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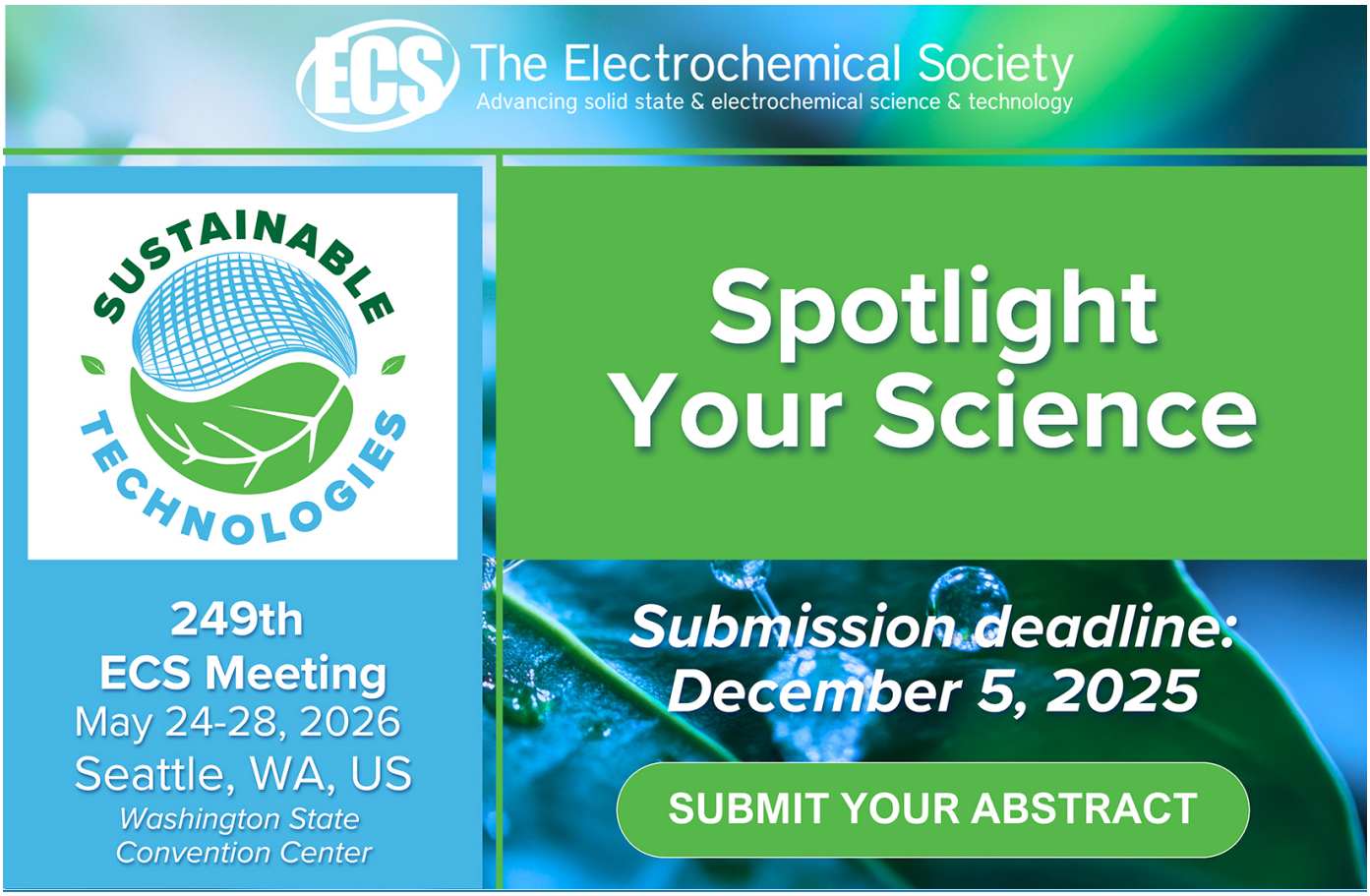
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Development of computer systems for urban mobility

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Abstract. The growth of cities generates displacement problems that need to be regulated and streamlined. An intelligent city uses technology in favor of citizens, automating everyday processes, through the use of electronic devices that capture, transmit and process information that allows them to make decisions, in the search to improve the quality of life of human beings in harmony with natural resources. This article presents a review of the research at the bibliographic level of the smart city concept focused on the urban mobility axis which allows knowing the technologies and processes of transition from conventional mobility to intelligent mobility where the actors of a city like vehicles, pedestrians are involved and public areas guaranteeing development and evolution in citizen services.

1. Introduction

The development of cities is generally conceived in the investment at the level of technology and tools that give the inhabitants new management opportunities to improve their quality of life, to gradually achieve the transition from a conventional city to a smart city [1]. The conservation of natural and urban resources is a topic of great interest worldwide, governance strategies are sought that provide cities with opportunities for quality of life and services focused on improving the social environment. The concept of smart city tries to apply methods to make the urban environment more efficient, effective and sustainable responding to the daily needs of citizens [2].

