

**POSITIONING ALBACETE IN THE EUROPEAN CONTEXT OF SMART CITIES: AN ENERGY AND ENVIRONMENT STUDY ACCORDING TO ISO37120**

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**Abstract.**

Smart cities have emerged as a key and strategic concept towards the development of sustainable and user friendly cities. Towards this end, the use of novel information-and – communications technologies should set the basis on developing solutions enabling a better use of resources while improving a wide spectrum of services. Furthermore, smart cities should also provide new business and employment opportunities to their citizens. Even though, a large number of cities around the globe have already joined one or other smart city initiative, many medium and small sized cities are still struggling to find their way on setting their priorities and defining their agenda. The development and investment on novel smart city solutions requires a careful analysis of the strengths and weaknesses to establish a strategic plan. Furthermore, the contribution of research and educational centers should prove of great help not only on the analysis of the current situation, but on the training of professional capable of contributing on the development of novel solutions. In this work, we follow the indicators in iso37120 in order to set a starting point on the smart city agenda of Albacete: the largest city of the Castilla-La Mancha region, Spain. We focus our attention on the energy and environment indicators: two strategic sectors on our region. In order to better diagnose the status of the city of Albacete, we graphically compare the results of our analysis with respect to other european cities whose data are reported in the world council on city data open data portal.

## 1. INTRODUCTION

Current estimates predict that the world urban population will double by 2050. In order to properly manage large-scale urban areas, there is a strong demand for smart sustainable environments capable of reducing the human activity impact while ensuring a high quality life for all. It is within this context that Smart City initiatives are underway. Due to the need of involving all stakeholders, various national and international organizations have published various documents with the main aim of setting a common language and a set of standards to be used by leaders and innovators.

Towards this end, the British Standards Institution (BSI) published a document compiling the basic Smart City vocabulary, namely the PAS 180 Smart City Vocabulary [1]. According to this document a Smart City is defined as the effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens.

Nowadays, most major cities around the world are very actively involved on the development and deployment of innovative services. On the race towards the development of smart sustainable cities, many small and medium-sized cities are struggling on exploiting the great potential of the numerous funding opportunities offered by different national and international organizations [2][3].

In this study, we argue that the success of Smart City initiatives will depend very much on the degree of involvement and participation of all stakeholders. In fact, we make a case for the participation of regional innovation centers and universities as a key actor on the development of the strategic agenda of a Smart City. Many universities and regional innovation centers across the world play a major role on the society and economy of many medium-sized cities. Further to the fact that many cities greatly benefit from the service demands of the student population, the large and wide number of information and communications applications are evolving and penetrating into the market at a great pace. Many young entrepreneurs are making their way on the design and deployment of services with a great social and economic impact.

In this study, we briefly overview the current status of the city of Albacete, the largest city of Castilla-La Mancha with a population of 170.000 inhabitants, located in the south-east of Spain. Albacete, as many other small and medium-sized cities throughout Europe, is already involved in various initiatives. In fact, Albacete makes already part of the National Network of Spanish Smart Cities: a national networks grouping the large majority of Spanish cities [4][6]. Since our main aim is to highlight the great benefits that our university and regional research center as contributors to the Smart City agenda, we focus on the energy and environmental. The rationale for this choice is twofold: 1) Albacete has made a priority these two activity sectors; and 2) the regional university counts with numerous research centers and faculties centered on these two sectors.

In the sequel, the paper is organized as follows. In Section II, we review the most relevant initiatives and standards in the area of Smart Cities. We justify our choice on using the indicators defined by the ISO37120 Standard as starting point [7]. Section III is devoted on assessing the current status of our city and illustrating its placement within the context other European cities whose data are publicly available in the World Council on City Data Open Data Portal [8]. Section III summarizes a set of recommendations to be undertaken by the local authorities in close collaboration with other major players. We also discuss the

role that our university community could play in the Albacete Smart City agenda. Finally, some conclusions and future work are outlined in Section V.

## 2. ISO37120: SUSTAINABLE DEVELOPMENT OF COMMUNITIES – INDICATORS FOR CITY SERVICES AND QUALITY OF LIFE

In this section, we overview the major initiatives and standards related to smart cities issues. We then focus on the ISO37120 Standard as the starting point on assessing the level of maturity of our city on its Smart City agenda. We primarily focus on the energy and environment indicators.

