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# Prioritizing a Cloud Based Trusted Business Model for Sustainable Smart City

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***Abstract:*** *The rapid increase in urban population will inevitably present cities with a slew of new challenges. This emphasizes the significance of shifting paradigms in how cities operate in terms of sustainability. There is no single best-established definition of urban sustainability, but there is a commonly-used set of features. Sustainability characteristics include intergenerational equity, significant reduction of non-renewable resource use, economic vitality and diversity, community autonomy, citizen well-being, and satisfaction of basic human needs. These characteristics encompass the three dimensions of sustainability: environmental, economic, and social. Smart cities and Trusted Cloud Based Business modeling (TCBM) have arisen. TCBM is used in a variety of sectors in smart cities, including urban expansion modeling and pollution management. This paper highlights the cloud based trusted business model towards the sustainability of smart city.*

***Keywords:*** *Cloud Computing, Smart City Sustainability, Smart City Generation, Multi-scale Modeling (MM), Trusted Cloud-Based Business Modeling (TCBM)*

## I. Introduction

'Smart City' is becoming a common phrase in all news outlets, especially in the post-pandemic era. A quest to become smarter, greener, and more sustainable has reverberated in our daily news and lives more than ever before [1].

The term "smart city" refers to a framework based on information and communication technology that enables the creation of sustainable practices to address urbanization issues. One of the most important foundations of smart cities is the use of technology to increase efficiency and improve the quality of life for residents and the city's services [1].

The goal of a smart city is to maximize the use of resources in a city in order to make daily life easier and better for those who work and live there. In the coming years, cities are anticipated to see a large influx of people. Cities are becoming increasingly crowded, and by 2050, 2.5 billion extra residents are predicted to come to the city. There is a growing desire to make cities more livable and intelligent in order to improve living standards[1].

The rapid adoption of technological breakthroughs around the world provides the city with additional opportunities to use them into their operations. It is divided into several categories in the city, including public transit, water management, and power supply. The goal of a smart city, on the other hand, is fairly common and is based on the following: improving performance and transportation, utilizing data, improving citizen quality of life, access to various government services, optimizing resources, reducing waste, improving consumption and costs, and so on[2].

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Connectivity and data, governance and citizen, energy and environment, mobility and urban space are some of the five major areas that smart cities strive to address to cover existing global content resources. To ensure citizen participation, inclusivity, and security for residents, the government and citizens must work together. The right of citizens to participate in information exchange is critical in smart cities[2].

Smart cities that use integrated technology in all aspects of their operations receive a slew of advantages. Information and communication technology (ICT), the Internet of Things (IoT), sensors, geospatial technology, artificial intelligence (AI), and, of course, Block Chain Technology are all major smart city technologies that are required for better functioning[17].

Smart city technology has the potential to help cities run more efficiently while also enhancing services to inhabitants and companies, among other things. Effective, data-driven decision-making, improved citizen and government participation, sustainable livelihoods, reduced environmental footprints, improved transportation, increased digital equity, new economic development opportunities, efficient utility services, improved infrastructure, and increased workforce engagement are some of the benefits that may be realized[13].

However, cities will face several issues, including those related to growth, performance, competitiveness, and people' livelihood, as a result of the rapid growth in urban population and the resulting increase in resource consumption. Rapid urbanization has created problems such as waste management, scarcity of resources, air pollution, and traffic congestion, all of which are harmful to human health, as well as ageing public infrastructure. This statistic emphasizes the significance of changing paradigms in the way cities operate in order to achieve long-term sustainability[13].

A sustainable smart city (SSC) is one that has created technical infrastructure to develop, deploy, and foster sustainable operations while also assisting in meeting the expanding urbanization needs. It paves the way for technological dynamism to be integrated into local governance, education, healthcare, energy, infrastructure, and mobility, among other sectors [13].

A cloud-based trustworthy smart city business model is proposed in this article as a way for a city government to arrange its services in order to produce and deliver value for its inhabitants in an economically successful, socially inclusive, and environmentally sustainable manner [3].

## II. Background and Literature Review

A smart city is an urban region that collects data using various electronic methods and sensors. Insights gathered from the data are utilized to efficiently manage assets, resources, and services; in turn, the data is used to improve city operations. This includes information gathered from citizens, devices, buildings, and assets, which is then processed and analyzed in order to monitor and manage traffic and transportation systems, power plants, utilities, water supply networks, waste, crime detection, information systems, schools, libraries, hospitals, and other community services. The smart city concept integrates ICT and other physical devices connected to the Internet of Things (IoT) network to improve the efficiency of city operations and services while also connecting residents. A smart city's major purpose is to increase policy efficiency, minimize waste and inconvenient situations, improve social and economic quality, and increase social participation [13].

Smart city technology enables city officials to connect directly with the public and city infrastructure, as well as monitor what is going on in the city and how it is changing. ICT is utilized to improve the quality, performance, and interactivity of urban services, as well as to reduce costs and resource consumption and boost citizen-government interaction. Smart city programmes are designed to control urban traffic and respond in real time. As a result, a smart city may be more equipped to face issues than a city with a purely "transactional" connection with its residents. However, the term itself is ambiguous in terms of its characteristics, leaving it open to a variety of interpretations. Another important aspect of smart cities is sustainability. In the following years, urbanization is anticipated to develop even more. According to the United Nations, around 55 percent of the world's population currently lives in a metropolitan or urban environment, with this proportion expected to climb 68 percent in the next decades. In the years ahead, smart technology will aid cities in sustaining growth and improving efficiency for citizen welfare and government efficiency in urban areas [14].

