ICTs FOR SMART CITIES

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Abstract

Cities all around the world endeavor to advance in arrange to reply to the upcoming challenges that the increment of populace brings. The integration of technological arrangements addresses these challenges and facilitates citizens' needs. The smart cities concept alludes to the technological advancement of cities for progressing services and quality of life by joining innovative technological standards. The purpose of this paper is to focus on smart cities by using Information and Communication Technology (ICT) to support different aspects of the worldwide marketplace driving expanded economic development. Usually interrelated with a country's quality of governance, It aims to underline the importance of Security systems in Smart Cities, but also to create world-influencing urban, and governmental methodologies, and sustainable economic growth in global business and investments. In any case, IoT (Internet of Things) integration within the cities infrastructure, requires new technology (sensors, wireless communications, cloud computing, etc.), to guarantee a dependable associated framework.

The results regarding the effectiveness of the cyber-security system show that this technology is particularly promising for the smart city concept. Generally, our discoveries highlight the requirement for the sending of a crowdsourced-driven digital measurable status system, received by all the individuals and parties of a smart city, continuously taking into thought the development level that it has accomplished. The Blockchain and smart contracts are proposed to illustrate how they contribute to the system for digital measurable preparation by keeping up the Chain of Guardianship keenness and advertising a few of the essential built-in highlights, such as unchanging nature, transparency, non-repudiation, and versatility.

The smart concept is a recent subject and there are few studies on this theme. This paper contributes to the discussion about the opportunity of regarding ICT as a possible source of competitive advantage of smart cities in urbanization and global Business. It will hopefully provide valuable input for future researchers who tackle the same subject.

Keywords: ICT, Blockchain, Cybersecurity, Smart cities.

Introduction.

The fast advancement of the IoT and Big data is regularly considered the most factor within the execution of smart cities' services. Any sort of inefficiency in this basic network can cause enormous loss of time, devaluation within the level of safety, high pollution, and debasement in the quality of life. A smart city benefits from information collection and handling by utilizing diverse technologies of communication, networking, and computing, which in turn leads to the development of smart services over diverse divisions counting health, transportation, security, and more. A future smart city infrastructure must be able to coordinate the smart area into a coherent smart city concept. Vitale components in this concept are the Internet of Things (IoT), and Artificial Intelligence (AI) connected through inescapable and always-connected communications. IoT is a crucial component in smart cities that produce Big data. (Chimeh & Mazoochi, 2020).

Considering this quick growth, the governments are ordered to conduct major advancements to their particular cities' infrastructures to handle the developing requests of the inhabitants. The quick increment in cities' populaces will, in the long run, lead to plenty of issues, such as pollution, clashes over water resources, traffic congestion, and health frameworks that cannot adapt to the expanding population. Such issues may surpass the capability of providing adequate services for the residents (Neirotti et al. 2014).

ICT includes the collection, planning, saving, and distribution of information, counting content, sound, video, and pictures, which are gotten to and extricated utilizing computers and telecommunication innovation (Niebel, 2018). ICT is an umbrella term for any of the following modes or applications: the internet, mobile/cellular phones, computers, network hardware/software, satellite communications, and electronic/digital tv on cable or aerial systems (International Telecommunication Union (ITU), 2017).

The move towards smart cities has ended up an advancing event, particularly with the fast increment in civilized populace development and the exponential progressions in technology (Ijaz et al. 2016). In any case, what precisely could be a "smart city"? According to Baig et al. (2017), a smart city could be a technologically advanced urban zone that comprises primarily four components: smart grids, building automation systems, unmanned aerial vehicles, and smart vehicles. The smart city envisions an associated environment that's accomplished through viable empowering technologies such as the IoT. Furthermore, various sorts of IoT sensors ought to be utilized to empower the utilization of a large number of services such as smart parking, traffic blockage level monitoring, smart traffic and road lighting, and structural health mindfulness.

Ijaz et al. (2016) contend that a smart city ought to comprise five major components, specifically: smart commerce (real domain, banking, and finance), smart environment (energy management, waste management, and water administration), smart governance (government, security, health, infrastructure, and education), smart communication (identity and communication), and smart mobility (transport and traffic).

Experts around the world are concerned about Cybersecurity vulnerabilities in Smart Cities. The Internet of Things (IoT) gives a broad "surface area" for hackers to assault. Cities will have to create cyber security skills and remain side by side with the continually advancing dangerous environment. They will get to get ready for how to reply breaches-including not as it were specialized remediation but how they will keep up calm and how they will communicate. (Kaplan, 2015, Bughin et al., 2018). Whereas the already said cybersecurity procedures and methods can be utilized to counterattack hackers, new and more complex cyber-attacks are continually being created (Mohamed et al. 2020). Hence, it is basic to examine the deficiencies of the execution of the actualized data and cyber security administration, and to what degree security layers and procedures ensure the computerized life of the inhabitants of smart cities. In expansion, the sum of cyber security information of the people must be inspected to decide whether they have satisfactory Cybersecurity information to secure themselves.

ICT may influence different viewpoints of economic activities such as the creation of occupations, expanding salaries, progressing business activities, giving available information and communication technology ICT, improving education services, advancement, and human capital advancement. All these exercises lead to social and economic sustainable development.