The growth of the urban population, the transformation in the habits of life have caused in the cities great changes that force the government to look for strategies to face challenges and unexpected changes that must give solution and not create an imbalance in the way of life of the citizen [3]; the cities that achieved development in factors at the social level provide their inhabitants with quality of life, proper management of the environment and investment activities and developing [4,5].

Smart city projects group six major factors called axes: smart mobility, smart environment, smart government, and smart economy, smart people, smart living. Particularly, smart mobility makes the city sustainable, the integration of information and communications technology tools (ICT) allow the grouping of adequate factors to support the development of the daily life of citizens, managing to meet the needs at the level of mobility, some of them are worth highlighting: new mobility infrastructure, optimal public transport, parking systems, soft mobility, shared mobility , electric mobility, information services at the mobility level, mobility platforms, technological tools and mobile products; these allow the urban mobility system, the environment and access to the community to improve [6].

The information generated in a city can be used to support the decision-making of electronic devices that can regulate traffic or provide advice on a less congested route. Also, digital image processing can be applied in the detection or assignment of reprimands for noncompliance with traffic regulations [5,6]. The innovation that imposes being a smart city generates services including smart mobility, where

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operation projects are developed that integrate all citizen management capabilities and will consolidate a strong city that responds to the processes of evolution and changes over the years. This research explores the concepts of smart city, smart mobility and complementary topics; It starts with some definitions and then goes deeper into the scientific advances that seek to improve the quality of life of citizens affected by living in more populated and congested places.

2. Methodology

The literature review was conducted on keywords such as: Smart city, smart mobility, internet of things (IoT), sustainability, citizen services, in electronic databases, such as: IEEE Xplore digital library, Association for Computing Machinery digital library, ScienceDirect, Scopus and Google Scholar, resulting in scientific articles that explicitly described issues related to smart mobility and the factors that affect the evolutionary processes of conventional mobility. The development of this research relied on the systematic tracking of literature; using search strings, in database engines. The selection of the articles was made starting with the contextualization of the title, summary, and keywords, resulting in 207 articles. Then a pre-selection process was carried out taking into account the fulfillment of the research parameters where smart city was described, focused on the mobility axis, leaving 134 articles and finally the final selection, 50 focused on capture and processing of information on pollution produced by vehicles or improvement in automatic decision making based on intelligent transport systems. The discarded articles describe conceptualization in general of the subject but no real actions were proposed that are a point of reference in the subject of study, the selected articles allow to identify the factors and characteristics such as innovation at the technological level, sustainability, environmental, citizen security, efficiency and organization of mobility systems that allow exchange actions in a conventional city.

3. Results

In this literary investigation as final result articles were obtained from 2006 to 2019; having as a period of growth in this subject the years 2017 and 2018, where important studies on smart mobility are concentrated [7,8].

3.1. Smart city

It allows the implementation of technological tools and platforms for the benefit of citizens providing quality of life, security and the provision of services with reliable and quality innovation models [9-11]. The literature refers to smart city to those areas that are a source of development and its objective is the management of resources offered in cities with the implementation of IoT technology and with the governance of citizens. smart city uses technology, machine learning and big data integrated in an IoT solution for capturing, transmitting, processing and making decisions based on the huge amount of data generated in a city [12-15]. The definitions to contextualize a smart city show similarity and it is concluded that it is a city that implements the use of ICTs with the sole objective of providing citizens with the quality of life [16,17].

Smart city addresses models and applications that allow a real-world fusion to data environments and technology simulation networks; software engineering allows the use of applications that through the cloud provide the opportunity for communication [11], software platforms allow the development of services for Smart city strategies [6]. These technologies incorporate large infrastructure that allows IoT devices to be implemented, which carry out data collection actions for the scenarios of cities that project the transformation of their traditional to intelligent environments, implementing techniques such as data mining, routing protocols [15], software platforms which develop and support services in a Smart city [3]. Methodologies, applications and technological services are the drivers for the creation of smart environment initiatives in cities to be materialized and implemented, achieving a change in the perspective of life in urban areas, converting more sustainable environments, with greater and better management of natural and technological resources to provide better quality of life to the inhabitants.

The smart cities finally allow an analysis and modeling of the actions to be carried out to give effect to the technology, information and communication, electoral, energetic and social strategies that allow quality of life and work [16].

3.2. Smart mobility

Smart mobility literature assumes that it is a definition of technology focused on the development of transport systems, services, and actions [18]. The increase of the urban population has generated socioeconomic changes and opens the way to the transition from traditional mobility systems to intelligent mobility systems, this change always has a positive approach prioritizing the provision of services to citizens [19]. Traditional mobility presents difficulty in different fields, massive use of cars, which generate vehicular congestion, at the environmental level high levels of pollution and the human level with health problems and sedentary lifestyle [20]. Smart mobility covers not only aspects related to infrastructure or road design, social strategies that educate and help citizens adapt and implement changes to existing systems are also implemented [21].

