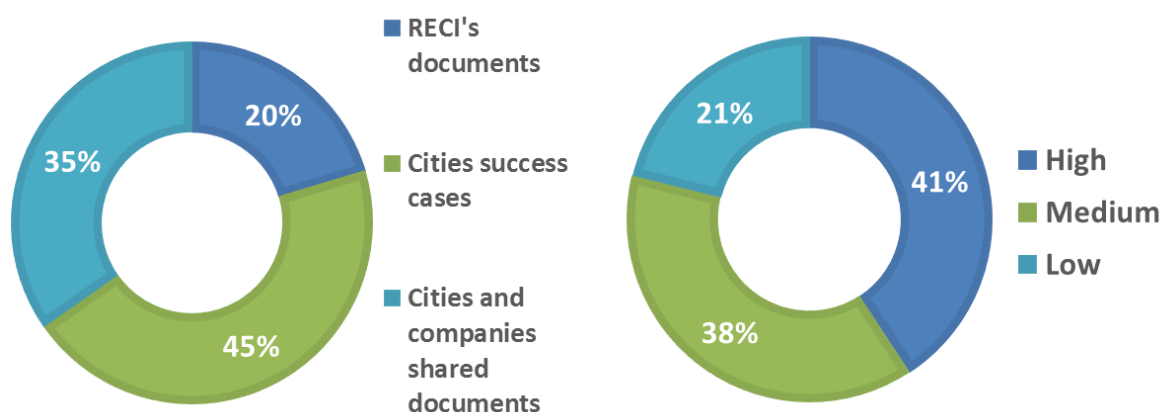


Figure 4: CMS content considering document classification (left) and replicability level (right)

Local managers are in charge of feeding and editing the CMS alongside ICT resources that might be further retrieved by other local managers. This collaborative work promotes the creation of innovative bidding for documentation among local governments of member cities. At the same time, it provides technical staff, civil servants and hired labour with a wide amount of information to employ in their local projects.

4. The Impact of RECI in the National and International Telecommunications Normalisation Panorama

In order to promote the complete interoperability between cities, a greater effort is required to record and share success cases and best practices among RECI’s members. In other words, official normalisation and standardisation mechanisms, encapsulating all the different aspects within the ‘smart city’ concept need to be established, so cities can utilise them as standard practice.

Following this objective, AENOR in collaboration with RECI, created in 2012 the Normalisation Technical Committee 178 for Smart Cities (CTN 178). This committee is divided into five subcommittees, as shown in Figure 5, are: SC1 – Infrastructures, SC2 – Indicators and Semantics, SC3 – Government and Mobility, SC4 – Energy and Environment, and SC5 –Touristic Destinations.

Through observing the division of sub-committees and then comparing it with RECI’s working groups division, the normalisation activities do not only focus on the vertical silos that form a smart city or ‘attributes’ but instead the first two subcommittees focus their activities on transversal fields. Such fields include the infrastructures that form the foundation of a smart city (e.g. ICT, water, energy, transport, waste, etc.) and the indicators that allow measuring the degree of evolution of a city in its smart enterprise.