**Demand of smart city**

More than half of the world's population now lives in cities. According to projections, by 2050, that figure will have risen to two-thirds. This drastic change is owing to the numerous options people are given in cities to construct their own lives. Rising urbanization, on the other hand, brings with it new challenges: as cities expand, people's wants and aspirations must be satisfied in environmentally friendly ways [14].

One of the most important concerns we are now dealing with is climate change. CO2 emissions must be reduced in the coming decades, as well as efforts to prevent global warming, floods, and prolonged heat waves. Cities are responsible for over three-quarters of global greenhouse gas emissions. They are also expected to supply remedies because they are large pollutants [3].

Cities are affected by the global networking of labor forces, institutions, and information. Economic and social systems are shifting, and city politicians must adjust their policies to meet these new challenges. It entails putting cities in a position where they can cooperate and compete on a global scale. The actions taken must not be solely cosmetic in nature, but must also consider internal social, economic, geographical, and structural factors [14].

Education, qualification, research, and entrepreneurial spirit, as well as innovation, productivity, and flexibility, are all actively supported in smart economies. The fundamental ingredients for creative production are continuous information acquisition and transfer, as well as local and global networks. Businesses that provide IT, environmental, and energy services, in particular, are seen as the powerhouse of smart economies [2].

One of a city's main issues is reducing energy and raw material use, as well as planning ahead for resource management. For energy, mobility, infrastructure, and buildings, smart supply and disposal systems are equally as crucial as process-driven improvements, technology innovations, and networks. Smart grids, for that matter, are a step toward smart energy consumption: energy generation, storage, and consumption are all managed by intelligent networks and monitoring systems. To make actual energy consumption more transparent, smart meters are implemented [14].

**Functionalities of a smart city**

A smart city's main purpose is to develop an urban environment that provides citizens with a high quality of life while simultaneously creating overall economic growth. As a result, one of the most significant advantages of smart cities is their capacity to permit improved service delivery to inhabitants with less infrastructure and cost. As the population of cities grows, it becomes vital for these cities to make better use of existing infrastructure and assets in order to handle the growing population. Smart city applications can help to make these improvements, as well as improve city operations and citizens' quality of life [14].

Cities may use smart city apps to discover and develop new value from their existing infrastructure. The enhancements help governments and citizens save money by facilitating new revenue streams and operational savings. Smart cities use a web of connected IoT devices and other technology to fulfill their aims of bettering people's lives and growing their economies [13].Smart cities that succeed follow a four-step process;

1. Data collection - Data is collected in real time by smart sensors placed across the city.
2. Analysis - The data collected by the smart sensors is analyzed in order to derive useful conclusions.
3. Communication — It is made through strong communication networks, the insights gained during the analytical phase are shared with decision makers.
4. Take Action - Cities use the data insights to develop solutions, improve operations and asset management, and improve inhabitants' quality of life.

**Technological framework for a smart city**

To provide connected solutions for the public, smart cities use a variety of software, user interfaces, and communication networks, as well as most importantly the Internet of Things (IoT). The Internet of Things (IoT) is a network of interconnected devices that communicate and share data. Vehicles, home appliances, and on-street sensors are all examples of this. Data collected from these devices is kept in the cloud or on servers, allowing both public and private sector efficiencies to be improved, resulting in economic advantages and improvements to individuals' lives [19].

Edge computing is used by many IoT devices to ensure that only the most relevant and important data is sent through the communication network. A security system is also in place to safeguard, monitor, and regulate data transfer from the smart city network, as well as to prevent unauthorized access to the city's data platform's IoT network. The deployment of technology is critical in a smart city. Smart city technologies are made up of various combinations of technical infrastructure that combine to generate an array of smart city technologies with differing levels of human-technology interaction [19].

• Digital: To connect people and gadgets in a smart city, a service-oriented infrastructure is required. Innovation services and communication infrastructure are two examples. "A connected community that combines broadband communications infrastructure; a flexible, service-oriented computing infrastructure based on open industry standards; and innovative services to meet the needs of governments and their employees, citizens, and businesses [3].
• Intelligent: Cognitive technologies like artificial intelligence and machine learning can be trained to recognise patterns in data generated by connected city devices. Cognitive systems that analyze the continual interactions of humans with their urban surroundings can quantify the efficacy and influence of certain policy measures [3].
• Accessible: A ubiquitous city allows citizens to use public services from any connected device. Because of the facility in terms of accessibility to all infrastructures, U-city is an extension of the digital city concept [3].
• Wired: In the early stages of smart city development, the physical components of IT systems are critical. To support the IoT and wireless technologies that are at the heart of more networked living, wired infrastructure is necessary. The general public has access to constantly updated digital and physical infrastructure in a connected city setting. Telecommunications, robotics, the Internet of Things, and other connected technologies can then be used to promote human capital and productivity [1].
• Hybrid: A hybrid city combines a physical conurbation with a virtual metropolis that is connected to the physical space. This connection can be created by virtual design or the presence of a critical mass of virtual community members in a physical metropolitan location. Hybrid spaces can help to bring future-state smart city services and integration projects to life [1].
• Information city: A smart city's vast number of interactive devices generates a large amount of data. The way that data is interpreted and kept is essential to the growth and security of Smart cities [1].