This paper focuses on the concepts of smart cities by using Information and Communication Technology (ICT) to support different aspects of sustainability processes. Technologies such as the Web, individual computers, and cordless phones have created an interconnected worldwide network of people, businesses, and governments. For the created world, a modern telecommunications framework is a prerequisite for taking an interest in increasingly competitive global markets and for pulling in foreign direct investment that, in turn, contributes to the spread of technology and riches creation. (Bon et al., 2016)

Based on the above, the specific question is: Can smart cities be important to increase the perceived in the quality of life and business environment?

To reach our aim we will tackle these three questions:

1- What is the effect of smart technologies on quality of life?

2- What is a general perception of a city where cyber-crime scenes could be detected on time from the position of investors and business owners?

3- What is the effect of safe Smart Cities to create and build an image of a safe location for new investment?

At last, this paper proposes a new system of smart security and its impact on the quality of life and sustainaibility. It relates to various domains of social and global economic development via smart technology. However, the most outstanding facet is the security sector. This paper is conducted to benefit the ICTs and the blockchain with Cyber security , thereby contributing to sustainable development and helping to create and build an image of a safe location for life and business.

Literature review.

Nowadays, over 50% of the world's populace resides in cities, and it is detailed that urban residency will reach 68% within the following 30 years. Agreeing to the United Nations, the world populace will too increment by 2.5 billion in 2050. This huge development will force a few challenges on cities, counting the economic administration and improvement of urban regions as well as the capacity to ensure an amazing quality of life for citizens. Hence, the advancement of smart cities ought to be considered

both a successful and pressing arrangement to support the few needs of this developing populace. On the other side, the quick advancement of the IoT and Big Data analytics is frequently considered the most calculated within the execution of smart cities (United Nations, 2018). (**Figure 1 and 2, Appendix A**, UN, 2015).

Literature reveals that society is faced with a large number of security issues, justifying the need for Smart Cities to continue thinking about ways to address the problem. The increase in the urban populace increases the requirements for mobility and the expanding utilization of nourishment and energy. This leads to an increase in living costs, the misfortune of time (e.g., in traffic), and the improvement of poor living habits. That's why there's a need to discover inventive arrangements that will improve the quality of life of citizens, ensure sustainable economic development, and use smart security in cities, to protect the districts from over-urbanization. The solution to these issues lies within the concept of smart cities and advanced technologies. The Smart City concept involves various application areas. Considered that the most important are shown in (**Figure 3, Appendix B,** Lim et al., 2018)**.**

Sustainable urban advancement implies "achieving a balance between the development of the urban zones and assurance of the environment with an eye to equity in income, business, shield, fundamental services, social infrastructure, and transportation within the urban areas" (Huang et al., 2009). The European Commission-Directorate General for Regional Policy (2011), propose that Urbanization is not as it making space for living or working, but they too pick up an intelligent and global measurement (Ekblom, 2017). We can presently watch the advance towards economical urban improvement, which isn't as it were due to dynamic urbanization, but moreover due to developing crises in numerous regions of life. In practice, these exercises regularly target a circular economy, green growth, or smart growth. Although the concepts of economical city advancement take into consideration social, financial, and natural components, as was last mentioned is treated as a need (Robinson & Cole, 2015).

In the meantime, arranging city improvement requires a systemic approach that takes all aspects of its working under consideration to a rising degree (Höjer & Wangel, 2015). Moreover, Evangelista et al. (2014) examine the economic impacts of computerized technologies on numerous subordinate economic factors (work rate, work efficiency, and GDP per capita) for 27 European nations from 2004 to 2008. They utilize a collection of complex ICT markers to discover the finest depiction of ICT and how it enables people socially and economically. Numerous transmission instruments are distinguished, such as get to ICT, as well as primary pointers related to ICT, counting utilization, framework, and strengthening. Results appear that digitalization is one of the foundations of economic development and contributes to the creation of new employment for disadvantaged individuals.

In smart cities, road lights, air pollution, car meters, electricity usage meters, smart cameras, temperature, and humidity sensors, etc. are all controlled through the Internet of Things (IoT). Six vital criteria in a smart city are an innovative economy (stock exchange, e-banking, etc.), smart transportation, smart environment, smart citizens, intelligent behavior, and smart regulation for example The electronic government (**Figure** 4). Two-layer of smart cities are outlined in (**Figure 5**). These layers incorporate the equipment framework in layer 1 and smart applications in layer 2. Smart individuals can be within the third layer. Other than that, smart cities ought to incorporate quickening agents and new companies.

Otherwise, smart cities must house accelerators and new companies, such as web taxis, computerized stores, and our companies based on modern technologies. Accelerators are supportive of new businesses in many steps of development (**Figure 4 and 5, Appendix C,** IberdrolaA, 2016).

Agreeing to the UN-Habitat Key Arrange (2020–2023), Urbanization is right now one of the advanced world's major megatrends. It is a relentless and irreversible preparation. Modern cities are centers for a network of financial associations. Ours inquire about works with two concepts: Smart City and Secure City. The Smart City itself was characterized in our work as the city, that by the interconnection with the Secure City concept, and integration of technology and characteristic environment improves the effectivity of forms in each field of the city working to attain feasible improvement, security, and health of citizens in arrange to extend the living standard of citizens of the city and its locale. (Ristvej et al., 2020).

