THE ROLE OF ICT FOR DEVELOPING SMART CITY

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ABSTRACT: -

Smart society with smart cities and communities. An ICT-infrastructure handles data and information and encompasses devices and networks, protocols and procedures including Internet, Internet of Things and Cyber-Physical Systems. The current challenges of ICT-infrastructures are delivering services and applications that are requested by users, such as residents, public organisations and institutions. These services and applications must be combined to enhance and enrich the environment and provide personalised services. This requires radical changes in technology, such as dynamic ICT-infrastructures, which should dynamically provide requested services to be able to build smart societies. This paper is about pursuing smart and connected cities and communities by creating smart volatile ICT-infrastructures for smart cities and communities, called Ipsum. The infrastructure is of multidisciplinary art and includes different kinds of hardware, software, artificial intelligence techniques depending on the available parts and the services to be delivered. The goal is to provide a powerful and smart, and cost-saving volatile ICT-infrastructure with person-centred, ubiquitous and malleable parts, i.e., devices, sensors and services. Volatile means in real-time constitute a volatile network of devices and deploying it into cities and communities. Ipsum will be smart everywhere by collaborating with several different hardware and software systems and cooperating to perform complex tasks. The paper presents the partial results of the EU BlueSCities project [1]. The project is developing the methodology for the integration of the water and waste sectors within the 'Smart Cities and Communities' concept to compliment other priority areas such as energy, transport and Information and Communication Technologies (ICT). The project has developed the City Blueprint Framework for water and waste and the City Amberprint Framework for energy, transport and ICT

KEYWORDS: database, IoE, networking, open data, smart city,.

1. INTRODUCTION

To create smart cities and societies, Information and Communication Technology (ICT)-Infrastructures become increasingly important. An ICT-Infrastructure "encompasses all the devices, networks, protocols and procedures that are employed to enable ICT-technology and foster interactions amongst the different stakeholders. Commonly, an ICT-Infrastructure consists of ICT-systems, services, networks and systems in societal infrastructures, such as rails, roads, power, water, telecommunication and Internet. The ICT infrastructure includes a network of parts, i.e., more or less, smart and some mobile, devices, sensors, and services in the surrounding environment, e.g., Internet of Things (IoT) [1, 2] and Cyber-Physical Systems (CPS) [3-7]. By combining these, it is possible to create a high-tech society that augments human capabilities in the environment and enhances individuals' quality of life that can increase sustainability with accessible care, like health and elderly care. It is also possible to increase user experiences with extended awareness, perspicacity and participation and provide unique attentions and experiences, which can lead to extended safety in the society. Also, the combination can improve prosperity by being a part of smart connected cities and communities that include economic incentives to provide person-centred and, thereby, more sustainable decisions for the entire society. The term ICT-infrastructure is used as an overall name for all the computers and communication technologies involved in managing tasks in organisations. The ICT-infrastructure commonly refers to a range of technologies for services in organisations [8] including hardware, software, networks and implementation. The current challenges of ICT-infrastructures are developing dynamic ICT-infrastructures capable of delivering services and applications that are requested by residents, professional users and public organisations and institutions [9]. Since ICT and digitalisation are currently gaining dominant positions in companies and organisations, there is a growing need of services and applications that are combined to enrich the performances and provide smart personalised services. This requires radical changes in handling the parts in available infrastructures, necessary to provide the essential data and information, and hence become volatile, i.e., dynamic, virtual and digital ICT-infrastructures. This paper presents a smart volatile ICT-infrastructure that comprises person-based, smart ubiquitous malleable devices and services, called Ipsum. The Ipsum-infrastructure is a virtual dynamic infrastructure built on ordinary available ICT-infrastructures, which provides possibilities

to be smart everywhere by supporting collaborations between different parts, as well as co-operations to perform complex tasks. This includes identifying and utilizing hardware, the tools, with devices and sensors, and software, the algorithms, architectures and systems for the devices, sensors and services. It also includes networks, as well as human resources in different competence areas and end users. One may argue that Ipsum is equal to a volatile network but the contra argument is that Ipsum is much more than a network and includes hardware, software, networks and human resources since all are S1Q to fill the needs, carry out tasks and provide smart services. The aim with Ipsum is provide the opportunity to create smart cities and communities based on personal needs and requirements. Ipsum includes the entire process from identifying to deployment of selected parts that are needed to supporting a decision and solving a problem, hence constituting an infrastructure for the particular task at hand. This volatile Ipsum-infrastructure incorporates ubiquitous smart devices, including sensors, and services, available for anyone and everywhere in the society with person-centred malleable devices that are "user-formed", i.e., according to the users' needs by using personal data. Hence, Ipsum, focuses on incorporating personal data into devices and services to make them person-centred, smart and malleable and act accordingly.

