Concerns for city development: Explore the approach to smart cities

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Abstract. In 2050, the United Nations predicted that 70% of the global population would be living in urban areas, and such intense urbanization will mainly take place in developing countries. However, although living in cities improves the residents' quality of life, a massive urban population, bringing about a shortage of infrastructure and serious environmental pollution, will burden the society and government. In order to avoid these problems, the concept of a smart city, which takes advantage of advanced computer technology to make the city livable and sustainable, has been mentioned frequently for the last decades. This paper, intending to provide some directions for students of engineering, introduces one core technology used to construct smart cities and two aspects of smart cities.

Keywords: Component, Smart City, Information Communication Technology (ICT), Smart Transportation.

1. Introduction

It is a global trend that the population is progressively concentrated in a few megacities, which brings high productivity and economic benefits to cities. However, in accommodating large numbers of new citizens, governments face a tough challenge as a massive population also produces negative aspects such as traffic congestion, energy consumption, competition for resources, crime, etc. To address these difficulties, governments should seek new approaches to innovate the design of services and infrastructure, finance, and governance. Smart cities, which describe how information technology can function in the condition of growing urban populations, can be broadly seen as a solution. This essay will be divided into three sections to discuss how to build a smart city, including Information Communication Technology (ICT), community, and transportation, and analyze their current situation and future trends.

In most cases, the smart city is considered to be indistinguishable from digital cities, but in fact, diverse purposes can be used for differentiating between smart cities and digital cities. Compared with the digital city, which is data-oriented and determined to develop the economy, the smart city implies innovation and frontier and aims to build a sustainable city for mankind [1]. Therefore, the digital city should be regarded as the foundation for constructing a smart city. Moreover, as its abstract concept, the definition of the smart city has been various and controversial since it was proposed. Some scientists, who overemphasize its function and intelligence, put forward some exaggerated goals that are too tough to accomplish. For example, professors Albino et al. once mentioned that the smart city will govern

everything and build an environment with seamless experiences when sharing information and collaborating [2]. However, this paper recommends that the definition of a smart city should not be tough to start with and achieve, but it can provide some practical help in building a smart city.

A smart city is recognized by more and more people that it utilizes information and communication technology (ICT), which integrates various departments in the city, to create a sustainable city with high operational efficiency and convenience for residents. However, although cities urgently desire to be reformed, multiple obstacles still stand in the way of the transition to smart cities. Traditionally, cities operate as separate departments and many projects are established to solve some single problems, which causes inefficiency and confuses the fabric of the city [3]. In contrast, the smart city requests an integrated department system that allows effortless information sharing. However, the process of transforming from an inefficient structure to an ideal state requires a lot of investigation and financial investment. It means that the government needs tremendous determination and courage because the complex revolution and long process require the cooperation of all sectors and citizens.

2. Information Communication Technology (ICT)

In the early phase, ICT was defined as a technology that provides access to information through telecommunications, which includes the Internet, wireless networks, etc. [4]. At present, because ICT is based on the integrated development of mobile communication technology and Internet technology, scholars mostly deem that the common advantages of both technologies are integrated into it. Table 1 presents that various fields have applied this kind of technology to promote economic development and facilitate people's life. For example, the relationship between businesses and clients has been enhanced due to the existence of ICT because it makes information becomes more transparent, and transactions become more secure, which leads to a tremendous impact on the economy [5]. In addition, ICT has improved admittance to education and health care for people around the world by creating databases and building communication platforms. In the field of education, ICT promotes the development of e-learning, based on the network providing online courses and studying systems, and blended learning, which combines traditional face-to-face education and e-learning [6]. Professor Haluza and Jungwirth suggest that using ICT in healthcare can mitigate the surge in healthcare spending in an aging society, and it could play a role in predicting and preventing diseases [7].

Table 1. The application of ICT.

Medical science	Finance	Public governance	Education	Agriculture	Job opportunities
Electronic Case	Remote work	E-governance	E-learning	Digital Farming	Software Engineer
Telemedicine	Cyber Business	Digital services	Blended Learning	Market Access	Development Engineer
Mobile Health	E-finance	…	Disability Education	Early Warning System	Network Engineer
Practising Games	…		…	Safety and Traceability	Project engineer

Given that numerous organizations benefit from it, in what ways is ICT essential to the construction of the smart city? Collecting and analyzing data to predict and respond finally is the basic principle of the smart city. In fact, there is no shortage of data, which is constantly collected during urban and economic development, such as geographic surveys, censuses, market information, customer data, etc. [8]. However, despite the vast amount of data gathered, cities are still operating inefficiently on account of decentralized data and incomplete analysis. Digital infrastructure, which is the hardware layer of ICT including broadband, cable, etc., and data information processing, flexibly deal with personal data and information, as well as applications used to provide services to the public, can be seen as two types of tools for ICT pervading into intelligent cities [9]. In addition, internet technologies, allowing

information interchange between various departments, and powerful computer technologies, which offer the possibility to analyze all kinds of data in the city, are both involved in ICT, which means that using ICT in smart cities can well ameliorate this problem.