Cheng et al. (2021) inspected the relationship between monetary development, ICT dissemination, and economic development by taking into consideration the interaction between ICT and finance, the reason for their study was to capture the effect of financial development on economic development, employing a wide file of budgetary development by using the vital component examination. The results appear that ICT dissemination can improve economic development in high-income nations, but the effect is dubious in middle-income and low-income nations. For case, mobile telecommunications development will boost financial development in the center- and low-income nations, whereas development in web or secure web servers will not. The interaction term among budgetary development and ICT features a positive impact on all income-level nations, and this interaction may decrease the negative impacts of budgetary development, although the impacts are fair and critical for high-income nations.

Mim and Jeguirim (2021) measure the impact of ICT on economic development. The Internet utilizes advanced development altogether, and agreeing to estimation comes about. Most transmissions are either investment or human capital. This relationship between ICT and development isn't direct and is more serious in nations investing intensely in the ICT framework.

This section provides an overview of the smart city definition, ICT technologies for smart cities development related to (IoT, CoT, Big data, Blockchain, Artificial intelligence (AI), Cybersecurity), Smart Cities as an image of a safe location for life.

Smart City definitions
Urbanization has been reliably expanding over the last few decades, as an endless number of individuals migrate to big cities around the world to settle, work, and live. Thus, the concentration of individuals inside urban situations comes beside concerns for the living conditions, traffic air and noise pollution, and the expanded generation and amassing of waste. Proficient solutions for tending to sustainability issues that urbanization raises are basic with Information and Communication Technologies (ICTs) playing a critical part in tending to these challenges. Over the last few years, the move from a traditional to a smart city has come to the highlight, and this concept isn't a new one. The (International Telecommunication Union (ITU), 2014), has captured more than 100 definitions for depicting the smart city concept. In addition, the term "smart" isn't the only one utilized to portray urban situations that utilize technological enablers. These terms incorporate wired

city, connected city, intelligent city, and digital city (Mohanty et al., 2016).

Nonetheless, *some smart city definitions are* present in the literature, these definitions are demonstrated in Table 1 below:

Smart City definition	Author(s)
A city that monitors and integrates conditions of all of its basic infrastructures, counting streets, bridges, burrows, rails, trams, airports, seaports, communications, water, control, indeed major buildings, can way better upgrade its assets, arrange its preventive maintenance exercises, and monitor security perspectives whereas boosting services to its citizens.	*Hall et al. (2000)*
A Smart City is a city well performing in a forward-looking way in these six characteristics (economy, mobility, environment, individuals, living, governance) built on the "smart" combination of blessings and exercises of self-decisive, autonomous, and mindful citizens.	*Giffinger et al. (2007)*
Regions with a high capacity for learning and advancement, which is built into the creativity of their populace, are educated in knowledge generation and their digital frameworks for communication.	*Hollands (2008)*
a city is smart when investments in human and social capital and conventional (transport) and advanced (ICT) communication frameworks fuel maintainable financial development and high quality of life, with wise administration of characteristic assets through participatory governance.	*Caragliu & Nijkamp (2009)*
a city may be called "smart" when investments in human and social capital and conventional and advanced communication infrastructure fuel-economical financial development, and a tall quality of life, with wise administration of normal assets through participatory governance.	*Schaffers et al. (2011)*
Smart City could be a city that employments information and communications technology to form its basic infrastructure, components, and utilities more intelligently and proficiently, in this manner making citizens more mindful of them	*International Study on the Situation of ITC (2012)*
the smart city is the system of frameworks, and the presence of rising opportunities to present digital nervous frameworks, intelligent responsiveness, and optimization at each level of	*MIT, 2013*
framework integration	
Smart cities combine assorted technologies to decrease their natural effect and offer citizens way better lives. This is often not, in any case, basically a technical challenge. Organizational alter in governments and undoubtedly society at large is fair as essential. Making a city smart is hence a multi-disciplinary challenge, bringing together city authorities, inventive providers, national and EU policymakers, academics, and civil society	*Smart Cities and Communities, 2013*
A city looking to address public issues through ICT-based arrangements on the premise of a multi-stakeholder, municipally-based organization	*Manville et al.,2014*
A smart city employment information and communications technology to upgrade its livability, workability, and sustainability.	*Smart Cities Readiness Guide, 2015*
A "Smart City" is a sustainable and innovative city that uses ICTs and other means to improve the quality of life in urban areas and the efficiency of operations and competitiveness, without harming the future progress in the city concerning social, environmental, and economic wellness.	*United Nations (2016)*
A city is deemed smart if it equalizes economic, social, and environmental improvement and if it joins up to majority rule through a participatory government. Smart City includes the usage and arrangement of information and communication technology (ICT) frameworks to back social and urban development through progressing the economy, citizens' inclusion, and government proficiency	*Yeh,2017*
A "Smart City" is a municipality that utilizes information technology to enhance operational efficiencies, share information with the public, and improve governance and social welfare. From these definitions, a "Smart City" can be rightly defined as a new technological approach that harnesses the technological potential to foster social, economic, and environmental sustainability. This definition also fosters a possibility to argue that the scopes of activities that make a "Smart City" are broad. The broadness and lack of standards allow each urban community to develop different developmental models and label them as "Smart Cities".	*Rouse, 2018*

Smart cities as an innovatively progressed and modernized domain with a certain intellectual capacity that bargains with different social, technical, and economic perspectives of development based on smart computing strategies to create prevalent framework constituents and services.	*Nripendra et al. ,2019*

Table 1: Smart City definitions

These definitions rotate around technological integration and maintainable improvement, another perspective of a smart city that develops over the last years is the human figure, in specific citizens' support. Despite the uncertainty of the smart city term, the central idea of the term lies within the utilization of advanced and state-of-the-art ICTs. The objective of advanced ICTs integration incorporates the advancement of management forms and administrations of a city and the quality of citizen's life.