2. RESEARCH OBJECTIVES AND RELATED WORKS

ICT Infrastructures require integrating hardware and software into a company's business. Since, Ipsum is about integrating devices and services into society, Ipsum, in real-time, constitute a volatile network of devices deployed into cities and communities. To make these smart, the devices and services must be capable of reasoning and performing negotiations, within the devices and services, as well as between them [10-16]. Deploying the smart devices and services will provide possibilities to create smart ICT-infrastructures. ICT-infrastructures are inherently multidisciplinary. To set up ICT-infrastructures, it requires hardware, i.e., computers, devices, sensors, network with Internet and Intranet [17-20], and software, i.e., services, operational and

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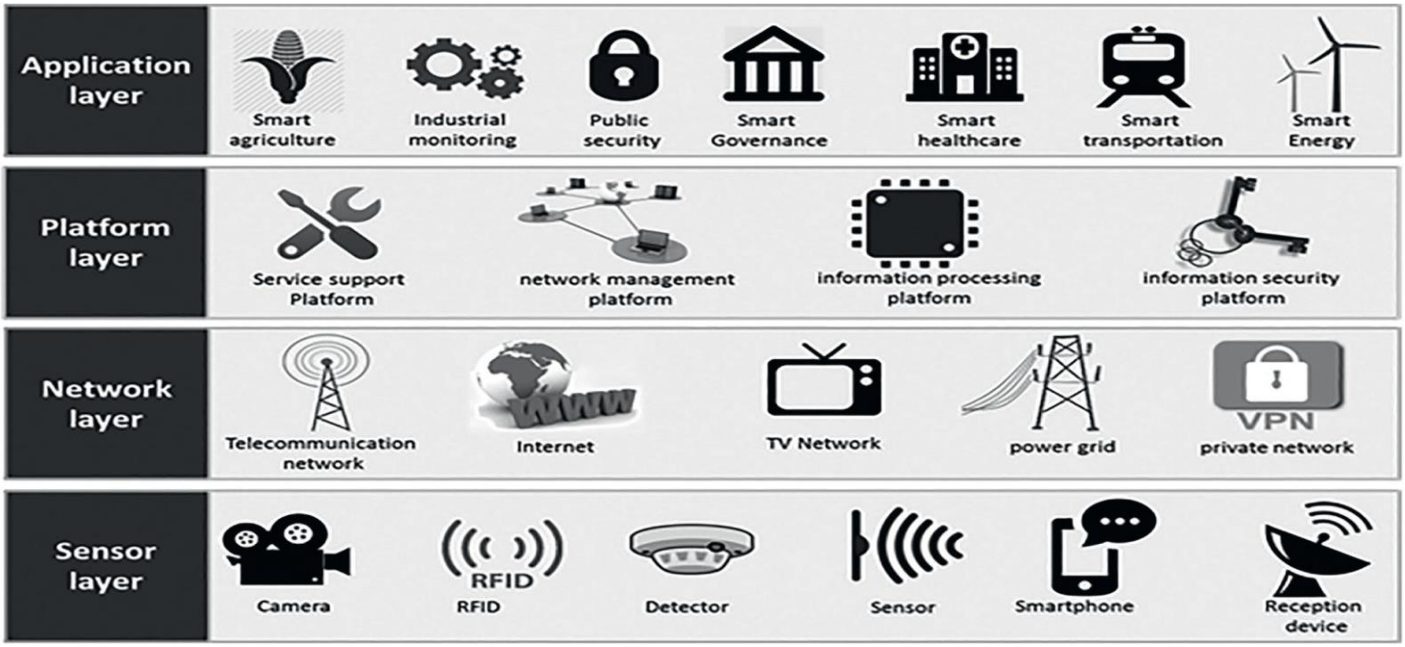

Figure 2. Four layers of smart city

Devices can be any hardware. Beside sensors, it can be any stationary and mobile device, such as computer, computer component or a peripheral device, printer, digital camera, hard-drive and personal digital assistant. Software is systems that perform operations. For example, all kinds of services, information systems, operating systems, databases, middleware, clouds, software packages, licenses, versions of and upgrades of software systems, digital manuals.