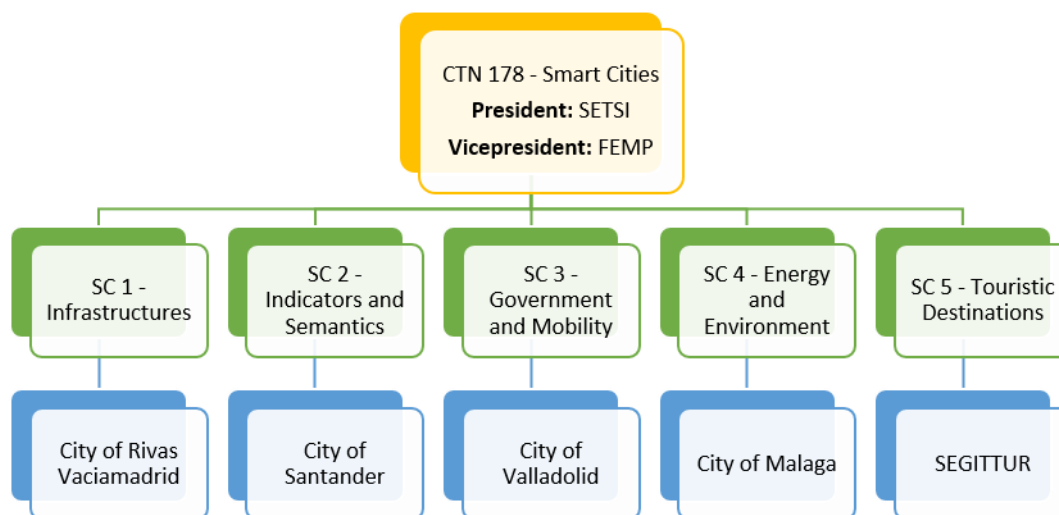


Figure 5: Smart cities Technical Normalisation Committee 178 structure

RECI plays an important role within this committee, since four of its chair members are also members of the subcommittees, with the exception of the Touristic Destinations Subcommittee which is chaired by the State Agency for the Development of Innovation and Touristic Technologies (SEGITTUR). Other important bodies involved in the CTN 178 are SETSI and the Spanish Federation of Municipalities and Provinces (FEMP), president and vice-president respectively of the CTN 178; representatives of several Ministries; and AENOR's technical normalisation committee 133 focused on telecommunications, more concretely its first subcommittee which is focused on infrastructures.

To date, the CTN 178 has published a total of 20 norms on smart cities, most of them in the area of infrastructures, with other 28 norms currently planned and already being developed as shown in Table 2.

For AENOR and RECI, ICT are the key elements for the development of cities since most of their infrastructures show an ICT nature. As illustrated in the table above, the normalisation subcommittee focused on infrastructures has notably been the most active group out of the five in terms of both published and under development norms. This leadership has been a direct result of two factors. Firstly, most of ICT-related normalisation topics, such as transport and access networks, fall into this category. Secondly, the relevant role of RECI's members play in the normalisation committee and their experience earned in the ICT field applied to smart cities, empowered by its own best practices repository or CMS.

Table 2: CTN 178 norms by August 2016

Subcommittee	Number of WG	Norms Published	Norms Planned or in Development	Total # of Norms
SC 1 – Infrastructures	5	13	18	31
SC 2 – Indicators and Semantics	3	3	1	4
SC 3 – Government and Mobility	8	2	4	6
SC 4 – Energy and Environment	6	1	4	5
SC 5 – Touristic Destinations	5	1	1	2
Total	25	20	28	48

These norms cover a variety of aspects which include the pure hardware aspect of the city telecommunications network and the metrics involved in measuring its efficiency and integration with the environment[6]; passing through the different parts of the core and systems that form the local multi-service telecommunications network, build upon an IP-based core and systems which host different types of applications and services[7], [8]; and the different access and transport networks, which carry out the communications among all the different elements of the city always considering the security and privacy requirements[9]–[14].

Apart from this complete set of norms related to the different parts of the ICT architecture within a given city, a different specific norm has been written to describe the ‘brain’ of a smart city, the ‘Integral Management System’, also known as ‘City Platform’ or ‘Urban Platform’[15]. It is considered fundamental that all services of a smart city are supported by a management platform which ensures the correct performance of these, together with its efficiency, security and scalability. In Spain, for example, cities like A Coruña, Santander, Madrid, Valencia, Malaga, Murcia and Barcelona are just some examples of cities that have begun the implementation of their own city platforms. Each of the above cities are members of RECI, however, far from choosing the same platform these cities have chosen different options: A Coruña and Santander have opted for the commercial platform Sofia2 from Indra[16], Valencia has opted for a platform based on the open-source middleware FIWARE[17], Madrid is currently carrying out a pilot with IBM’s platform IOC[18], and finally Barcelona has opted for developing its own open-source platform through the Sentilo project [19]. From this panoramic viewpoint which considers all the different technical requirements that a city platform should meet, interoperability is probably the most important one.

As cities in Europe are beginning to implement these platforms at an increasing rate proportional to the popularity of the *smart city* term, the need for interoperability among these platforms has been highlighted as one of the main requirements. An example of this importance is the Urban Platforms initiative within the European Innovation Partnership on Smart Cities and Communities (EIP-SCC)[20]. This platform looks for the best ways cities can manage the current explosion and sheer volume of city data. It also seeks to develop a better channel of communication, whereby, all relatable data can be readily and easily shared between city services, in order to improve outcomes for society. To achieve this objective both cities (demand-side) and companies (supply-side) are brought together to define common requirements and provide common open solutions respectively. The core city group involved in this initiative is formed by 24 cities which have signed a Letter of Intent (LoI) to set a common core of city-need-led requirements to support the acquisition of Urban Platforms. Out of 24 cities, 6 are Spanish and RECI’s members (Barcelona, Murcia, Valencia, Málaga, Zaragoza and Vitoria-Gasteiz); together with RECI itself, which acts as a network of cities. Each city must provide a record of their experience in RECI and AENOR, to support European standardisation activities.

