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Towards A Service Oriented On-demand Cloud Computing Paradigm for Smart Cities

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Abstract: *Smart cities are advancing at a great pace. Advancements in wireless and sensor networks, information science and human–computer interfaces, urban computing etc. enable the integration of technologies that improve the living parameters of urban people, such as health care, urban planning, energy, and other factors. It's a set of intelligent computing solutions for managing key infrastructure components and services. In smart cities, a exclusively centralized cloud-computing architecture with elastic, on-demand, and pay-as-you-go computing resources likely to increase storage capacity and processing speed. Cloud computing adds scalability and on-demand computational resources to simulations of urban systems, allowing for more accurate forecasting. Cloud computing enables smart cities to store and access data and applications outside of their local computing environment using computer networks. As IoT has become more pervasive, smart cities can collect a lot of data and use it with edge applications. Data and applications also bring new challenges, such as; the need for nearly real-time feedback, privacy, and the need to send large amounts of data over network infrastructure. The service orientation reference model is the main reference model for cloud computing systems. It uses the idea of services as the main building blocks for application and system development. Service Oriented Computing (SOC) enables us to make low-cost, flexible, interoperable, and adaptable applications and systems. SOC introduces and spreads two significant ideas that are also central to cloud computing: quality of service (QoS) and software-as-a-service (SaaS).This paper proposes an ITes-based service-oriented on-demand cloud computing paradigm for smart cities.*

Keywords: *Smart City, Cloud, Internet of Things (IoT), Supply Chain Management, On- Demand Service Oriented Cloud Computing.*

1. INTRODUCTION:

The purpose of the Smart Cities Mission is to drive economic growth and improve people's quality of life by enabling local development and utilizing technology, particularly technology that results in Smart outcomes. An ICT-based framework, characterized as a "smart city," is used to develop, manage, and promote sustainable development methods for resolving the mounting issues of urbanization [24]. People, machines, and devices are now all integrated owing to recent advances in information and communications [3]. It has had a significant impact on every facet of our life. Often these daily activities in the business, government, health care, education, and other fields are now processed electronically, generating in large datasets and ushering in the era of BigData [24]. It is becoming extremely prevalent for cities around the world to develop and implement smart city projects in order to address a wide range of issues, such as traffic congestion and energy shortages; environmental pollution; a lack of economic opportunities; public safety; public health; social wellbeing; and high-quality education[24]. There have been a large number of applications for these smart cities in areas such as transportation and the environment as well as public safety and security. The internet's ability to provide a wide range of applications and services is being dramatically enhanced by the advancement of cloud-based technology[28].Cloud-based smart city applications can improve the way information is used while also making users' lives smarter and more easy[25].The success of cloud computing in terms of cost, global size, speed, performance, efficiency, security, and safety has led to its use in smart city technology[25].Cloud computing enables servers, storage

areas, databases, and a wide range of application services freely accessible via the internet, facilitating the integration of systems in smart cities and the transmission of information between them[40]. Cloud computing has had a significant impact on business service and individual application solutions. [19].

IoT and cloud computing have proven to be beneficial in so many ways. Many people are aware of IoT policies relating to smart cities, smart homes, etc. IoT is significant for integrating smart city responses into business tools and paving the door for high-quality input in healthcare, transportation, logistics, energy, and many other industries[19]. The benefits of cloud computing in IoT are numerous. IoT and cloud computing are perfectly compatible and both aim to increase the efficiencies of day-to-day operations. IoT interacts with smart cities but generates large volumes of data. Cloud computing, on the other hand, brings up new options [19]. IoT and cloud computing work together to improve integration across the board, from service possibilities to remote data access[19]. Supply chains are defined as a "network of connected organizations that work together to organize, manage, and optimize the delivery of resources and information from suppliers to end consumers." An organization's supply chain can be broken down into a number of value streams using Cloud technology, Internet of Things (IoT) and other technologies to share information and services from the manufacturer/supplier to the consumer/customer. Cloud computing systems use interoperability, virtualization, data management, and platform management in supply chain information sharing [19].