Networking and communications are two important parts. It can be LAN or WAN with different computer network topologies communicating by cable or wireless, NFC, Bluetooth or Wi-Fi. For ICT-Infrastructure, the network includes smart wearable Internet of Things devices where the devices receive and deliver data and information. Beside IoT, Smart CPS will be a part of ICT-infrastructures. Standards are a big part of the online service management, like the International Service Management Standard for IT service management (ITIL) and ISO/IEC20000. The Volatile ICT-Infrastructure, Ipsum, is based on earlier research conducted for context aware environment, wearable and Internet appliance systems and future embedded mobile systems are applied on smart IoT devices in ICT-Infrastructure. This includes communication protocols for different communication technologies.

Ipsum is also based on earlier research on Artificial Intelligence specifically on the reasoning strategies between the parts in CPS, Machine Learning for automatic handling processes and learning, as well as,

infrastructures for individualized and intelligent decision-making and negotiation are incorporated. Experience-based reasoning system coupled with real world knowledge is important, as well as automating decisions and e-trading products and services. Moreover, earlier research conducted on web services in dynamic environments, autonomic web service discovery for systems with heterogeneous communication capabilities, and mobile commerce is a part of the base for Ipsum, as well as security and possible attacks on web services. Urban centers wield significant influence over social, economic, and environmental factors, necessitating a focused approach towards three primary goals.

Energy resource management through the internet of energy (IoE) concept

Efficient management of energy resources is pivotal, guided by the principles of the Internet of Energy (IoE). This entails leveraging interconnected technologies to optimize energy consumption, enhance sustainability, and foster responsible resource utilization.

Safety and security enhancement

The second goal centers on bolstering safety and security within the urban landscape. This encompasses the strategic deployment of Closed-Circuit Television (CCTV) systems, automated alert systems for residents, detection of anomalous activities, and the provision of real-time information updates as needed. The overarching objective is to create a secure environment for residents.

Transportation efficiency and environmental preservation

The third goal focuses on improving transportation systems and safeguarding the environment. This involves initiatives to reduce pollution levels, implement energyefficient street lighting, and mitigate traffic congestion, contributing to a sustainable and eco-friendly urban ecosystem.

Advancement of educational facilities

Recognizing the critical role of education, there is a need for increased investment to ensure equal opportunities. This encompasses the facilitation of continuous learning through online and remote education modalities, as well as the integration of smart technologies in traditional classrooms.

Tourism development

Cities aim to harness their inherent resources to attract a greater influx of tourists, thereby contributing to economic growth and cultural exchange. Strategic development initiatives are undertaken to showcase the unique attractions and offerings of the urban landscape.

Healthcare enhancement for citizens

Embracing new technologies, particularly in the realm of healthcare, is integral to improving the well-being of citizens. This involves leveraging technological advancements to enhance healthcare accessibility, ensuring that citizens have access to proper and timely medical services.

Applying a Smart ICT-infrastructure for self-managed, customized health-care.

To evaluate the work, there is a need to develop a smart volatile ICT-infrastructure for person-centred services. Since, the Ipsum-infrastructure is for smart cities and communities, the example is to create a smart self-managed, customized health-care service providing precision medicine, where different individuals' needs are used for custom care. Hence, the volatile Ipsum-infrastructure is narrowed to person-centred self-care by utilizing hardware and software technologies with methods and software tools needed to support the individual self-care and using reasoning and negotiation to decide the needed medical treatments and health-care. Ipsum includes the entire process from identifying to deployment of selected parts that are needed to support decisions and solve problems. This includes identifying and utilizing data about the end users and storing the data in a proprietary database, and software, i.e., distributed systems with the algorithms, machine learning reasoning, and negotiation for the services. The services include hardware

parts, such as sensors and devices, IoT and CPS, and networks with Internet connections and databases. Acceptance of Ipsum requires enforced Ethics and Security, which must be encountered in the entire infrastructure.