Apart from the work carried out to normalise the different ICT parts which comprise the ICT architecture of a smart city, AENOR and RECI understand that the first step to design and build a smart city is to know what it really is. Due to the large number of stakeholders currently interacting within the smart cities world (local governments, service providers, citizens, public companies, private companies, etc.), a proportional number of definitions for a smart city have been already stated. Most definitions share some common key terms, but many differ in scope and also in the areas that a smart city should focus on. For this reason, establishing a clear and

universal definition for the smart city concept has been one of the first milestones for the Normalisation Technical Committee 178 with the creation of the norm “UNE 178201 – Smart Cities. Definition, attributes and Requirements”[21].

In this work, a total number of 116 different smart city definitions, with 750 occurrences of 50 terms considered key attributes where analysed. Among them, it was observed, that the most repeated term among all of them was “quality of life”; and the most popular category of terms was ICT, showing the key role of ICTs within smart city development. After careful analysis, the final smart city definition chosen by the normalisation committee was:

A Smart City is a fair and equitable city focused on its citizens which continuously improves its sustainability and resilience taking advantage of the available knowledge and resources, especially in relation with the Information and Communication Technologies (ICT), to improve the quality of life, the efficiency of urban services, the innovation and the competitiveness without compromising future needs in economic, governmental, societal and environmental aspects.

As detailed above, the significance of ICT within a smart city is highlighted in the definition. For this reason, this norm also establishes the ICT architecture of a smart city. This architecture is perceived as a complex set of components, functional blocks, hardware, networks, services and applications which interact with one another and massively influence the development of the city. In addition, this architecture must allow the progressive introduction of current and future technological trends and paradigms, such as IoT or Cloud Services as part of the architecture.