Cloud computing will solve real-time information demand and inventory visibility in DeM and DM (DiM). Cloud-based real-time data travels backwards as inventory moves forward. Importantly, goods and services are delivered promptly and consistently [26]. When customers and suppliers share more data, it's easier to balance supply and demand across the network. It reduces lead time, helps to defeat the bullwhip effect, and optimizes supply chain management [26].

From the user's perspective, the on-demand-self service facility in smart cities is inadequate because infrastructure such as internet access and IoT devices varies with geographical and socioeconomic status. This study suggests ITes-based on-demand cloud computing for smart cities [11].

2. BACKGROUND:

Smart city and its sustainability factors

A sustainable, efficient, equitable, and livable city is what we mean when we talk about being "smarter." An ICT-based framework, known as a "smart city," is used to develop, implement, and promote sustainable development methods to solve the rising issues of urbanization. [13].

Various new challenges will arise when the urban population grows rapidly and the demand for resources rises as a result. Changing paradigms in how cities operate in terms of sustainability is highlighted by this fact to determine the scale at which a system's sustainability can be measured. Global sustainability requires a different set of actions than urban sustainability. There isn't a single best-known definition of sustainable urban development. Despite this, a common set of attributes for urban sustainability exists [23]. For example, ensuring that future generations are treated equally are important considerations as are retaining the original environment, reducing the consumption of non-renewable resources, encouraging local autonomy and citizen well-being as well as meeting the most basic human needs. [13].

There are three aspects to sustainability: the environmental (ecosystems and resources), economic (energy generation), and social (community) [20]. These traits integrate all three. A city's economic vitality and variety is part of its economic vitality, where as fairness, community autonomy, citizen satisfaction of basic human needs, and community well-being comprise up the social dimension. Cities can be called sustainable when they meet certain objectives in terms of equality, environmental protection, economic vitality, and social well-being [20]. Smart cities are considered as resilient and inclusive cities that are developed cooperatively and utilize different types of technology and data to improve the quality of life for all of their citizens. A city can be considered as a community that performs in six areas: the environment; economics; mobility; people; living; and government [20]. They are based on a combination of human, infrastructural, social, and entrepreneurial capital and are developed from creative knowledge-intensive techniques aimed at improving cities' socioeconomic, ecological, logistical, and competitive performance. Participatory governance and resource management help to ensure long-term economic growth as well as a high quality of life for the citizens of these societies. [20].