3. PROPOSED SYSTEM (METHODOLOGY)

Furthermore, the adoption of smart public safety systems is anticipated to decrease crime rates and improve emergency response times. Smart healthcare systems hold the potential to enhance access to healthcare services and cut down on costs. Additionally, smart education systems can offer personalized learning experiences, thereby improving student outcomes. The concept of a smart city revolves around the deployment of pervasive communication technologies and intelligent devices aimed at enhancing urban environments and fostering development [4]. In this framework, the notion of a smart city can be categorized into four distinct levels, as depicted in the **Figure 2**. In this concept, these four levels, according to Xu, interact with one another. The Sensor layer collects and accumulates information and data in real-time, allowing data handling in the following layer to be more efficient. To acquire data, the Sensor layer frequently employs cameras, RFID, and detectors. The Network layer comes next, and it is in charge of data and information interchange and transit. The most often used network layer channels are the internet, telephony networks, and television networks. Following this layer is the Platform layer, which incorporates information processing and management via platforms such as business support, network, and cloud computing platforms. The last layer is the Application layer, which allows users to interact with smart services based on data collected in the smart city [5]. **Figure 3** depicts the many schemes of a smart city's technical architecture. These schemes interact with one another through actors (Service Providers, Municipal Departments, and the general public). The Sensor and Network layers form the foundation of the infrastructure (**Figure 3**). A flowchart of interactions between citizens, governments, and other service providers in a smart city is shown in **Figure 3**. Citizens are the end users of smart city services, and they interact with the city through a variety of channels, such as mobile apps, websites, and in-person services. They can use these channels to access information about the city, report problems, and provide feedback.

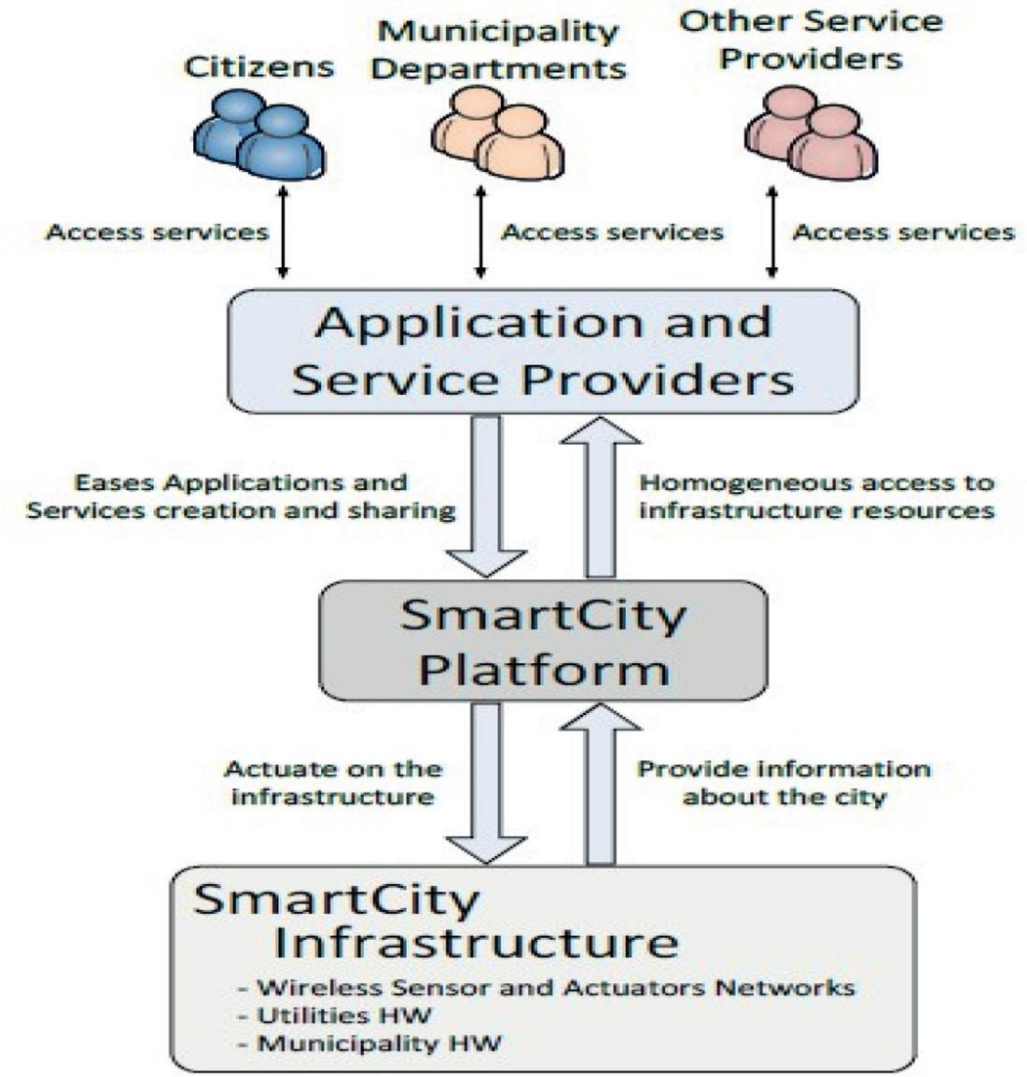

Figure 3. Smart city actor's interactions [6].