Smart mobility, is one of the main sustainability alternatives so that cities can achieve the goal of conversion to a smart city, which provides a better life opportunity for its inhabitants; it is focused on the use of ICT, in urban mobility systems with the support of tools and devices that, together with intelligent mobility strategies, allow consolidating actions to reduce the levels of environmental and auditory contamination, control vehicle congestion, consolidate plans for security, effectiveness and efficiency of information transfer and cost reduction [22]. That is why smart mobility, with the incorporation of ICTs, has an opportunity for integration and complement, evolving together government and technology [7,23]; by which ICT are fundamental for the management of the implementation and consolidation of a smart mobility [24-28]. Smart mobility describes significant life changes framed in the provision of transport services in which mobility needs are met and work is done in an environment-friendly environment [29,30]. Cities currently experience large-scale problems and must face mobility situations due to the increase in the urban population, the use of individual means of transport and poor mobility practices [31,32].

Smart mobility is a complex issue from which different factors derive, with IoT integration with technology and communication platforms that allow offering optimal mobility options for citizens [33]. This becomes the main aspect for the transition from a traditional city to an intelligent city framed in the axis of mobility.; It is reflected how a smart mobility must face challenges and turn its current actions towards sustainable, multimodal, inclusive, non-motorized mobility, without traffic congestion and pollution reduction [34,35]. These can be defined as transformation dimensions which are described below.

3.2.1. Sustainable mobility. It is mentioned in the vocabulary of the European commission of the year 1992, in the green book on the impacts of transport on the environment. It can be defined as actions focused on guidelines for change towards an effective system where mobility systems, environmental resources and the quality of life of citizens are combined. These actions achieve transformation in the forms of travel and transport systems, it is a change of the urban mobility model towards appropriate actions for the well-being of the environment and the population [36,37]. The means of transport are located at a very important point about the means of sustainable mobility [38]. The process of conversion in traditional mobility environments to sustainable ones is a factor proposed by smart city [39]. Climate changes have been generated largely by carbon dioxide emissions, gases such as nitrogen oxides, coarse and fine particles. The actions for the reduction and use of these pollutants aimed at improving the environment and the health of citizens are geared towards mobility without pollution agents [40,41].

3.2.2. Mobility included. It is mobility that is accessible and adapted to all types of users without the restriction of age, gender, physical, economic and/or cultural capacities [42], this mobility allows people with physical problems to travel in different geographical spaces without difficulty [43].

3.2.3. Multimodal mobility. It is the combination of several forms of mobility that allow creating fluid networks of displacement towards the same path contributing to the efficient and effective use of the means of transport [44], this type of mobility allows it to be used more than one mode of transport in the same trip [45], can also be defined as intermodality [46]. With this type of mobility, a process is sought with intelligent technological tools that manage online databases and optimize the logistics of means of transport in cities [47].

3.2.4 Non-motorized mobility. The use of means of transport to reduce costs and damage at the environmental level is to mention non-motorized mobility; that is to say the displacements and ways of mobilization where the driving force is generated by the human body [48]. This mobility is characterized by two main pedestrian and vehicle actors without motor use [49]. This mobility allows factors to be minimized at the energy level, accidents and at the level of quality of life [50].

The implementation of these dimensions and their actions allow Smart Mobility to provide citizens with more sustainable services, with improvements in the urban and energy environment and also allow it to be defined as mobility of services with human quality [51].

Globally, research and implementation are developed to guide cities towards the transformation of their mobility [52], in European countries strategies are created to offer sustainability, improvement and environmental conservation systems, transport systems with the use of ICT tools which are sources of security for citizens and strengthening at the level of competitiveness. Models of sustainable mobility, the interconnection of sustainable and intermodal transport [53], strategies of environmental conservation [54], conservation of natural resources that allow harmonizing means of transport and green areas [55]. It is noteworthy in Latin American countries such as Colombia, Brazil, Mexico, Chile, Peru [7,56], which can be implemented through actions that allow enhancing the efficiency of your mobility, with a sustainability approach, such as car- sharing and electro mobility [30,57].

4. Conclusions

The bibliographic analysis in this article was the analysis of smart city and smart mobility, where it was possible to explore the context of change in actions by implementing ICT tools and environmental protection actions. The era of IoT allows the creation of a vision of transformation and evolution in urban areas achieving the implementation of mobility strategies to provide citizens with the quality of life, efficiency, and effectiveness in the urban environment, with planned actions to environmental, structural and educational level.

The study made it possible to identify cities worldwide that have already implemented Smart Mobility strategies and the positive effects on changes in citizen activities generating sustainable development. Standing out 11 Italian cities that have implemented models focused on smart mobility; Santander, Spain, with the implementation of IoT tools to obtain real-time information on the state of vehicular flow and parking areas; London with intelligent parking systems; Colombia, Bogota traffic management center with road monitoring platforms and open data for web inquiries; Medellin pioneer in connectivity, content platforms and service communication aligned with digital ecosystems; database technologies, electronic tolls, passenger information systems and automatic and electric vehicle, integrated transport management and control system, all mobility axis implementations reflect the importance of governance in the technologies involved with ICT tools for the connection of data and provision of services to urban systems.

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