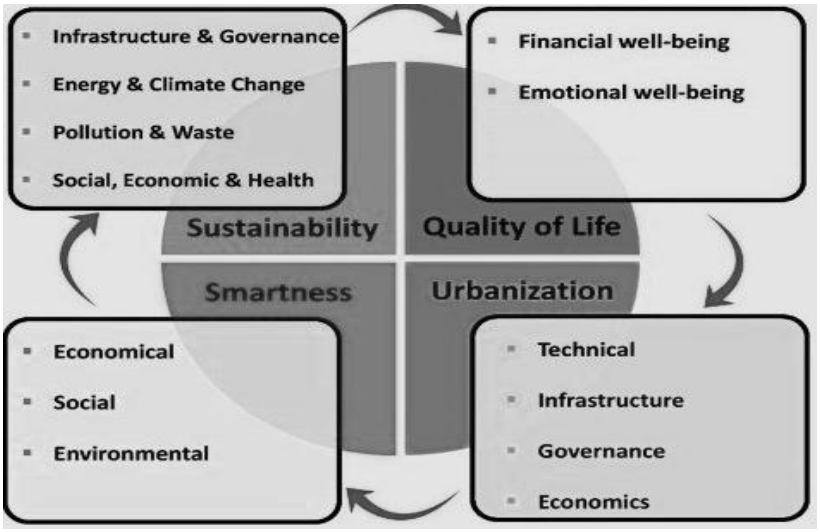

Fig. 1: Smart City Scenario

The term "smart city" has been defined in a number of different ways by a number of different researchers, but the most common definitions include the following aspects[30]: (a) increased administrative and economic efficiency that enables the development of culture and society through the use of networked infrastructures; (b) an underlying emphasis on business-oriented urban development; (c) a strong focus on the goal of acknowledging the social inclusion of various types of urban residents in public services; and (d) an emphasis on the significance. A focus on equity in income, employment, housing, basic services, social infrastructure, and transportation in urban areas is a primary goal of sustainable urban development, which takes all of these factors into account. Sustainable urban development seeks to find a balance between urban development and environmental protection [34]. The rise in popularity of smart cities and related concepts can be attributed to a number of factors, including the fact that the majority of the world's population lives in cities, climate change, the depletion of natural resources, globalization, and increased competitiveness [30]. Citizens of smart cities are able to take advantage of technological advancements to improve their quality of life (QoL) and reduce environmental impact [27].

Cloud Computing and IoT

The cloud computing model is the progenitor of distributed computing, parallel computing, and grid computing [32]. Cloud computing is similar to the internet in that it distributes computation across a large number of distributed machines rather than local or remote servers [32].

In other words, cloud computing is a networked system that manages, stores, and processes data using Internet-hosted far away computers. It is the on-demand availability of computer services over the Internet that enables corporate innovation, agility, and growth by leveraging digital technology trends. The primary goal of cloud computing is to give organizations remote access to data centers and the ability to handle tasks. Pay-as-you-go pricing is used in cloud computing, which allows enterprises to reduce operational costs and improve infrastructure efficiency. In the recent trend, cloud computing and IoT (Internet of Things) are two of the most highly contentious topics in technological fields [36]. Despite of the fact that these are two distinct technologies and are intertwined [5].

In the Internet of Things (IoT), there are many networks. There will be a system in which all of the electronic gadgets in a local area are connected to each other when these systems are connected, the Internet of Things will be able to function as an unified, integrated system [22]. In the Internet of Things, devices or nodes function as active sensors and actuators that collect data and perform ground-level processing. The Internet of Things (IoT) seems to have had an impact on a wide range of industries, including supply chain, education, and architecture [22]. It has done it all, from making human life easier to giving security checks, sitting on new faults, automatic data transfer, robotics automation, and even creating a toast for people. In the Internet of Things, sensors and other components communicate with each other through physical connections [22]. Data storage, security, and other IoT features have all been enhanced thanks to the development of wireless communication methods. Integration of IoT and Cloud Computing has increased multiple options and created doors for domains that operate with enormous volume of data and IoT Cloud integration [22].

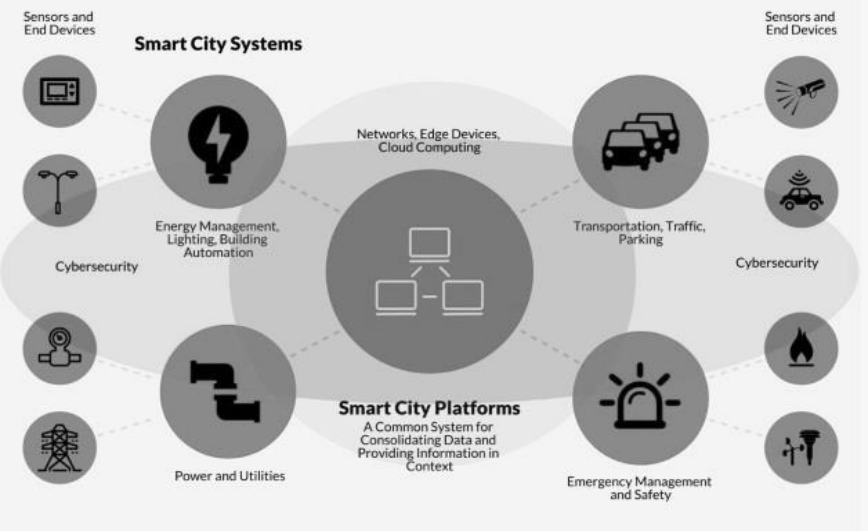

Fig 2. Cloud Computing and IoT in Smart City

Cloud computing and the Internet of Things (IoT) have become progressively prevalent in recent years. Cloud computing and the Internet of Things (IoT) are becoming an important aspect of smart city technology because of their many advantages, including their low cost, global size, high speed, performance, efficiency, and overall security[25]. Smart city systems may be readily integrated and exchanged information over the other due to cloud computing. The Internet of Things (IoT) enables practically every client to request necessities and have them supplied together with connected services. [25]