Municipalities are responsible for planning, implementing, and managing smart city services. They interact with citizens to collect feedback and identify needs, and they work with other service providers to deliver integrated solutions. Other service providers include businesses, utilities, and non-profit organizations that offer a variety of services to citizens, such as transportation, energy, and healthcare. They interact with municipalities to share data and collaborate on smart city initiatives. The diagram shows how these three groups of actors interact with each other to create a smart city. For example, citizens can use a mobile app to report a pothole to the municipality. The municipality can then use this information to dispatch a crew to fix the pothole. Or, a utility company can use data from smart meters to identify areas where energy consumption is high. The utility company can then work with the municipality to develop programs to help citizens reduce their energy consumption. Smart city actor interactions are essential for the successful development and implementation of smart city initiatives. By working together, citizens, municipalities, and other service providers can create a more efficient, sustainable, and livable city for everyone. Here are some additional details about the interactions between the three groups of actors in the diagram:

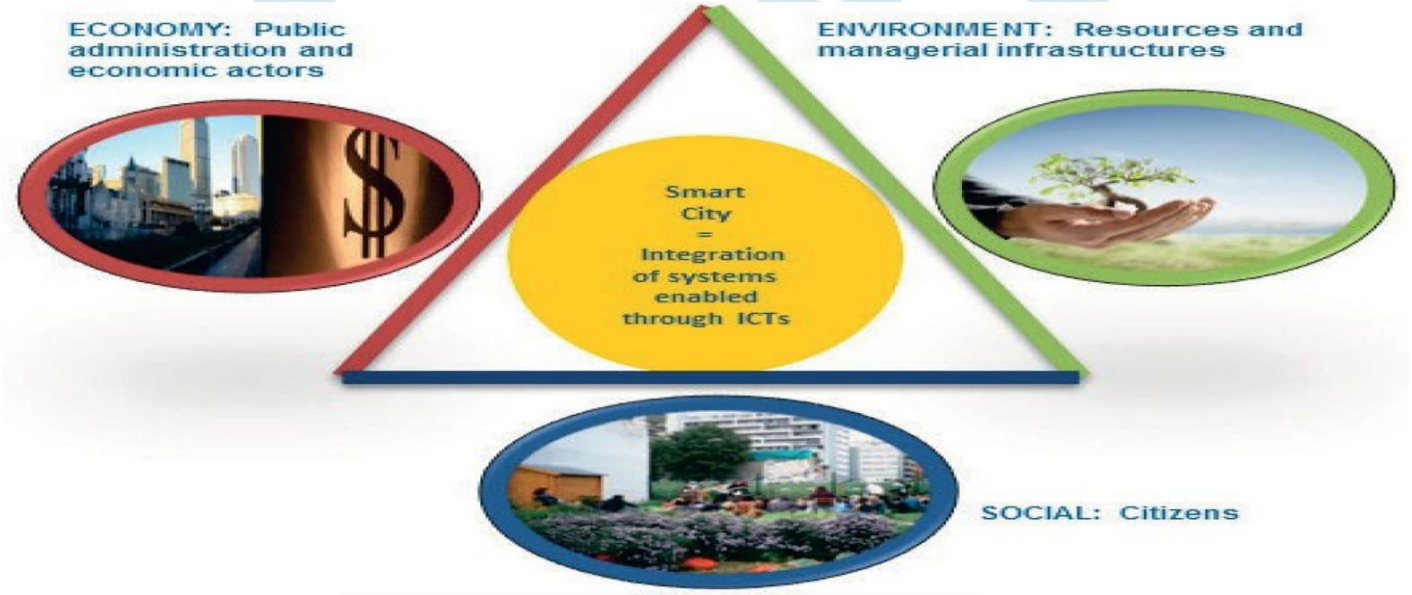

Figure 5. Application layers in smart cities [8].

Economy

Smart grid technology to manage energy consumption and reduce costs. Solutions for intelligent transportation that minimize emissions and enhance traffic flow. Smart parking systems to make it easier to find and pay for parking.

Environment

Air quality monitoring systems to track pollution levels and identify areas where action is needed. Water conservation systems to reduce water usage and protect resources. Waste management technologies that increase efficiency while lowering environmental effect.