### 2.1. INITIATIVES IN SMART CITIES

As already stated, many worldwide Smart City initiatives are underway. Public and private organizations are actively developing their agenda and business plans. Within the later, high-tech companies with a long tradition in the information age have published their own vision in the worlds Smart City. Many of these private organizations, such as IBM [9], Toshiba [10], regularly organize development solution contests in an attempt to attract talent and position their underlying technological development solutions. This is the case of the Smart City challenge annually organized by IBM [11]. The success of such events is a clear evidence that the involvement of young talent teams may greatly contribute to the development of innovative applications. Other organizations, such as the IEEE, are also currently engaged on the use of novel technological solutions based on standards: a must to ensure the interoperability and wide acceptance of a technological solution [12].

Complementary to the technological solutions proposed by the aforementioned organizations, other initiatives are addressing the regulation side of what a Smart City should be. The BSI has published the PAS 180 and PAS 181 whose main goal is to clearly spell-out a common language and a set of smart-city metrics [13]. Other major initiatives are the Global City Indicators Facility [14] and the European ranking of Smart Cities [15]. In general, when talking about Smart Cities, the previous initiatives focus their efforts in the characteristics show in Figure 1.



Fig. 1. Characteristics of a Smart City

Although most initiatives share the common goal of defining, analyzing and assessing every aspect of a smart city, current rankings widely vary on their approaches or methods [16].

## **2.2. STANDARDS RELATED TO DIFFERENT ASPECTS IN SMART CITIES**

To regulate the different aspects related to Smart Cities, it becomes critical that all the actors involved in their development will follow the same rules or criteria. Those criteria are established by the standards. In this sense, the International Organization for Standardization (ISO) plays a major role. In fact, several ISO committees responsible are actively involved on the specification of a set of international smart-cities standards. In this section, we first briefly review some of the most relevant standards to our efforts on assessing the energy and environment indicators of our city [17].

When talking about sustainable communities, ISO created the technical committee ISO/TC 268 called Sustainable Development of Communities. Under this committee, ISO has developed different standards: ISO 37101 related to management systems, ISO 37120 related to global city indicators and, in a near future, ISO 37151 for smart infrastructures. All these standards unify the performance when talking about smart cities, over all taking into account the amount of initiatives to evaluate smartness.

Regarding the environmental sustainability and energy efficient buildings, ISO has developed a set of standards that represent the state-of-the-art International Standards in this field. To carry out this purpose, ISO created both ISO/TC 163 and ISO/TC 205 Technical Committees. ISO/TC 163 and ISO/TC 205 collaborate closely in the following issues: Heating, cooling, lighting, ventilation, domestic hot water, appliances. As a result, a set of standards have been developed or are in progress. For the purpose of this paper, ISO 16343 becomes relevant dealing with Energy performance of buildings - Methods for expressing energy performance and for energy certification of buildings. In the particular case of a home, there are many ways to make it more energy efficient. Trying to unify criteria, ISO/TC 205 created ISO 13153 standard. Another important committee related to energy issues is the ISO/TC 257 which is actively involved in developing the basic standards for determining energy savings in projects, organizations and regions; and providing effective tools, including quantitative methodologies. The effort of this technical committee will be materialized in the ISO 17741, ISO 17742, ISO 17743 and ISO 17747.

At a national level, the AEB/CTN 178 Committee consisting of the Spanish Standardization Committee (AENOR [18]), Spanish Network of Smart Cities (RECI) and Spanish Federation of Municipalities and Provinces (FEMP [19]), has adapted the international standards related to smart cities in order to develop the National Plan of Smart Cities as a basis to boost the transition of Spanish cities to address the new challenge of XXI century based on the sustainability, the energy efficient, etc according to the roadmap 2050 [20].

All this standards are summarized in Figure 2.

## **2.3. ISO37120 OVERVIEW**

The ISO37120 defines and establishes the methodologies for a set of indicators to steer and measure the performance of city services and quality of life. The standardization provides a consistent and comparable set of metrics over time or across cities. The standard has been developed by the ISO/TC268 from a subset of the Global City Indicator Facility, and was released in May 2014.