Cloud Computing in Supply Chain Management

By using cloud, businesses can re-imagine their supply chain management from planning and sourcing to production, logistics and distribution as well as obtain new insights for decision making and automate processes[19]. As a result, more resilient and smarter supply chains may be built [19]. Organizations benefit from unprecedented supply chain visibility and agility because to the cloud's ability to connect and scale the supply chain in real time. In the SCM field, cloud computing is having a major impact. The SaaS (Software as a Service) module will execute functions such as planning and forecasting, e-procurement, warehouse management systems, logistics systems, and collection systems. The use of SaaS solutions helps to reduce uncertainty by providing on-demand information regarding product or information flow in forward or reverse flow [19].

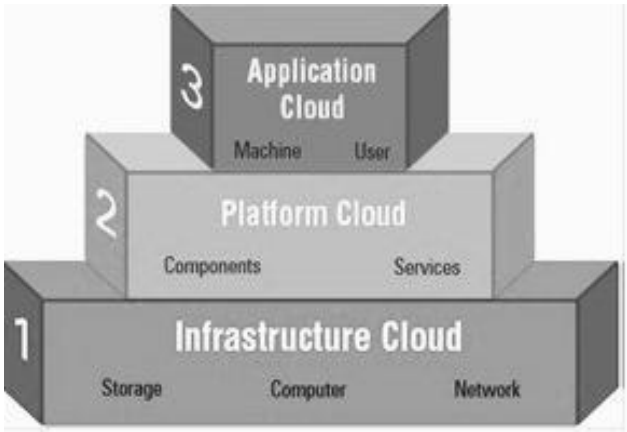

Fig 3. Business Model for Cloud Computing

The cloud computing structure makes use of a variety of technologies, including consistency technology, online tracking technology, statistics supervision technology, and proposal supervision technology. The cloud computing system seems to be very reliable as it is always updated. It gives clients the ability to give themselves more or less computational capabilities as needed. [2]. This is referred to as adaptability. Flexibility ensures that on-demand services are available to clients at any point in time. This cloud computing feature makes it possible to reduce uncertainty. The

cloud provides flexibility services from which any SCM client can benefit. The SaaS of cloud can be accessed by the echelons of any organization that has different branches in different geographical locations [16]. If an organization is dispersed across the globe, each unit will require its own cloud communications system. As information allocations must be consistent and trustworthy across a wide variety of organizations, there is no need for a concealed cloud system in the future[7].The allocation of secretive cloud communications has been completed in a trustworthy and secure manner. Furthermore, any organization should use a disseminated information centre under a confidential cloud state of affairs with a centralized Cloud information hub. Implementing CC for SCM enables decision makers in any organization to make the right decision at the right time, right place, right product, and right quantity [7]. SaaS Cloud assists decision makers by reducing uncertainty and, as a result, the Bull whips effect. SaaS Cloud provide a low price method to get SCM functions, effectively works on budget constraint, rapidly transfer information about any products with help of RFID tag, enable organizations to try innovations at a lesser price with no long-standing commitment with benefits such as; and detriments are Scalability, Immediacy, Cost control, Elasticity, Accessibility, Competence and Optimization[7].