**Features of a smart city**

The following are some of the most common characteristics of comprehensive development in Smart Cities.
1. Promoting mixed land use in area-based developments: planning for 'unplanned areas' with a variety of appropriate activities and land uses close to one another in order to maximize land use efficiency. To adapt to change, the states will provide some flexibility in land use and building bye-laws[14].
2. Housing and inclusion: increase housing options for all;
3. Creating walk-able neighborhoods: minimize traffic, pollution, and resource depletion while also boosting the local economy, promoting interactions, and ensuring security. The road network is being built or upgraded not only for vehicles and public transportation, but also for pedestrians and cyclists, and important administrative services are being made available within walking or cycling distance[13].
4. Preserving and developing open spaces: such as parks, playgrounds, and recreational areas to improve inhabitants' quality of life, reduce urban heat island effects, and promote eco-balance in general;
5. Promoting a diverse range of transportation options: including TOD, public transportation, and last-mile para-transport links;
6. Making governance more citizen-friendly and cost-effective: relying on online services to increase accountability and transparency, particularly through the use of mobile devices to cut service costs and provide services without the need to visit municipal offices. Creating e-groups to listen to people and get feedback, as well as using online monitoring of programmes and activities with the help of a virtual tour of work sites[14].
7. Giving the city a distinct character: based on its primary economic activity, such as local food, health, education, arts & crafts, culture, sports products, furniture, hosiery, textiles, and dairy;
8. Improving infrastructure and services: through Smart Solutions in area-based development.

**The core infrastructural elements of smart city**

• Adequate water supply,
• Assured electricity supply,
• Sanitation, including solid waste management,
• Efficient urban mobility and public transportation,
• Affordable housing, particularly for the poor,

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• Robust IT connectivity and digitalization,
• Good governance, particularly e-Government and citizen participation,
• Sustainable environment,
• Safety and security of citizens, especially women, children, and the elderly, and
• Health and education

**Smart city attribution**

- Sustainability, smartness, urbanization, and quality of life are four major characteristics of smart cities.
- Sustainability is concerned with urban infrastructure and governance, energy and climate change, pollution and waste, as well as social, economic, and health issues.
- Technology, infrastructure, governance, and economy are only a few of the components and indicators that make up the urbanization characteristics of a smart city.
- QoL: Quality of life can be measured in terms of residents' emotional and economical well-being.

Smartness: The various aspects of a city's smartness include smart environments, smart living, smart mobility, smart governance, and smart people. A smart environment is an appealing and clean natural state with minimal pollution and resource management that is sustainable. Smart governance involves individuals in decision-making and gives easy access to public and social services. [3].

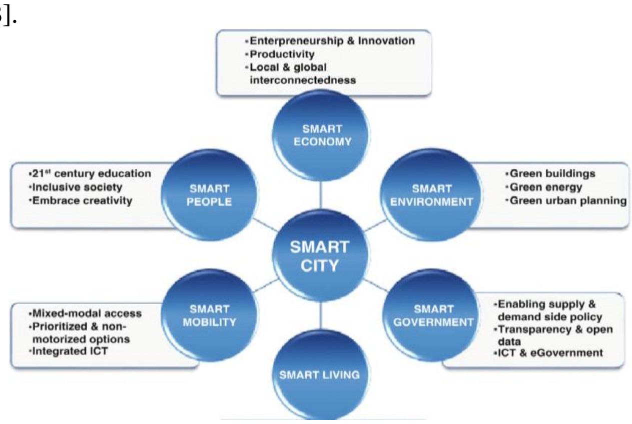


**Fig.1**: Smart city attribution

**Smart city and its growth**

In the current era, smart cities are gaining traction among technology companies and entrepreneurs, as well as local governments and civil society. On the one hand, smart cities hold the promise of potentially making the world's growing number of cities more efficient, tech-savvy, and wired–all of which can undoubtedly improve citizens' quality of life[13].

- *Smart City 1.0:* Smart city 1.0 is characterized by technology vendors driving the adoption of their solutions in cities.
- *Smart City 2.0:* Smart city 2.0 is appropriate when technological tools are explicitly developed to address problems such as pollution, sanitation, health, and transportation in consultation with citizens. Unfortunately, citizen participation in informal decision-making structures and assemblies is poor and appeals only to a small minority.
- *Smart City 3.0:* In Smart city 3.0, the public should be able to express their opinions, with the government acting as a facilitator and definer of government specific user needs. Thus, a smart city represents the entire connected ecosystem that brings together the technologies, solutions, actors, and audiences in the smart city, including IoT, 5G connectivity, transportation and smart automotive, energy and utilities, health and public safety, artificial intelligence, and data analytics.
- *Smart City 4.0:* By adopting industrial revolution 4.0, the benefits of smart cities are appreciated to overcome the cost of the city with the platformization of the city. smart city 4.0 represents the best of the past, for instance, the

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technological disruption of generation 1.0, the individualization of 2.0, and the engagement of 3.0; however, it adds two critical success factors: a holistic approach and the challenge of integrating solutions.

- *Smart City 5.0*: Smart city 5.0 is distinguished by the collaboration of humans and Artificial Intelligence systems, and it can harmoniously balance all aspects of life as well as the competing interests of various city stakeholders. The city provides an approach that can assist in reaching a "consensus" among various services and, more importantly, with citizens. As it reflects real-life, it should take into account not only past or current information, but also the constantly changing interests, preferences, and constraints of all actors in real-time, which should be identified, analyzed, transformed into plans, implemented, and controlled. [16].