ICT Technologies for Smart City Development.
States presently executing new technologies to change over into smart cities. It is exceptionally basic to require the concepts of smart cities as a technology with individuals. Numerous challenges to solve for changing over cities into smart cities. The most component of smart cities is the IoT, with the utilization of Artificial Intelligence, and the usage of blockchain (Singh et al., 2020). The utilization of (AI) within the hazard evaluation can give new measurements as the AI can distinguish intrusion, data hack, and information leakage (Raghuvanshi & Singh, 2020). So, usually the challenge we ought to actualize and to secure our lives and privacy from ruddy group attacks utilizing conventional ways or indeed to hack utilizing (AI) frameworks. (Al Sharif & Pokharel, 2021).

The smart city is an urban advancement extend that employments information and communication technology to improve the effectiveness and viability of its operations. Its core technology is based on the concepts of privacy, security, and reality. We propose a comprehensive approach for tending to the security and privacy issues of the information administration interface of smart city applications. It is based on the concept of "holistic Big Data integrated AI." The Big Data analytics assisted privacy to conspire has been actualized to progress the effectiveness and security of the information administration interface of smart city applications. It also supports the adaptability of the information management interface. (Chen et al., 2021).

Risk evaluation and treatment are together called "processes of risk administration." They are the foremost critical milestone in data security for companies, organizations, and smart cities. Additionally, the hardest milestone in executing data security is usually, the method of collecting the risks, assessing them, and treating them. this process gives us the foremost critical risks to bargain with and additionally the capacity to treat them based on the foremost vital treatment against privacy, integrity, and accessibility (Kalinin et al. 2021). This handle gives us how much data security controls to execute other than the sum of cash to spend on each data security control which is called security appetite. To be able to reach the residual risk which is the form of the security acknowledgment where the upper administration can accept it. (Kosutic, 2021).

The double network permits the macro-cellular arrangement to act as the control plane and the little cells to act as the client plane. The control plane is dependable for signaling between networks and the client plane is allotted for information services (e.g. video spilling or calls). Telecom suppliers are pointing to overcoming the challenges of the indoor dependable network through the utilization of small cells, with suppliers pointing to extending the number of little cells by 900% from 2018 to 2026. (Marek, 2019; Galal & O'Halloran, 2020; Osseiran, 2022). As appeared in **(Figure 6, Appendix D,** Authority ACMA, 2016), this permits clients to connect to two systems at the same time.

Future smart cities require ICT technologies as a center to be able to handle the inventive smart city challenges. These ICT innovations must join a strong, sustainable, and profoundly leveraged network that gives network, smartness, security, and effective vitality administration. Within the following, the most contributing technologies are discussed. They are IoT, CoT, Big data, Blockchain, Artificial intelligence (AI), and Cybersecurity.

Big data
Big Data could be viewed as a technological enabler of a smart city. The utilization of IoT and other future web innovations give a gigantic sum of Data (Big Data). The work of big data plays a key role in upgrading given services in a smart city environment through the utilization of the correct devices and strategies for a viable information investigation. This information investigation will progress and contribute to the communication and improvement of new services that will benefit citizens and allow for a better client experience. Information created by the interaction of utilized technological enablers and citizens with the smart city frameworks ought to be put away and continue for examining purposes to address current requests of the city environment. This information ought to be appropriately analyzed and overseen to extricate designs, which are useable for applications, services, and integrated ICT approaches like public health, public data frameworks, city administration, energy proficiency, transport, security, and crisis services, squander administration, and water management. Common for these services is that the information requires procurement, capacity, and handling on either a nearby smart city server or on a cloud-preparing stage. Handled information can be utilized for creating new services such as smart economy, smart governance, smart environment, and smart portability. Probabilistic Data Structures (PDSs) are greatly helpful information structures that diminish the time and space trade-off to an extraordinary degree compared to capacity and recovery and questioning information. (Dutta et al., 2013; Feng, 2020).

Although the forms of Big Data inside a smart city environment may be considered basic and accommodating, there are related challenges that must be addressed. The primary challenge is related to the cost of dissecting an endless amount of information. Another challenge is related to the low degree of automation in fast inquiries and the recovery of Big Data. Amid an emergency circumstance, where data retrieval is basic, the method must be quick. The automation of these frameworks in terms of information recovery and fast inquiry response should be considered. Utilizing these automatic strategies, it'll be possible, on occasion, to recover information while exercising earlier caution and effectively avoiding illicit acts. Automation will empower preventive interventions, crisis circumstances requiring quick addition, and post-event measurements (Pan et al., 2016).

Big Data has three characteristics as **volume**, **speed**, and **diversities**. A Big Data activity volume may be measured in petabytes or exabytes, constituted from billions or trillions of bits of information from millions of individuals or hardware. **(Figure 7, Appendix E,** Report ITU- Report M.2370-0, 2015) appears that the volume of M2M traffic approaches 5013 petabytes by 2019. It outlines non-video, video, and M2M portable traffic sorts particularly. Video traffic approaches 4200 EB and non-video traffic such as IoT and eHealth approach 600 EB by 2030.