The indicators and associated test methods in this International Standard have been developed in order to guide cities on the following tasks:

- measure performance management of city services and quality of life over time;
- learn from one another by allowing comparison across a wide range of performance measures; and,
- share best practices.

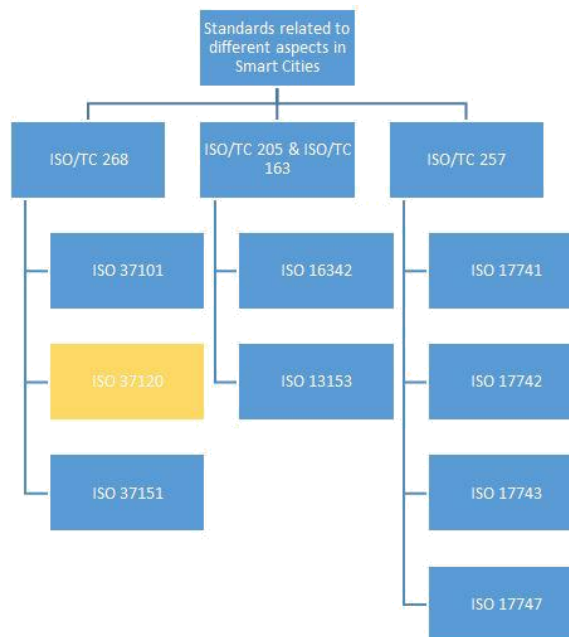


Fig. 2. Standards related to different aspects in Smart Cities

The indicators are structured around themes. Recognizing the differences in resources and capabilities of cities world-wide. The overall set of indicators for city performance has been divided into core and supporting indicators. The core indicators refers to the set of requirements while the supporting to a set of recommendations. In the ISO 37120 Standard own words, core indicators are required to demonstrate performance in the delivery of city services and quality of life. Supporting indicators are recommended to demonstrate performance in the delivery of city services and quality of life. ISO 37120 practically addresses all services offered by the municipalities and the impact on the quality of life. They are regrouped in seventeen topics: Economy, Education, Energy, Environment, Finance, Fire and Emergency Response, Governance, Health, Recreation, Safety, Shelter, Solid waste, Telecommunication and Innovation, Transportation, Urban planning, Wastewater and Water and Sanitation. The indicators for more than 250 cities across the globe can be found in the World Council of City Data portal [8]. The portal also includes a profile of every city registered in the portal. Furthermore, the portal offers a set of service to interactively visualize and compare the data of all the member cities

### **3. ASSESSMENT OF ALBACETE ACCORDING TO THE ISO371200**

Albacete is a medium-sized city located in south-eastern Spain. The total city population is of 172:000 inhabitants, representing the 43; 45% of the regional population and living in a city land area of 1125; 91km<sup>2</sup> and a population density around 153 persons/km<sup>2</sup>.

Traditionally, the main productive sectors are: agrifood companies (wine and Mancha cheese), cutlery, chemical industry and footwear industry. In 2008, the regional government launched a set of initiatives to make of the Albacete province the second major producer of renewable energy in Spain. Furthermore, the regional university was granted the status of Excellence Campus in the areas of Environment and Energy Sciences and Technologies. It is worth to mention that various research institutes of the regional university have a long tradition in those two areas. In fact, numerous researchers collaborate with worldwide institutions and national industries.

Since one of our main focus is to assess the current status of Albacete as well as to verify its standing within the European context, we carry the analysis using the data available for in the World Council of City Data portal. In particular, we picked the following European cities whose data are available in the portal: London, Barcelona, Amsterdam and Valencia.

As already mentioned, in this study we have taken into account only those ISO37120 indicators related to energy and environment. In particular, chapters 7, 8, 16, 19, 20 and 21. Note that not all the indicators have been considered because at the time of writing this article, not all the data were available for all the four aforementioned European cities.

Notice, that yellow rows represent those data with a significant difference amount the cities. Figure 1 shows a graphic with the considered indicator where the number 1, 2, 3, 4 and 5 represent the cities of London, Barcelona, Amsterdam, Valencia and Albacete. To compare the different indicators it is necessary to standardize the values. Then, following the methodology employed, the comparative analysis is reported in terms of the variance because easily shows the deviation of an indicator in one city with respect to the rest of cities.