**State-of-the-art technologies**

The Internet of Things (IoT) provides a platform for sensors and actuator devices to communicate seamlessly within the smart city environment, as well as increasingly convenient information sharing across platforms. The recent adoption of various wireless technologies positions IoT as the next revolutionary technology, taking advantage of all the opportunities provided by Internet technology. The Internet of Things (IoT) has recently been implemented in smart cities to develop intelligent systems such as smart grids, smart retail, smart homes, smart water, smart transportation, smart healthcare, and smart energy. However, there is no universally agreed-upon definition of a smart city, and recognizing common global trends is difficult. [15]. The smart city focuses on integrating next-generation information technology into all aspects of life, including hospitals, electricity grids, railways, bridges, tunnels, roads, buildings, water systems, dams, oil and gas pipelines, and other items around the world, constituting the Internet of Things (IoT). The Internet revolution resulted in unparalleled levels of connectedness and speed amongst people. The integration of objects to build a smart city will be the next revolution. The interconnectedness of sensing and actuating devices is emphasized in the smart city, allowing information to be shared across platforms via a uniform framework. Such sharing is enabled by cloud computing, which serves as the unifying framework for omnipresent sensing, data analytics, and information representation. The post-PC age is here, and smartphones and other mobile gadgets are transforming our environment by making it more interactive and informational. [15].

In smart cities, big data systems are efficiently stored, processed, and mined to generate information to improve various smart city services. Furthermore, big data can assist decision-makers in planning any expansion of smart city services, resources, or areas. Big data's various characteristics demonstrate its significant potential for gains and advancements. The possibilities are limitless, but they are constrained by the availability of advanced technologies and tools. Using the appropriate tools and methods for efficient and effective data analysis, big data can achieve its goals and advance services in smart cities. Such efficiency will encourage collaboration and communication among entities, as well as the development of new services and applications that will enhance the smart city experience. [21]. Big data applications can serve many sectors in a smart city, providing better customer experiences and services that help businesses achieve higher performance (e.g., higher profits or increased market shares). Healthcare can be improved by improving preventive care services, diagnosis and treatment tools, healthcare record management, and patient care. Big data can help transportation systems optimize routes and schedules, accommodate varying demand, and improve environmental friendliness [21].

Cloud computing refers to a variety of computing models that incorporate a large number of machines or clusters connected via a real-time communication network. Cloud computing allows users to execute complicated large-scale computing operations like mining massive amounts of social network data provided by smartphone apps. Platform as a service (PaaS), software as a service (SaaS), and infrastructure as a service (IaaS) are examples of cloud computing services that can be integrated with IoT. This combination has the potential to alter any organization; with big data technologies, a massive volume of data can be analyzed quickly. Furthermore, cloud computing can provide a virtual infrastructure for utility computing that includes monitoring, storage, analytics, visualization platforms, and client delivery. [13].

Cloud computing's cost-based paradigm, which employs a business framework, will enable end-to-end service provisioning for enterprises and individuals, allowing them to access apps on demand from anywhere. The basic engine for cloud computing is provided by big data technology such as the Hadoop framework. Hadoop was created to provide a platform and programming models for distributing the processing of massive datasets over several clusters. Hadoop is made up of two main components: the Hadoop Distributed File System and MapReduce, which are closely linked.

Despite the fact that the real-time requirements of data storage and processing in the smart city are taken into account, the use of streaming architecture will ensure efficient and seamless communication between sensing devices within the smart city network. With the introduction of many stream processing platforms, such as Apache S4, Storm, and Spark streaming, which can enable data storage and processing across various interconnected nodes, such technology has recently been adopted. [20].

**Emerging communication technologies**

Most big data applications for smart cities necessitate smart networks that connect their components, including residents' equipment like cars, smart house devices, and smartphones. This network should be capable of efficiently transferring data from their sources to where big data is collected, stored, and processed, as well as transferring responses back to the various entities in the smart city that require them. [9]. For real-time big data applications in smart cities, network support for quality of service (QoS) is critical. All current dispersed application events should be sent in real-time to where they can be processed in these apps. These events can be transferred as raw events, filtered events, or aggregated events from their sources. In this section, we discuss the various technologies that can help the smart city environment, such as smart city IoT and big data technologies. To embrace the smart city, IoT technology must be installed, which allows different things to be sensed and controlled remotely through existing network infrastructure. This project will open up possibilities for the smart city's diverse objects to be integrated in a more flexible manner. When IoT is supplemented with sensors and actuator components, such innovation will boost efficiency and accuracy while also providing cost savings. As previously said, the best way to achieve this goal will be to use an open standard IoT technology. [15].