Big Data innovation is basic for smart cities. However, since it is obliged by the accessibility of other technological enablers and devices, such as the IoT worldview and Cloud Computing, its stream must be kept up. The generation, investigation, and capacity of Big Data are all subordinate to other devices and technologies, as well as their accessibility (Hashem et al., 2016). Finally, mining huge information for knowledge purposes is challenging. Mining huge sums of information ought to be a fastidious method in arrange to secure important data when it is required. The essential highlight of Big Data is that it may make mining challenging. Information mining from datasets containing topographical data, for case, could be a difficult process (Pan et al., 2016).

Internet of Things (IoT)and M2M

The Internet of Things (IoT) alludes to the linkage and associations among billions of distinctive objects over the web to create a smart environment. Based on standardized communication conventions, these gadgets share and trade data over heterogeneous stages. (Gubbi et al., 2013). Thus, IoT upgrades the interactivity and effectiveness of basic frameworks such as those utilized in transportation, security, instruction, agriculture, and healthcare. The IoT is considered another huge step in the advancement of the Web.

The (European Commission, 2009) has composed an IoT activity arrange for Europe expressing that IoT will adjust the way our social orders work within the coming 5 to 15 years. A combination of Web and emerging technologies like remote communications, setting awareness, and inserted remote sensor systems change regular objects into brilliantly and context-aware IoTs These IoTs will offer setting mindfulness and communication highlights, and they will share a few levels of pseudo-intelligence depending on their preparing capability and expended control restriction. (Jianhua, 2010) It has been anticipated that 7 trillion wireless gadgets utilized by 7 billion individuals in 2020, i.e. more than a thousand gadgets for each human on the soil, (Klaus, 2008) numerous of these will be IoTs. IoT and M2M are utilized in Smart Cities. In IoT, sensors are controlled through the Web and incorporate all interactions between humans/apps/things. As the predecessor to the IoT, M2M has been utilized all through the decades as the standard innovation in telemetry indeed before the development of the Web itself, because it included an interaction between two or more machines without human intervention. Briefly, IoT may well be seen as M2M, but acting in a more extensive setting. **(Figure 8, Appendix F,** Avsystem.com, 2019)**.

The current state of the Internet of Things application layer protocols and their adjustment is to progress execution. Machine learning can help create and execute new protocols that can adjust powerfully (Donta et al., 2021). Numerous of the gadgets conveyed for the Internet of Things is being utilized in the wild. These incorporate monitoring basic frameworks such as power networks and telecom towers. Current approaches depend on a secret key that can be stored in non-volatile memory. This strategy is helpless

to exploitation due to its energy-consuming nature (Vaidya et al., 2021). The Internet of Things (IoT) could be a wide-scale arrangement that empowers different gadgets to communicate with each other. Its developing ubiquity has caused different security concerns. We consider points to clarify the different reasons why IOT security is critical and what the most recent investigation is doing to make strides in it (Garg & Singh, 2021).

Cloud of Things (CoT)

The CoT is imperative within the smart zone and smart city settings since IoT gadgets deliver a gigantic amount of data that must be stored and prepared. In basic terms, a CoT could be a pool of assets and calculation capabilities open through the Web. For smart cities combining IoT and CoT is significant, so that IoT information can be prepared and stored. Combining the pieces, an advanced ICT-based framework must include technologies such as IoT, CoT, blockchain and AI. Particularly, the AI portion is challenging since it is inserted into the IoT setting, which offers restricted assets. (Yamazaki, 2006).

Blockchain to secure IoT.

The term Blockchain alludes to a Distributed Ledger Technology (DLT) and depicts an arrangement of blocks that comprise bunches of confirmed exchanges list, which is called the ledger that is kept by the network as records without being conceivable to be changed. A duplicate of the ledger is gotten and stored by all the members of a Blockchain network, the nodes. Each block gets two parts, the block header and the main portion of it that incorporates an exchange counter and exchanges. The block header portion contains the header of the past block in arrange for the grouping of the chain to be accomplished. Each node of a Blockchain organize possesses one pair of deviated encryption keys, a public and a private, which are utilized for marking and confirming exchanges that are traded among nodes. The sender signs a new exchange with the private key and the recipient can confirm this new exchange by utilizing the public key of the sender. As of late, Blockchain innovation has pulled in the consideration of analysts in totally different zones. Zheng et al. (2018), have characterized the blockchain as "a grouping of pieces, which holds a total list of exchange records like customary open ledger". Blockchain was presented to back the usage of security techniques, but it has found employment in numerous other areas and zones of application as well. To improve the security of IoT applications, the thought of receiving blockchain with IoT applications was proposed. (Fernández et al., 2018). For smart cities, blockchain makes a difference in constructing a secure environment for their applications by adopting decentralized designs (Ali et al., 2018). Blockchain smart contracts are promising and advantageous innovations that can be utilized to manage forms between benefit suppliers and clients (Portmann, 2018).