Ideally, ICT, counted as a technological basis, could build a huge information platform for smart cities, which can be regarded as an optimal integration of all the information that is available in various departments of cities. This approach, a system through which government officials can work and from which ordinary people and companies can get the information they want, will significantly facilitate E-governance. Besides, authentic and real-time information, which almost determines success, would be offered on this platform to the public, so it will also bring new opportunities to the business. However, arbitrary information access is not allowed on this platform, so the storage and management of data are particularly important. Each person should have their own authority to access public information, which is reasonably defined by the platform. In addition, this platform can empower citizens to have the right to have a voice and make decisions because citizen participation is considered a key element of smart cities [10]. Hence, the dissemination of information is essential to the platform because it requires frequent communication and interaction between individuals and groups on any device. Even though the ICT industry is currently a highly prospective industry for developing smart cities, there are still some drawbacks embedded in ICT, such as privacy issues. Privacy problems and information breaches may expose clients and companies to blackmail risks directly and invisible collateral damage. As a result, to have better ICT development, it is necessary not only to enhance the technology itself but also to pay more attention to information security.

3. Community

Cities are a combination of various infrastructures and the diverse communities that inhabit and utilize these infrastructures, and well-planned communities can streamline waste collection, reduce traffic congestion, etc. Shifting from building a smart city to building smart communities is a brilliant decision because it is impossible to build a smart city at once, even if all the details have been planned, and another fact is that newer requirements for smart cities may be raised during implementation as the technology matures. In order to solve complex social problems, the Japanese government proposed the concept of a super-energy society in 2016, which called for the digital transformation of industries and will also enhance the convenience of life by interconnecting everything through artificial intelligence and the Internet of Things. In addition, it stipulates that communities should take responsibility for improving the quality of human life, including the integration of energy, transportation, education, and intelligence, which can be applied to smart communities.

From a future perspective, should there be any metrics to measure whether a community is up to standards? Even though different cities have their own requirements for intelligence, smart communities should all be people-oriented, which are unified with smart cities, and they can serve humanity in multiple aspects [11]. In terms of infrastructure, a reasonable amount of green area and necessary ecological parks should be considered. In addition, a digital platform for the community should be established to manage and scheme the community and monitor the construction progress. In terms of education, compulsory education and equal educational resources are the basis of a smart community, and creating a digital education platform is crucial. In addition to online learning resources, the information on books from nearby libraries and bookstores, as well as real-time information on cultural events such as art exhibitions should be involved in this platform. In terms of healthcare, community health services can be joined with large hospitals for information exchange and remote treatment. In addition, the digital sports platform should not be neglected, and it should include information on gym and sports field rentals as well as real-time information on competitions, which can improve the physical fitness of the residents and further enhance the neighborhood relations, and then, maintain the stability of the community at the same time. Similarly, other fields of communities can be also combined with the internet, which will also lead to newer breakthroughs and gains. A more specific application of ICT to smart communities described in figure 1 is given by a professor [12]. Overall, digitization is at the

heart of making communities intelligent, which further confirms that ICT is the key to building smart cities.
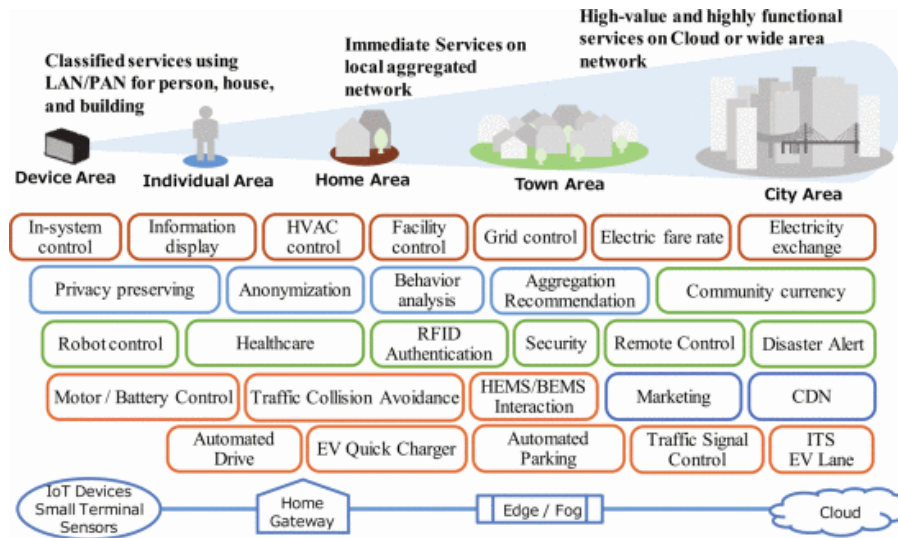