**Table 1**: Emerging communications technologies

| Technology | Operation |
|---|---|
| RFID | • Enables the realization of smart city intelligent devices through the RFID embedded technology. |
| WSN | • It can cope with large-scale deployment in any environment, and it is therefore applicable for smart city integration. |
| Wi-Fi, Ultra-Wideband, Zigbee and Bluethoot | • Integrated wireless communication platforms.<br>The reliability of the wireless communication networks is of utmost importance in smart city realization, coupled with the need for self-organizing and self-healing networks. |
| 4G and 5G | • Improve data throughput and spectral efficiency using multiple antennas at the transmitter and receiver.<br>• Result in fast and resilient access to the Internet and support for smart city realization |
| Network Function Virtualization | • This technology transfers hardware-based network functions to software-based applications running on commercial off-the-shelf equipment.<br>• Network functions can be initiated from different locations such as data centers, network nodes, and end-user.<br>• Provides many benefits, including platform openness, scalability, flexibility, performance improvement, reduced capital, and operating expenditures. |

**Big data in the smart city**

The use of big data technology in the smart city allows for effective data storage and processing, resulting in information that can be used to improve a variety of smart city services. Big data also aids decision-makers in planning for any future development of smart city services and resources. Big data requires the correct tools and methodologies for efficient and effective data analysis in order to achieve its aims and enhance services in smart cities [22]. These technologies and strategies may improve consumer experiences and commercial prospects by encouraging collaboration and communication across entities and providing services to numerous sectors in the smart city. The different smart city applications are summarized in Table 2.

**Table 2:** Summary of different smart city applications

| Application | Specific Use | IoT | Possible Communication On Technology | Advantages | Limitations |
|---|---|---|---|---|---|

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| | | | | | |
|---|---|---|---|---|---|
| Smart Health Care | Health Monitoring | Sensors, Smart Wearable devices | Bluetooth, Zigbee | Early diagnose of disease | Lack of precision |
| Smart Transportation | Efficient route management | Smart Cars, Cameras, RFID cards | RFID, 3G, and 4G | Automatic traffic Management, Efficient and route management Less congestion | Network dis-connectivity can cause serious accidents |
| Smart Governance | To make smart policies with the aim of managing the citizens | Smart phones, cameras, sensors | WiFi, LTE, LTE-A, WiMax, Bluetooth, LoRaWAN, | Awareness in terms of citizens needs Clear policy | Collectionand analysis of data seem difficult task |
| Smart Grid | To manage the power supply | Smart meters and Smart readers | WiFi, Zigbee, Z-Wave | Efficient power Supply, Future needs estimation | Costly, Hard to manage |

**Multi-scale modeling**

Multi-scale models in smart cities and megacities have recently gained importance because they can understand complex adaptive systems and efficiently solve complex problems at multiple scales (i.e., micro, meso, and macro) to improve system efficiency and reduce computational complexity and cost [5]. This is a scientific model-based stance at the various scales encountered in urban areas, requiring skills in engineering sciences (civil and urban engineering, energy, equipment and infrastructures, networks), as well as skills in land and space planning, architecture, and urban sciences, to account for environmental constraints, sustainable construction, and potential impacts of climate change. It also aims to analyse and reduce the level of vulnerability of goods and people in urban areas [11].

The use of ICT has enabled a new era of advanced services that have improved people's living standards. Starting new businesses in a country, making reservations for medical examinations, a system for remote patient monitoring, and waste disposal by the city administration, among other things, are examples of information services. all of these are the various objects of a smart city and smart city Smart labs for living, smart infrastructures, neighborhoods, new and fast services for citizens, open and accessible data, and smart city management are all part of the strategy[1].

- *Sequential Multiscale Modeling:* Microscale models are employed initially in the sequential MM to pre-compute and produce data inputs, which are subsequently used in the macro model. Information is sent from lower to higher scales in this manner, and operations/activities at higher levels are postponed until lower-level processes are completed. [6].
- *Concurrent Multiscale Modeling:* Both micro and macro models run concurrently in concurrent MM, and the data required by the macro model is generated on the fly from the micro models. Concurrent models are further subdivided into "partitioned-domain" and "hierarchical" methods. The partitioned-domain current approach deals with a physical problem that has been partitioned into two or more contiguous regions, with each region using a different model scale[5]. Hierarchical methods, on the other hand, employ both micro and macro scales in all of their applications. Figure 2 depicts a typical application of the concurrent multiscale model for social systems.

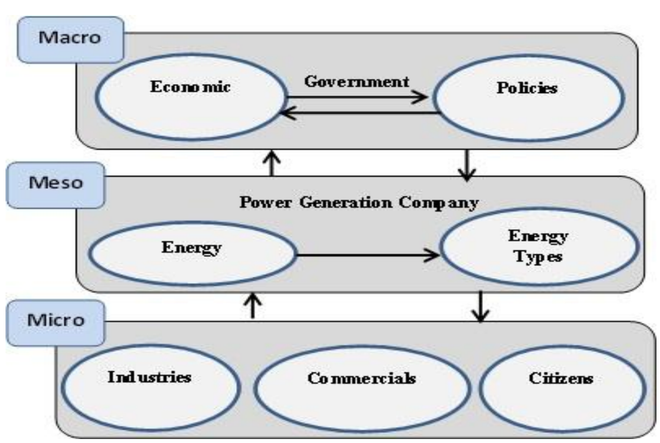

**Fig.2**: Concurrent multi-scale model

**Need of Business Model for a Smart City**

Regardless of the hype, aspiring smart city administrations must demonstrate to inhabitants that they can generate, deliver, and sustain value for them. The concept of a city business model can help city governments define how they will produce and provide public value through smart services, similar to how a firm's business model shows how a corporation creates and delivers value for consumers and how it collects profits [14].