As such, information judgment may be checked. Three sorts of Blockchains include public, private, and consortium Blockchains. Blockchain innovation is decentralized, in this way, there's no requirement for a centralized authority to oversee a blockchain organization. In arranging for the agreement to be achieved inside a network and reliability and consistency of exchanges to be guaranteed, agreement components are used. Some of the foremost prevalent agreement mechanisms of Blockchain incorporate the Proof of Work (PoW), the Proof of Elapsed Time (PoET), the Proof of Stake (PoS), Practical Byzantine Fault Tolerance (PBFT), and Delegated Proof of Stake (DPoS). Each agreement component has different qualities and weaknesses in terms of node personality

administration, vitality reserve funds, enemy tolerance, and the requirements of each blockchain application. Also, throughput is characterized by the number of exchanges that are stored in the ledger per second. The throughput of convectional Blockchain, such as is constrained, as in Bitcoin. The throughput of Bitcoin is restricted to seven exchanges per second, due to the complexity of the PoW agreement instrument that's utilized (Zheng et al., 2017).

The blockchain workflow is displayed in **(Figure 9 and 10, Appendix G,** Baru, *2018*). The creation of an exchange is the primary step within the blockchain network, in a request form. The asked exchange is broadcasted into a Peer-to-Peer (P2P) network. Other hubs can approve the status of nodes and exchanges. Once a transaction is confirmed, it is combined with other exchanges and stored in a new block that will be included in the chain as a record. Once the new block is produced and added to the chain, all the duplicates of the ledger are upgraded. Blockchain technology has different highlights related to security and privacy, such as solid cryptographic strategies, permanence, transparency, and resilience. The dispersed measurement of blockchain increases its flexibility (GSMA, 2018). Due to the decentralized and disseminated highlights of the Blockchain, the ledger can be stored over diverse frameworks, gadgets, and areas of the network (Kosba et al., 2016).

The security and privacy of the network are accomplished by utilizing solid cryptographic procedures that are connected over the ledger and the network in general. Some of these methods incorporate hash capacities, deviated cryptography, a public-private key plot, and digital marks. (Fernández-Caramés & Fraga-Lamas, 2018).

Blockchain innovation has ended up being well known as a portion of the most celebrated cryptocurrency, Bitcoin (Nakamoto & Bitcoin, 2008). Indeed, its capabilities can be connected to numerous other existing innovations and fields to encourage progress. As of now, it is connected over budgetary advertising, primarily due to its involvement in cryptocurrency plans, IoT, supply chain, e-voting, healthcare, and storage. Moreover, it gives security where it is connected due to the solid cryptographic techniques that it employments and resilience due to its conveyed nature. A few of the elemental highlights of the blockchain include transparency, in that each member of the blockchain arrangement can get to the records of the conveyed ledger and check the information that's stored there. The members can check the computerized signatures over the information, so they can check the judgment of it. Additionally, all of them have access to the same information on the distributed ledger (GSMA, 2018).

Moreover, Blockchain Immutability, once a participant node of the peer-to-peer network verifies a transaction, usually recorded, stored on the dispersed ledger and gets to be part of the exchange history of the network. It is greatly difficult for a node to change the history of the dispersed ledger. For the Security of Blockchain, Strong cryptographic procedures are connected to over-dispersed ledger technology to secure its records of it. That every node within the network keeps a duplicate of the ledger records makes the technology more secure. (GSMA, 2018; Xie et al., 2019).

Blockchain technology and Decentralization are the most highlighted. The distributed ledger innovation does not depend on a central specialist, who checks the network, and its execution and endorses exchanges. Blockchain transactions have their confirmation of legitimacy and authorization to implement the

constraints. Since the blockchain employs agreement instruments to arrange for the nodes to work legitimately, the exchanges can be confirmed and handled exceptionally fast. All exchanges of Blockchain-based frameworks are digitally signed and stored in blocks, which are connected and secured utilizing hash functions. As such, all the modifications can be identified making the ledger unchanging. Each member may be considered "incapable" to create changes to the ledger and to deny their association with the network. (GSMA, 2018; Xie et al., 2019).

Numerous companies and organizations have invested vast sums of cash in the blockchain. This explosion of Blockchain applications has significantly altered how frameworks are designed, enabling better approaches to keep records of all activities that have occurred within a network and how dispersed, untrusted substances communicate with one another. On the other hand, despite the opportunities and the development of this innovation, the blockchain may be exposed to vulnerabilities and come with new risks which will not be found. These risks can impact organizations' and companies' systems and hurt their operation. In expansion; another challenge related to the Blockchain is the number of produced blocks and the increment of the ledger measure. In specific, within the case of the work of both, the Blockchain and the IoT worldview may raise challenges related to the execution of the final specified, due to the gadgets restricted capacity. The increment of the ledger measure in understanding the obliged memory capacity and capability of the IoT worldview may raise challenges related to the preservation of data. Traceability is an essential highlight of the Blockchain for avoiding improper behavior of clients and guaranteeing the security of the network. According to Möser et al. (2017), experimentally assessed two link ability-related weaknesses of blending methodology on the Monero. The research uncovered that 66, 09 % of exchanges in this framework don't incorporate chaff coins. This truth can lead to the conception that the privacy spillage of the senders of these exchanges is attainable (Li et al., 2020).

Artificial Intelligence (AI).