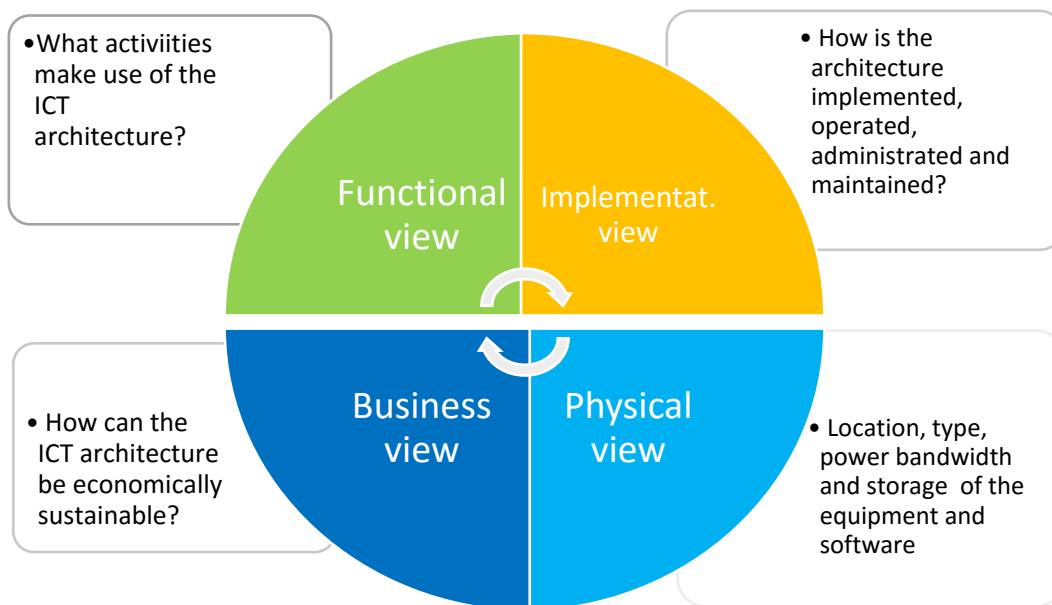


Figure 6: Architectural views of a smart city according to UNE 178201

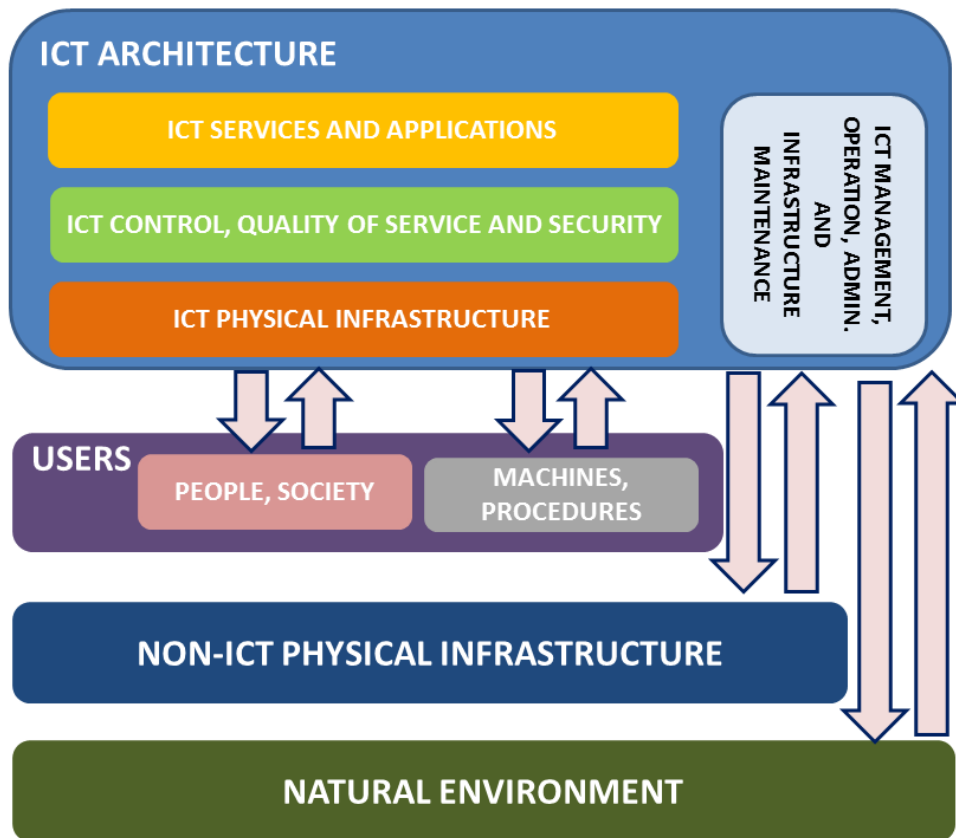


Figure 7: ICT Architecture of a Smart City According to AENOR and RECI

Despite the complexity of its components, an ICT architecture is perceived differently by the different city stakeholders, therefore, different conceptual views of such architecture are needed to show how the necessities of these stakeholders are solved. In this respect, the UNE 178201 adopts the same four ICT architectural views as the ITU-T Technical Specification “Setting the Framework for an ICT Architecture of a Smart Sustainable City”, with the exception of the Software View [22]. These four views are displayed in Figure 6.

In order to carry out the difficult task to represent the elements covered by each view in a single architectural model, a layer-based architecture approach, similar to the one proposed in [22] but with a different layer distribution, is proposed as shown in Figure 7.

This model is based on four layers: Natural Environment Layer, Non-ICT Infrastructure Layer, ICT Architecture Layer and Users. As detailed above, this system allows users (people, intelligent machines and processes) to establish communications such as machine-to-machine (M2M), human-to-machine (H2M) or human-to-human (H2H) among each other; to manage the non-ICT physical infrastructures; and overall, to consider the necessities determined by the natural environment of the city. Overall, this ICT architecture classifies and enumerates the different elements which other norms are individually focused on.

Finally, all these national norms have led to the recognition of AENOR and RECI’s work in the ICT applied to smart cities field by the International Telecommunications Union (ITU). This body is currently reviewing some of these norms in order to establish international technical recommendations. Furthermore, discussions are currently being held for AENOR’s participation in ITU’s Study Group on IoT and its applications including smart cities and communities (SC&C) [23].

5. Conclusions

By studying this successful reference case, this research contributes to academic literature analysing the successful governance and mode of operation of public networks, focusing on the case of RECI. This operational analysis of RECI has shed light on new trends in governance in cities. The work has made a contribution to the literature on governance in complex networks and on the conditions for network performance.

The literature studying the conditions for success in shared-governance networks [24] claims that a network success depends on: 1) the importance of formalised coordination mechanisms; 2) formalised rules to increase the liability of decisions made; 3) well organised network meetings, contractual agreements and informal relationships; 4) contracts with partner organizations that are also key to understand the performance of these networks. The analysis of RECI successfully confirms the existence of these conditions, as extensively described in this article. Such conditions are also extended to the relationship and influence over other stakeholders, such as the national government and standardization bodies.

The case analysis in [25] shows a successful mode of operation for experience exchange. The local governments obtain different benefits from their network participation gaining synergies and efficiency in their operations. This replicability has already led to important savings in terms of contracting services and staff development.

Furthermore, municipalities have a limited power to influence wider decision and policy making. RECI is an example of a well organised network, capable of configuring future policies in local administration, necessarily related to efficiency, digitalization and citizen centricity and with key topics to build the future (such as social innovation or environment). The network establishes a strong peer-to-peer collaboration with national and supra-national government and also manages to influence the normalisation of smart cities procedures and technology usage, as a way to guarantee that their action and projects will be followed by other local administrations, with a clear purpose of reinforcing their own strategies and plans.

In addition to the political component established in this paper, the function of the RECI network as a powerful marketing tool for the participants with an avant-garde positioning in technologies and development that is clearly observed.

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