The business model clarifies some major needs of a smart city such as; How can city governments take ownership of smart city projects to ensure that they provide value for residents?, What value do smart services truly create?, How can local governments ensure that value is created and delivered?, and finally, in terms of economic, environmental, and social dimensions, what are the costs and advantages of smart city services? [1].

The term "smart city" refers to a notion that combines three elements: smart people, smart technology, and smart collaboration. They conclude that a city's 'smartness' is determined by its ability to attract and mobilise human capital as well as enable collaboration through the use of ICT. They define'smart services' as ICT-enabled public services that improve mobility, optimise resource consumption, and facilitate collaboration. Applications that integrate all modes of transportation so that people can choose the quickest or cheapest way to get to their destination, as well as applications that distribute traffic during rush hour or direct users to available parking spots, are examples of smart services that improve mobility while lowering greenhouse gas emissions [14].

Despite the appeal of such services, city governments require a framework to integrate and evaluate them within their current service delivery structures. While such smart services have the potential to provide value to city citizens, municipal governments cannot assume that they will in fact do so. This is dependent on how smart services are conceived, implemented, and governed, or on smart service business models [14].

Smart city governance necessitates novel decision-making models, new government capacities, and collaborative networks, with business models serving as a decision-making methodology and planning tool to assist municipal governments in the complicated decision-making processes surrounding smart cities [14].

A business model expresses exactly what value a private firm creates for customers (i.e., the value proposition), defines the structure of the value chain required to produce and distribute the service or product, and assists the firm in calculating the costs and potential profits of its activities in order to remain profitable and sustainable. Despite the fact that public organizations and other non-profit seeking organizations do not have the same incentives and requirements as private firms, they can benefit from developing a business model logic to articulate how they provide social and/or environmental value, to whom they provide it, and how they can sustain it over time[14].

It can be summed up to articulate that a 'smart city business model' can be defined as the way a city government arranges its services to produce and deliver value for its inhabitants in an economically viable, socially inclusive, and environmentally sustainable manner[14].

The business model logic can help planners address current criticisms regarding the social impact of smart cities that are directly tied to the current underlying financial models for smart services, in addition to analysing the financial issues of smart services. The development and operation of large-scale ICT initiatives (such as data platforms and sensor technology) now rely on private investment and skills. While private finance models can be effective from a financial and technological standpoint, there are concerns that the growing role of corporations in smart cities will lead to an urban governance model that prioritizes large-business goals over social goals, increasing social polarization and inequality inadvertently [14].

To summarize, city managers can benefit from using business model logic to develop smart services in order to coordinate the diverse stakeholders involved, assess the social and environmental impacts of smart services as well as their economic viability, and ensure that smart city project decisions are centered on a value proposition for residents [14].

## III. Contribution

**Proposed structure of the big data and smart city**

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As the smart city applications generate continuous and large data from heterogeneous sources, big data processing technologies, which are based on distributed data management and parallel processing, have provided enabling platforms for data repositories, distributed processing, and interactive data visualization [22].

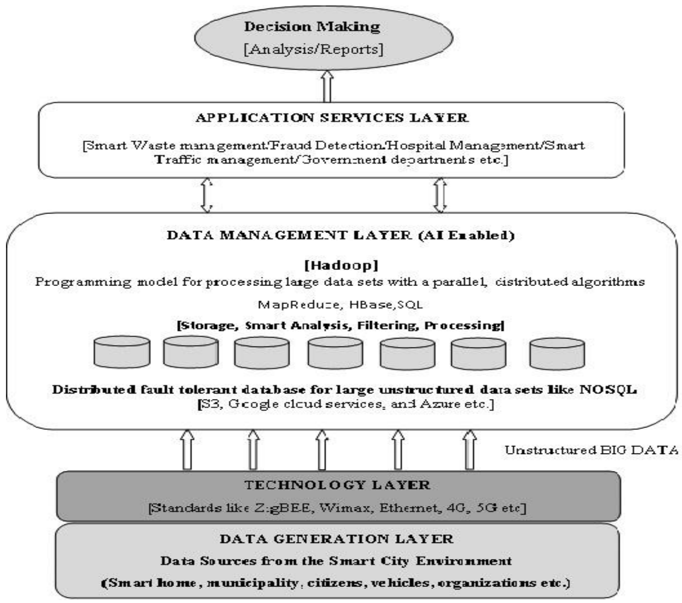


**Fig.3.** Big data technology in smart city

The system structure of big data in the smart city, as shown in Figure 3, can be divided into multiple layers to enable the development of integrated big data management and smart city technologies. Each layer represents the potential functionality of big data smart city components[26].

1. **Data generation Layer**: The first layer is the set of various heterogeneous devices or objects connected via local and/or wide-area networks integrated for transparent and seamless communication under the umbrella of Internet of things (IoT. Most of these objects and devices actively generate a huge amount of unstructured data every second[22].
2. **Technology Layer**: At the second layer, all the unstructured data are sent to the data management layer using ZigBEE, WiMaxm Ethernet, 4G, 5G wired/wireless technology standards[22].
3. **Data Management layer**: This layer includes a shared distributed fault-tolerant databases located either in the city data center equipped with all network elements or by big data storage such as S3, Google cloud services, and Azure from vendors such as Amazon, Google, Microsoft, and Cloudera. Various big data store systems can be used in these cases such as Cassandra, Hbase , MangDB, CouchDB etc.Within the same layer, the stored data are processed depending on the incoming queries using batch based programming model such as MapReduce framework or other processing engines used for big data. MapReduce provides a powerful programming model for parallel and distributed processing of large data on clusters. In stream processing, data must be processed quickly so that companies and individuals can react to changes in real time in a smart city environment. Many technologies can help process and act on real-time streaming unstructured data in real time such as Spark, Storm, and S4[22].