Artificial Intelligence (AI) alludes to a portion of computer science and its application is involved with different themes, such as logical investigative devices, games, robots control, and medical devices. In expansion, Artificial Intelligence can encourage different modern services. The term Artificial Intelligence depicts the thought that intelligent resources perceive their environment, and collaborate with it in arrange to require activities and upgrade it (Russell & Norvig, 2002; Mitrou, 2018). Artificial Intelligence (AI) could be a generalized term utilized to portray a framework that shows the properties of human intelligence. An Advanced AI (AAI) framework is required for handling complex IoT designs, by combining AAI frameworks, and utilizing 5G to get to the Web, the ICT premise for a smart city is made as an Integrated Smart Home and Smart City (ISHSC) (Panch et al., 2018).

Artificial Intelligence depends on the ability of intelligent resources to get training and to anticipate and expect potential events that may take place in the future, based on information examination. The arrangement and the implementation of AI instruments upgrade choice-making, problem-solving, design acknowledgment, and learning forms (Mitrou, 2018). The application zone for AI covers wide runs of applications such as toys, logical investigation instruments, medical determination, and robot control. In expansion, numerous of today's administrations are based on inserted AI, cases are self-navigating, recommender

motors, gaming motors, car gearboxes, discourse acknowledgment, and mechanical robots. Smart situations within the smart zone have to actualize context-aware services that can bargain with everyday exercises, such as preparing, eating, drinking, taking pharmaceuticals and cooking, etc. These frameworks must be able to interface with hundreds or indeed thousands of sensors (Diane, 2012; Feng, 2020). In expansion, they have to be able to bargain with voluminous and wealthy information, which is exceptionally challenging for the AI learning and expectation process (Dominici et al., 2010; Shuijing, 2020).

The field of Artificial Intelligence comprises two domains, rule-based and machine Learning based that give computer frameworks to be trained by huge datasets. The AI technologies' learning approaches give openings to noxious parties to take advantage of them and perform automated attacks. The development of novel AI advances and the advancement of learning capabilities such as deep learning, reinforcement learning, hereditary calculations, and support vector machines may give criminals the implies for more advanced, automated, and proficient attacks (Goodfellow et al., 2016; Kaloudi & Li, 2020).

As the IoT worldview may be considered as obliged, machine learning techniques are utilized over IoT gadgets to procure the desired information to preserve only the data that's vital for the framework. In addition, there are use cases of machine learning methods being utilized to limit water and energy use. California utilized Big Data analytics back in 2017 to secure water amid drought conditions. It was finished through the utilization of smart water meters and an intelligent Deep Reinforcement Learning (DRL) based framework. This comes about supported by reducing water utilization throughout the summer period and during which hours of the day (Mohammadi & Al-Fuqaha, 2018).

Smart city environments give a ripe ground for utilizing and testing robots for urban administrations to be progressed. Robotics and autonomous systems (RAS) may be considered as an extra innovative enabler that will encourage the initial smart cities administrations and applications significantly. Different city cases, such as Tokyo, Singapore, and Dubai, have as of now been received (Fourtané, 2018). AI and machine learning are utilized for encouraging RAS advances for making decisions and tending to forms without the direct commitment of humans (Macrorie et al., 2021).

Various utilize cases demonstrate the application of robotics in keen urban environments. One of these utilizes cases incorporates the appropriation of robotics arrangements by the Olympic Games of 2020 in Tokyo, Japan, where individuals would be served by smart robots in 20 diverse foreign dialects. In expansion, different smart city ventures in Dubai include robotics that addresses and gives public administrations (Fourtané, 2018). New AI solutions that incorporate IT frameworks for the smart energy era and conveyance, management of intelligent traffic frameworks, smart waste administration frameworks, and so on (Golubchikov & Thornbush, 2020). In expansion, the National Science and Technology Council distinguished new opportunities regarding the appropriation of AI and robotics in other segments, such as healthcare, education, and environment administration (Felten, 2016).

Legal Systems for Executing Artificial Intelligence
The usage of AI brings a few legitimate concerns, such as information privacy threats. The information managed by the frameworks comprises private information of employees and providers, such as facial identification and bio metric structures for observing and security reasons. Within the European Union, the General Data Protection Regulation is utilized beside local privacy regulations in each locale, for case, the Data Protection Act 2018 within the United Kingdom (Cornock, 2018 p. A1). Something else, they may contain the characteristic dangers of making and utilizing an AI framework. Agreeing to research, there are no special European Union-wide laws that govern AI (England, 2013). In any case, the European Commission created the High-Level Expert Group on Artificial Intelligence and set up its Ethics Guidelines for Trustworthy AI in April 2019. The built up rules state that AI structures ought to be legitimate, solid, and moral to fulfill the seven crucial necessities to be seen as dependable. (**Figure 11 , Appendix H,** Thiebes et al., 2020)

Furthermore, the tasks have been executed on creating components to utilize the Ethics Guidelines for Trustworthy AI. As of late distributed report by the artificial intelligence division and scholastic offers proposals on how to progress the inspecting of attestations concerning things advanced by the AI industry (Thiebes et al., 2020, p. 1).

In 2020, the Information Commissioner's Office discharged direction for firms that need to actualize AI frameworks. The direction included headings for depicting the choices taken with artificial intelligence and rule for inspecting AI (Buruk et al., 2020, p. 387).