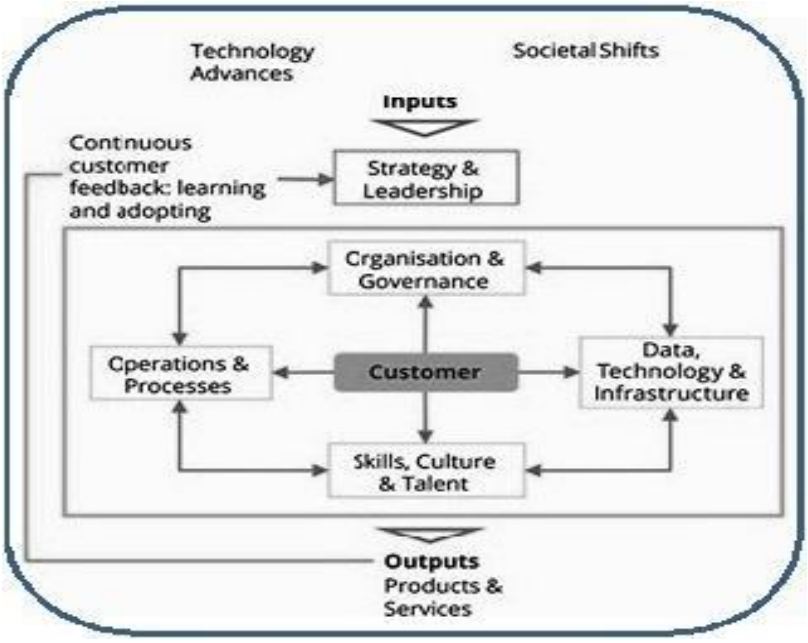

Fig 4. The Smart Supply Chain System

3. MOTIVATION:

Smart cities are defined by a number of elements, including big data, innovative infrastructure technologies, and Internet of Things [18].To begins, and the Internet of Things is the most important smart city landscape property. IoT is growing in importance in business supply chains to sense, monitor, and interact within a company and between a company and its supply chain, enabling for agility, visibility, tracking, and information sharing to facilitate timely planning, control, and coordination of supply chain operations [18]. Smart city businesses rely on gathering and managing the proper data, evaluating patterns, and enhancing system functions. Cities' digitization produces massive amounts of operational and supply chain data. Big data may therefore be both an advantage and a challenge[18].The analysis of big data can provide insights for product launch and release planning, enabling for shorter planning cycles and more effective execution. It can also enhance customer segmentation, allowing for increased product scalability and mass customization. In addition, field data from devices, user data, and supplier suggestions can all contribute to the enhancement of product design and innovation [18].

Despite the fact that big data is essential for smart city success, it also raises a number of challenges. There will be risks of incorrect data input and erroneous correlations [18].New surveillance and data abuse challenges are also a source of concern. As a result, government agencies may choose not to make their big data available to entrepreneurs, which would be a major economic setback. [18].

In order to handle supply chains effectively, smart cities require new infrastructure and management systems and most significantly, the complete Smart City Supply Chain System must be functional in terms of user satisfaction, providing requested services with all security measures in place. In smart cities, this study suggests a service-oriented on-demand cloud computing model [18].

4. CONTRIBUTION AND PROPOSED FRAMEWORK:

This research work presents a novel paradigm for the supply chain and discusses its implications. This paradigm makes use of information and communication technologies, in addition to other tools such as exploring big data from the internet of things (IoT), with the goal of improving the quality of business operations, the efficiency of operational processes, the quality of service, and the level of competition [17]. This is done so that the demands of the current generation as well as the needs of future generations may be met, while also taking into account the effects that economic, social, and environmental issues will have. Big data analytics in the context of a sustainable smart supply chain refers to a collection of complex software programmes and database systems that are powered by sophisticated processing equipment that is able to handle enormous amounts of data [17]. As a direct result of this, various sources of data involved in the supply chain need to be gathered, saved, processed, assessed and incorporated into the operations, functions, and plans in SCM that pertain to smart cities. Data mining is a process that consists of a number of discrete processes, some of which are information comprehension, data preparation, modeling, evaluation, and implementation [17]. Both of these processes are concerned with the environmental sustainability of an area and seek either to discover new information or to exploit large populations. The information functions for decision making, decision support, and automated decision making are all included in the knowledge that has been discovered or extracted [17]. Examples of information functions that can be utilized for both real-time and long-term decision-making include management, control, automation, and optimization, to name just a few. This framework collects, integrates, pre-processes, and converts user data from various domains of the supply chain based on service oriented on demand indicators of supply chain management [38].