   The smart analysis can be designed using scalable machine learning algorithms or other novel data mining algorithms to provide extraction of patterns and knowledge from large amounts of data. A typical example of such technology is Apache Mahout , in which many machine learning libraries for data filtering, clustering, and classification can be found[22].

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4. **Application layer:** This layer is for application services, in which people and machines directly interact with each other to make smart decisions. Such applications can be used for different purposes such as Smart Traffic, fraud detection, Hospital management, waste management and web display analysis etc[22].

**Trusted cloud based business model (TCBM)**

Big data and smart cities are the key elements for transforming future business models. The development of a business model can proceed more quickly because to the massive data collected from a smart environment. By revealing hidden patterns, correlations, and other insights from vast amounts of smart environment data, business leaders may improve their operations and help their customers. To help with information gathering and trend predictions, data collected from the smart environment can be examined. Several product suggestions can be made after analyzing seasonal variations. Analytics may help with the strategic placement of adverts for marketing purposes, allowing people to make better decisions regarding customers and products, as well as recognizing potential threats and opportunities for a company [21].

Analytics may also help organizations create smart plans after looking at employee data. By satisfying customers' desires based on their needs, business owners can increase their earnings by analyzing what consumers look for and buy [22].

After reviewing databases of consumer complaints, businesses can evaluate products that result in revenue losses. After the massive amount of data has been analyzed, hypotheses can be produced and tested experimentally. Figure 4 demonstrates how a database is used to store data from numerous sources. With the help of business intelligence and big data analytics, it may be possible to automate decision-making, develop data-driven businesses, and oversee performance using this data [22].

A report or an alert might be used to present the analysis' findings. The models may be readily interacted with using the dashboard. In addition to the application layer, which offers a collection of methods for drawing insights from unstructured large data, data science also covers the data source, business intelligence, and analytics. The ideal Trusted Cloud Based Business Model (TCBM) analyses security concerns from a systems perspective and includes a security model into all activities in order to provide commercial value to a business [16].

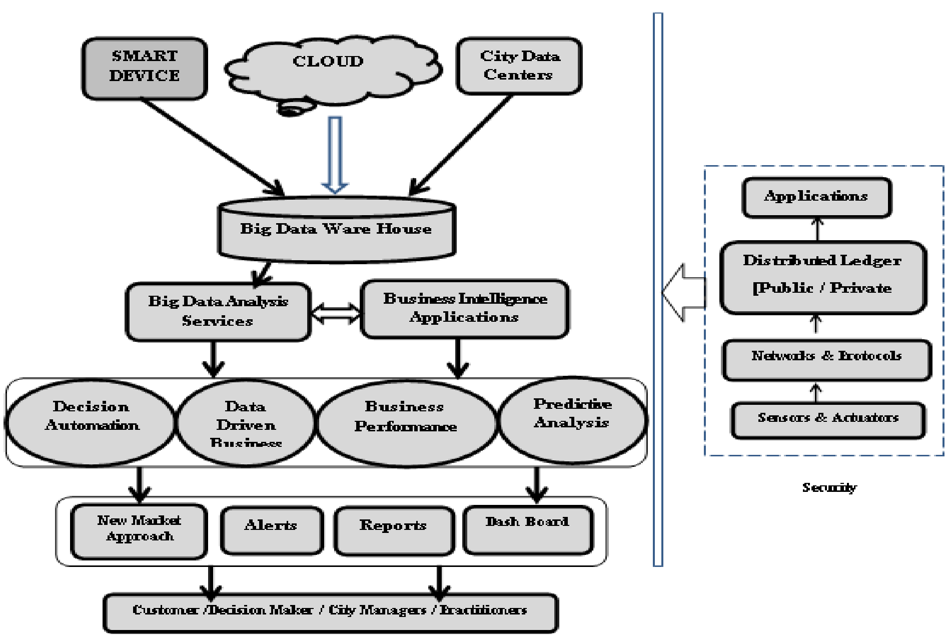

**Fig.4**: Trusted cloud based business model (TCBM)

The diversity of IoT devices and the wide range of communication protocols, interfaces and services used in urban information systems make it difficult to implement traditional security solutions and methods of well-known networked information technologies effectively [21].

The solution of security problems in information systems built on IoT devices is relevant in the context of all three layers presented in the architecture in Fig. 3. For example, the absence of encryption algorithms for transport protocols causes the communication processes between the IoT device and cloud services, IoT device and gateway, IoT device and mobile applications, various IoT devices, etc. to be unsafe. Much of the threats are due to IoT devices access through inadequate or ineffective authentication and authorization procedures. Authentication is one of the popular methods of implementing secure communications at the network level. Despite the limitations of individual IoT devices computing capabilities, IPSec may be implemented in the IoT environment using a separate adaptation layer [21].