### **4. RECOMMENDATIONS TO LOCAL GOVERNMENT**

The city of Albacete has started the road to become a smart city [5]. Since 2008, Albacete is carrying out a set of initiatives in the area of energy and environment. These initiatives have been coordinated through the Agenda 21 local project and the ESIMEC European project focused on increasing green zones, underground containers, noise maps, control of pollution and air quality, audits of energy efficiency in public buildings. The indicators are invaluable tool on assisting the local authorities to evaluate the impact and benefits of actions carried out.

Figure 3a depicts the results of the comparative analysis of the indicator on Energy (electricity) consumption of public buildings per year (kWh/m). The figure shows excellent results for the energy consumed by the public buildings in Albacete. This result clearly shows the great results obtained in rationalizing the energy consumption of public buildings. In fact, this one was one the main goals of the aforementioned projects carried out by the municipality. The local government invested a lot of resources on the acquisition and information campaigns among its employees. Nowadays, the local gov-

ernment is focusing on extending this initiative to the public within the framework of the ROADMAP 2050 project. The university is also actively collaborating with the municipality through informative campaigns among the student population.

Figure 3b depicts the results for the Percentage of Total Energy derived from Renewable Sources indicator. Once again, the results reported for the city of Albacete are very good. As already stated, the Albacete province is the second major producer of renewable energy in Spain. The results under this indicator show a remarkable trend on replacing fossil energies by renewable energy. However, the latest changes on the national policy with respect to the use of renewable sources of energy may affect this trend.

Figure 3c shows the results for the Particulate Matter (PM10) concentration indicator. As seen from the figure, the value for this indicator is very high, i.e., the level of pollution is quite high. This result may be mainly due to the lack of green areas. In fact, Figure 3g shows that the green areas per 100000 population indicator is very low. In fact, London exhibits great results on this indicator while other Spanish cities, Barcelona (number 2) and Valencia (number 4) report similar result to those obtained by Albacete. Other main reason for these results may be due to the poor transport system of the city. Here, one of the main recommendations to be made to the local government should be in increasing the green areas and transport systems. This may include the development of cycle routes.

Figure 3d and 3e show the NO<sub>2</sub>(nitrogen dioxide) concentration and O<sub>3</sub> (ozone) concentration indicators. These results were expected since Albacete does not count with a large concentration of transport or heavy industry, such as cement and combustion plants and incineration facilities. The closest chemical facilities are located at thirty kilometers from the main urban area.

## 5. CONCLUSION AND FUTURE WORK

Albacete is at the starting point of its way to become a Smart City. It has already launched some initiatives, projects or actions. From the seven indicators examined in this work, two of the environmental indicators, namely the concentration levels of particulate matter, the management of solid waste, have unveiled some serious deficiencies related to environmental issues. Among the actions to be taken in order to fix these indicators, the need of a better urban plan including the development of green areas and bike paths may be required.

Other indicators, such as the concentrations of NO<sub>2</sub> (nitro-gen dioxide) and O<sub>3</sub> (ozone) exhibit good results. However, these results are mainly due to the absence of heavy industry and not to good environmental policies. In contrast, the city unemployment rate is quite high 21%. In order to meet an acceptable pint in all counts, a cross examination of the pros and cons should involve the participation of all actors. In this analysis, the university may play important role by suggesting innovative solutions, such as the development of sensor-based solutions enabling the real-time monitoring of various parameters. Furthermore, the involvement of urban planning specialists and policy makers will provide a global answer to the pressing management matters of the city.

Our analysis has also shown the good results in areas related to the percentage of total energy derived from renewable sources, as a share of the city's total energy consumption indicator. These results clearly show that the Albacete province has greatly benefit from the deployment of windmills and photovoltaic plants. Other initiatives focused on reducing



the energy consumptions in buildings recognize the great efforts and investments having done by the local government.

However, the local government still has a long way to make of Albacete a competitive smart city. A strategy plan should involve all stakeholders. The authors argue that the university and its associated research centers should be called to contribute to this task.

It may seem unfair having compared Albacete with some major European cities, such as London, Barcelona, Amsterdam and Valencia. However, at the time of writing, the amount of data made available by other European medium-sized cities was rather limited. Our immediate research plans include a comparative evaluation of Albacete with respect to other European cities of similar size following the European model described in [15].

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Fig. 3. Indicators considered in this study.