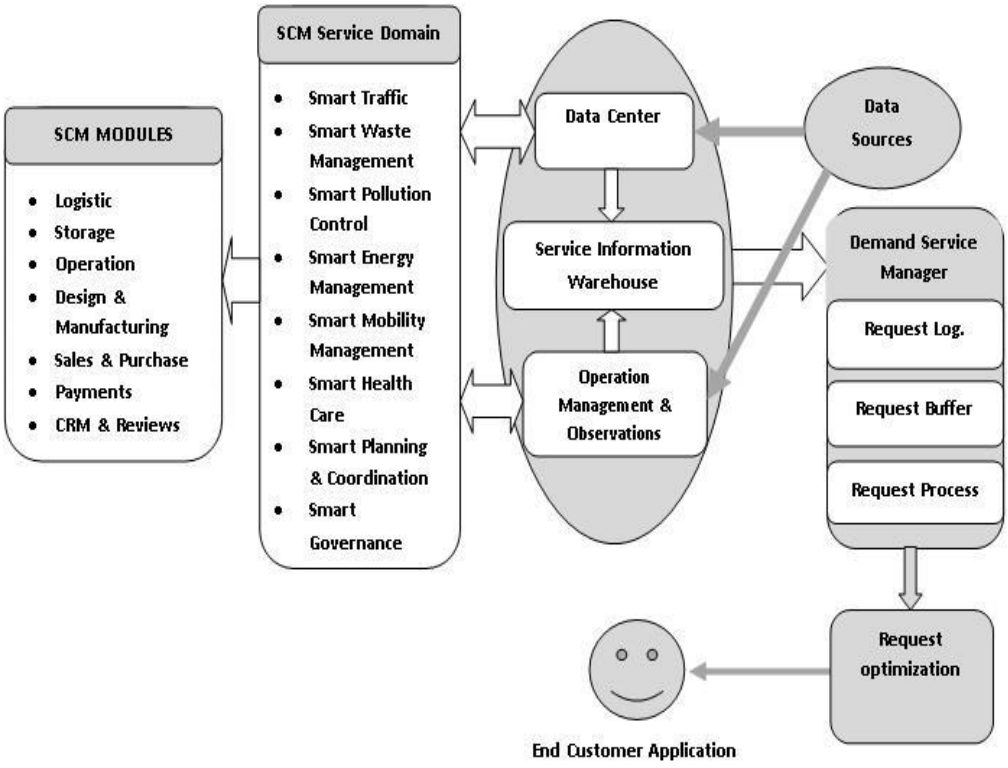

Fig 5. Proposed service oriented on-demand Cloud Computing Paradigm.

The proposed paradigm is made up of five major modules, which are discussed above in the Fig.5.

Module for SCM: This module defines the set of related services that the customer requires in a smart city.

Domain of SCM Service: The module defines the various SCM services that can be provided.

The Data Center, Service Information Warehouse (SIWH), and OMP (Operation Management and Observations) are used for data collection and storage.

Demand Service Manager (DSM) processes user requests for services and optimizes and provides them in real time to end user applications.

4. LIMITATIONS AND FUTURE WORK:

Because of the geographical and socioeconomic disparities, the paradigm's performance criteria in terms of urbanization may be impacted. As the SCM process in smart cities is driven/controlled by a third-party vendor, it must be secured. Block chain technology can be used to offer security for the SCM paradigm [17].

5. CONCLUSION:

There would be more smart cities in development as urbanization advances. We must increase the quality of our businesses in order to meet our customers' needs for the present and future generations, while also ensuring that these cities are sustainable in terms of both economy and environment.

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