The main difficulties in encrypting IoT devices are their relative simplicity, limited availability of computing resources, and reduced usability. Therefore, it is necessary to develop "light" and efficient encryption algorithms for IoT devices in order to ensure privacy and security while using them. Cloud gateways must be equipped with security controls to avoid malicious influences on their configurations change. Biometric and multi-level authentication tools can be effectively used to control access to cloud systems. In addition to implementing the security policy for individual IoT devices, the general requirements applied in the context of arbitrary information systems built with their use should be considered, particularly: heterogeneity of characteristics of sensors, actuators and computing means of IoT devices, data storage and management of IoT devices, Scalability of cloud services for IoT devices, Providing security of dashboards etc [21].

In this proposed model, the security module includes sensor layer, network layer, storage/processing/distributed layer and application layers where the sensor layers is responsible for sensing and gathering information about the environment. It senses some physical parameters or identifies other smart objects in the city environment. The *network layer* connects to other smart objects/network devices/servers there by transmitting and processing sensor data. The *application layer* delivers the desired services to the user [21].

Some of the key characteristics are being considered while proposing this model considered, such as [23]

- **Dynamic environment:** IoT devices allow the dynamic integration of a wide range of available assets without the need to define the boundaries of relevant IoT networks [23].
- **Heterogeneity:** One of the main features of this model using the Internet of Things technology is the ability to connect multiple types of devices with different sets of characteristics, such as operating systems, platforms, communication protocols and the corresponding range of functionality [26].
- **Large amounts of data:** Currently, the total number of IoT devices installed in the model is estimated as number of pieces. In the process of their operation, these devices generate data collections, which in many cases can be attributed to the Big Data concept. This raises the need for resources and effective means of implementing the device interaction processes, control, storage of generated data large volumes, their interpretation and analytical processing [26].
- **Context dependency:** On the IoT platform, a large number of sensors integrated into the city environment that implement the processes of selecting, storing and transmitting information that needs to be processed depending on the context[26].
- **System complexity:** The proposed model, using IoT devices typically contain a large number of heterogeneous objects with a variety of hardware and software characteristics, which significantly complicate the implementation of management processes under severe constraints on computing resources, power consumption, and response time[26].

Therefore, taking into account of the above characteristics this proposed model simplify the complex dataset through the designated layers depicted in the proposed model there by ensuring the security aspects of the resulted service oriented information according to the IOT configuration[26].

In this regard, Iot devices are equipped with embedded sensors, actuators, processors, and transceivers where sensors and actuators are interacting with the city environment. The data collected by the sensors has to be stored and processed intelligently in order to derive useful inferences from it. The storage and processing of data can be done on the edge of the network itself or in a remote server. If any preprocessing of data is possible, then it is typically done at either the sensor or some other proximate device. The processed data is then typically sent to a remote server [26]. The storage and processing capabilities of an IoT object are also restricted by the resources available, which are often very constrained due to limitations of size, energy, power, and computational capability. As a result the main research challenge is to ensure that we get the right kind of data at the desired level of accuracy. Along with the challenges of data collection, and handling, there are challenges in communication as well. The communication between IoT devices is mainly wireless because they are generally installed at geographically dispersed locations. After processing the received data, desired operation needs to be taken on the basis of the derived inferences [26].

The process of effecting a change in smart data is often dependent on its state at that point of time. Each action is taken keeping in consideration the context because the application can behave differently in different requirements [26].

## III. Limitations

A smart city model views the city as a complex adaptive system made up of services, resources, and residents that learn from one other and change in both space and time. The Trusted Cloud Based Business Model (TCBM) used in smart cities and megacities have recently been a big topic because they can better understand complex adaptive systems and address complicated problems at several scales, resulting in increased system efficiency and reduced computational complexity. However, the long-term viability of smart cities is dependent on the technology used and the infrastructure in place, which differs from city to city and must be linked to Human Computer Interface (HCI), which is not always cost-effective [166].

## IV. Conclusion

Overpopulation, poor urban design and planning, poor mobility and public transportation, poor governance, climate change issues, poor sewerage and water infrastructure, waste and health issues, and unemployment are all challenges for smart cities. Smart cities have risen to meet these challenges by making the best use of available space and resources for the benefit of citizens [16]. A smart city model considers the city to be a complex adaptive system made up of services, resources, and citizens who learn through interaction and change in both the spatial and temporal domains. For city planners, the characteristics of dynamic development and complexity are critical issues that necessitate a new systematic and modelling approach. TCBM (Trusted Cloud Based Business Modeling) is a method for better understanding complex adaptive systems. The TCBM seeks to address complicated problems at many scales, such as micro, meso, and macro, in order to increase system efficiency and reduce computing complexity and cost [13]. We provide an overview of TCBM in smart cities in this study. Finally, the paper identifies existing research challenges and future scopes for TCBM in smart cities, providing a roadmap for smart city system optimization.

## V. Future work

The main motivations for the creation of the Smart City Initiative are to build a sustainable model for cities and to protect inhabitants' quality of life. From data generation and acquisition to data administration and processing to application level, the multilayer architecture and working flow of the smart city design are illustrated in a top-down way. The Internet of Things (IoT) intends to link billions of smart things to the Internet, giving smart cities a bright future [18]. These items will generate vast volumes of data and transfer it to the cloud for processing, particularly for knowledge discovery, so that relevant actions can be made. Sensing all available data items obtained by a smart object and then transferring the entire captured data to the cloud is, however, less beneficial in practice. Embedded computing (edge computing paradigm combined with cloud computing) must be facilitated in order to make smart cities sustainable due to inherited strengths and shortcomings.

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