Social

Electronic government services to facilitate individuals' access to public services. People in rural places can receive healthcare through telemedicine services. Intelligent learning environments that enhance student performance. Although they are still in their infancy, smart cities have the potential to have a profound effect on people's lives all over the world. We can make our cities' economies, environments, and social fabrics better with the help of technology, giving everyone a more sustainable and livable future.

4. CONCLUSION AND FUTURE WORK

This paper presents an approach to approach to a Smart ICT-Infrastructure, Ipsum, with person-cantered, ubiquitous and malleable devices and services for smart cities and communities. Ipsum is about smart volatile infrastructures with hardware and software, i.e., devices and services, incorporating reasoning and negotiation strategies, network and human resources. This volatile Ipsum-infrastructure incorporates ubiquitous and malleable parts available for anyone and everywhere in the society and combines these parts with person-centred information to provide services from users' needs and requests. Hence, Ipsum-infrastructure focuses on incorporating personal data into devices and services and provides possibilities to collaborate between different parts and make the services user-centred, and co-operate to perform complex tasks. The need for these infrastructures and systems has grown enormously due to the demands of citizens, the need of economic growth with new globally competitive jobs, providing new smart services and handle the vast number of services and devices. A problem is that companies are developing these systems with the short-term goal of sales and an altruistic approach is needed to produce a design for a grand scheme for the benefit of society and the individual. The trend is to move closer to automatic systems that can support people in their daily life and give instant support, when needed. The significant benefits are facilitating informed and engaged populace, expanding public participation in important decisions, improving healthcare through the connection of services and equipment, and providing new jobs as a result of new services, new and growing businesses. To meet this objective, this approach will advance the state-of-the art in the theory, development and applications of algorithms, methods and software, which need advanced automation and important and smart decision-making and learning. Ipsum infrastructure can facilitate expanding public participation in important decisions, and improve for example healthcare through the connection of services and equipment by giving necessary and trustworthy health care everywhere at any time. As a result of new smart devices and services, it can provide new jobs and growing commercial establishments. The goal with Ipsum is provide the opportunity to create smart cities and communities based on personal needs and requirements. Stakeholders, academia, industry, and other communities, should have access to advanced technologies to leverage high information and communication technologies and services in society. The outcome of the ICT infrastructure in the society is self-managed, personalized systems that can give extra-ordinary user support.

For future work, the next step is to develop, provide, and test the smart volatile Ipsum-infrastructure for society, industry and organisations. The development includes implementing software techniques with reasoning strategies and negotiation, methods, software products and services in society, for individual, industry and municipalities. The reasoning and negotiation between parts require implementation of a system, often with mobile products and smart services. This system will be called Volatile Multiple Smart system, VoLM2s, and is for stationary and mobile systems, i.e., devices, IoT and CPS. This system includes multiple connected systems that are only connected in some situations or for some purposes. It must be volatile meaning that the situation decides the incorporated systems and be smart everywhere. The system provides multiple collaborations between different systems, everywhere; Co-operations to perform complex tasks; handles complex and situation-dependent data and can generalize in heterogeneous environments.

5. ACKNOWLEDGMENT

Enhancing the quality of life for citizens and bolstering governmental resources for urban development are pivotal advantages of smart city initiatives. These advancements, however, must be pursued with a steadfast commitment to environmental stewardship, public safety, and fiscal responsibility. This discourse delves into the comprehensive understanding of smart cities, elucidating their constituent elements and the intricate interconnections within the system. The identified challenges are juxtaposed
with discerned opportunities, thus rendering the proposition of widespread implementation of smart cities more compelling. It is imperative to underscore that the benefits derived from smart cities far surpass the associated challenges. To successfully institute a smart city, concerted efforts from developers, engineers, and architects are indispensable, with a focus on pivotal domains such as Data Management, Internet of Things (IoT), and the integration of renewable energy resources. Moreover, the inherent obstacles of security and privacy necessitate innovative solutions. It is imperative to acknowledge that while challenges exist, they
are surmountable through the application of cutting-edge Information and Communication Technology (ICT) tools. In summation, the complexity intrinsic to smart cities affords a flexibility that can adeptly address myriad qualitative factors requisite for a contemporary society. Acknowledging the existence of challenges is imperative, yet through innovative approaches and ICT tools, these challenges can be effectively addressed, underscoring the compelling trajectory towards the realization of smart cities.

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