Figure 1. ICT applied in communities.

At present, since urbanization has reached a certain point, it is almost impossible to develop new communities to form a city, so the development of communities should focus on the rearrangement and renovation of old communities [13]. Government should choose those backward communities that are in desperate need of a facelift because it provides an opportunity to transform old communities while providing a pilot for building smart communities. However, the renovation process is arduous, as the problems inherited from the previous urbanization process have to be solved while re-planning for the construction of a smart community. In addition, how to arrange the population and companies in the old communities will also confuse the government. Admittedly, it is a painful process, but in order to own a more convenient and comfortable living environment, it is worth changing.

4. Transportation

Satisfying the rapid and efficient flow of residents and goods in cities has been a prerequisite for smart cities. However, due to the rise of e-commerce and population growth, transportation requirement expands but road development steps forward slightly. At the same time, many challenges exist in the traffic system, such as unreasonable road layout, inadequate road capacity, limited parking lots, etc. To address the challenges faced by the transportation sectors in energy consumption and traffic congestion, ICT, as the core of the smart cities, can be embedded with vehicles to regulate driver behaviour and improve driving efficiency, while also being applied in road networks to monitor and manage traffic more strictly. it is coincidental that intelligent transportation system (ITS), a combination of ICT and transportation infrastructure, is frequently worked in constructing smart transportation. In addition, as vehicle exhaust has been recognized as the main reason for global warming, energy, powering the vehicles, is required transit urgently. At present, electricity is regarded as the most feasible new energy to replace gas compared with other renewable energy, and electric cars are admitted by more and more people.

4.1. Intelligent Transportation System (ITS)

The demand for public and vehicular transportation is risen due to the rapid growth of the urban population, and the requirements for transportation capacity have gradually increased. Consequently, the current transportation system is difficult to meet people's demands for high-quality travel cumulatively. The exposed issues such as congestion, pollution, accidents, energy, and land

consumption are becoming more and more serious due to the increasing number of vehicles and the construction and widening of roads. To resolve such problems, the ITS, which integrates a wide variety of systems, binds ICT, sensors, and controllers with transportation infrastructure. It is constantly being updated with new concepts and innovations and supplies reformatory services and transportation management, which enhance traffic efficiency and relieve congestion.

Similar to the smart city, three crucial components, which are data collection, data analysis, and information transmission, are essential for ITS to execute its functions [14]. Figure 2 shows the operation process of ITS [15]. In the future, data collection technology, designed to assemble all observable information from the road network, can form a more complete detection grid when cameras and radio-frequency scanners are distributed throughout the transportation system [16]. The imaging and sensing technology can collect data for analyzing traffic across a city and some data can be used to help individuals in more detail. The clients will obtain the results of the real-time and personalized traffic conditions analyzed by the data from communications technology of smartphones, Global Positioning System (GPS), media access control (MAC), etc., and then enjoy a pleasant experience in driving and traveling. 5G technology and cloud platforms have taken over as the main method of information transmission, which intends to transfer the collected data to the centers for evaluation and respond to the information and management measures to the drivers and infrastructures. Information analysis utilizes a variety of mathematical models, which process various sources of data, in order to feedback on the current traffic and provide necessary measures.
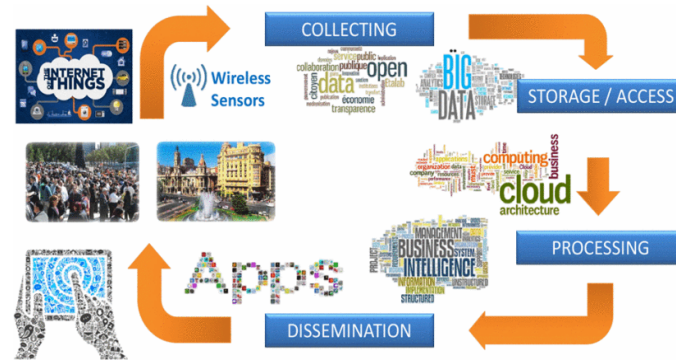

Figure 2. The ITS execution procedures.

Although it is still in a rapid stage of development, there are still many setbacks regarding the research and implementation of ITS. Firstly, due to insufficient funds and expensive sensors, the distribution of sensors is not enough to form a comprehensive urban transportation grid, and the low density of sensors will make the data inaccurate and unreliable as well. In addition, transportation infrastructure performance deteriorates over time and the maintenance costs are unacceptable. Secondly, the development of traffic models is in an awkward situation. In fact, there have been many traffic models proposed, but they are rarely applied in real transportation systems because of the gap between reality and theory. Moreover, with the popularity of self-driving cars and the Internet of Vehicles, a lot of computing will be generated, which means that new algorithms need to be proposed. At the same time, current models cannot adapt to future complex situations because their correctness cannot be verified, nor can they guarantee that they will work well in the future [17]. Overall, overcoming these difficulties can further improve its products, enhance transport safety and reduce pollution.

4.2. Electric Cars

During the process of constructing smart cities, the transition from traditional cars to electric cars has aroused heated discussions because driving an electric car is helpful to reduce car exhaust, which is one of the main pollutants of urban air pollution. Furthermore, due to the tight global oil reserves and the runaway greenhouse effect, it is inevitable that electric vehicles will become a trend. Electric cars use

electricity instead of oil, which greatly reduces carbon emissions and alleviates the oil crisis as well. In addition, compared to traditional cars, electric cars aid to decrease noise pollution, which can build up the life quality and comfort of cities. However, although electric cars seem common on the road now, leading people to believe that the industry is mature, in fact, there are limitations existing in developing electric cars.

Firstly, as some cities use coal-fired power generation, energy issues remain, which burdens sustainable development. Secondly, the lifespan of the battery, which mainly supplies the energy for electric vehicles now and almost determines their lifespan, is expected to be 10-20 years and it may be shortened when the weather is extreme [18]. Last but not least, electric vehicle charging is time-consuming and inconvenient. Currently, an electric car is charged mainly at charging stations, which can be seen as gas stations, and it takes at least half an hour to charge, which is too long for drivers used to driving fuel cars. In addition, because the number of electric cars is far less than that of fuel cars, so there are few charging stations relatively, and it is very difficult to find charging stations, which is one of the reasons why people refuse to buy electric cars [19]. In general, in the process of transitioning to electric vehicles, the government should generate electricity from clean energy, such as solar, wind, and water. While encouraging people to buy electric vehicles, companies can build more charging stations legitimately. Besides, issues that exist in electric cars urgently to be solved. For example, are there other improvements to electric vehicle batteries, how to increase the charging efficiency, and how to distribute charging stations properly in a city? As a result, it is very promising for scholars to enter the industry related to electric vehicles.

5. Conclusions

As of right now, the smart city can authentically be seen as the ideal solution to deal with intense urbanization, energy deterioration, and environmental pollution. However, even though the concept of the smart city has been widely recognized, its implementation is still hindered by high construction and management costs and people's concerns about privacy. What makes it preferable is that the concept of smart cities is still evolving, and new innovations and inventions are continuously being made to provide technological support for smart cities. Therefore, while developing smart cities faces some severe challenges and opportunities, it has a superior future with theoretical assistance and technological backing.

Smart cities aim to connect ICT infrastructure and various sectors of the city to improve operational efficiency and the quality of services for citizens. To meet people's demands for quality of life, smart cities will pay special attention to sustainable and efficient solutions for energy management, transportation, healthcare, etc. Smart communities, containing quantities of smart buildings and smart devices, are connected to various other systems to maximize the benefits of smart cities. Various communication systems and navigation systems have been applied in modern transportation so far. After traffic detection networks are developed completely, future transportation can ensure the convenience and sustainability of cities. At the same time, the transition to electric vehicles has contributed to the energy transition of cities as well. Although this paper only describes the most important technologies needed in the process of smart cities construction and the two aspects of their concrete implementation, in reality, the realization of smart communities and command transportation do not satisfy the requirements of smart cities, as they also need to involve more areas, such as smart healthcare and smart energy, to ensure the proper operation and use of urban systems.

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