Challenges of Artificial Intelligence
There are both technical and non-technical risks associated with the implementation of AI in smart cities (Al Sharif & Pokharel, 2021). In smart cities, AI can prepare private information such as issuing and observing the application of control in a private region. Individual information can moreover be prepared by supervising the movement and giving appropriate adverts established on geo-location to planned clients inside the urban residence (Scherer, 2015, p. 353). AI in smart cities may include facial identification to path and observe people motioning around an open range for assurance and professionalization (Verghese et al., 2018, p. 19). There are a few additional challenges around privacy and information protection when AI handles private information. (Figure 12, Appendix I, Verghese et al., 2018).

Yu (2020) recognizes that there are other challenges concerning the correspondence and consistency of the calculation. For occurrence, when facial identification innovation is actualized for policing and public protection, it is anticipated that information groups for training the innovation have a satisfactorily wide extend of different demographics symbolized inside it. Hence, facial acknowledgment innovation would precisely recognize people of different ethnic and racial roots rather than a particular ethnic group. The buyers of such advances ought to endeavor to distinguish how the innovation engineers received measures to guarantee that the AI avoided developing or cementing unequal inclination during framework advancement. For illustration, if the calculation were developed with the information group, it would actually process such people from diverse city, and if the methods were set up to look at conceivable inclination (Villasenor and Foggo, 2020, p. 295). There ought to be control measures to guarantee that the execution users can distinguish any likely imbalance. Such inclinations incorporate separation, or poor framework execution.

Cyber security defenitions

The term "cybersecurity" is ordinarily utilized by individuals within the same setting traded (Von Solms & Van Niekerk, 2013). The researchers contend that cybersecurity amplifies past the limits of data security, in expansion to ensure the data assets, incorporate the clients themselves. The human calculation in data security is ordinarily alluded to as the part of the human within the handle of security, whereas in cyber security the people are conceivable targets of attacks. Besides, it is secure to assume that one may portray a cybersecurity occurrence by utilizing characteristics utilized to recognize data security. Be that as it may, the creators have proposed a few scenarios where cybersecurity assaults don't take after the formally characterized scope of data security, such as cyberbullying, domestic automation, digital media, and cyber terrorism (Von Solms & Van Niekerk, 2013).

Von Solms & Van Niekerk, (2013) outlines the relationship between the three covering concepts, which are information security, ICT security, and cybersecurity. The idea of information security grows past ICT security to protect the data, comparably; cyber-security grows past information security to secure the users and any other resources, which may have been inclined to dangers as a result of vulnerabilities advancing from utilizing ICT. Craigen et al. (2014) contend that the literature needs a broadly concurred on and brief definition that handles the multidimensional nature of cybersecurity may result in hurdling the technological progression by supporting the prevailing viewpoint of cybersecurity, whereas the disciplines that need to be supporting the arrangements to complex security challenges are isolated.

Nonetheless, there are several cybersecurity definitions present in the literature, these definitions are demonstrated in Table 2.

Cybersecurity definition	Author(s)
Cybersecurity is the combination of rules, arrangements, devices, security concepts, activities, training, and technologies that may be utilized to ensure organizations' and users' belonging. Those belonging include online computing equipment, applications, staff, telecommunication frameworks, infrastructures, and data that are stored or transmitted all through the cyber environment.	International Telecommunication Union (ITU) (2008)
Cybersecurity requires the assurance of data, computers, and networks from infiltration or harmful hurt.	Lewis, 2006
Cybersecurity incorporates diminishing the risk of software harmful attacks, as well as computers and networks. It includes devices utilized to recognize penetrations, antiviruses, communications encryptions and block unauthorized access.	Amoroso, 2006
The capacity to defend or protect the use of cyberspace from cyberattacks	CNSS, 2010

Table 2: cybersecurity definitions

Smart Cities as an image of a safe location for life.

The term "smart Cities" by and large alludes to the utilization of technology-based arrangements to upgrade the quality of life for citizens, progress interaction with the government, and advance economic improvement (Yahia et al. 2019). A city can be depicted as shrewd where social, natural, and economic improvement variables are adjusted and connected through degenerated forms to more proficiently oversee key resources, assets, and urban streams for real-time forms (Yeh 2017). "Smart Cities" are outlined around an information and communication technology (ICT)-based foundation with the Internet of Things (IoT)-empowered sensor technology to support social and urban interconnectivity through more prominent citizen interaction and government proficiency (Lom & Pribyl, 2020; Mamonov & Koufaris, 2020; Alter, 2019; Gupta et al. 2019b; Yeh, 2017; Albino et al., 2015).

Smart city development has recently become extremely fashionable. Utilization of bullet trains, metropolises, metropolia, eco-cities, eco-towns, etc. speaks volumes about the ways unused business models are being advanced as inventive commerce recommendations. The thought that digitalization drives modern trade models is being broadly recognized. In common terms, a Smart city is ordinarily characterized by legacy, design, aesthetics, biology, way of life, smart security, etc. This separate center is coordinated towards the change of fundamental services, and the economy, with a center on the business era, transportation, healthcare, instruction, civil and social security, respectful services, security, etc. Numerous nations and cities have taken leads in these space regions; with, among other things one of a kind offering recommendations in international business terms (As a tourist destination; high-tech city, commonwealth heritage center, Port and Harbor, Olympic stadia, etc.).

It is very important to utilize technology for making a more secure urban environment because it seems to yield indirect benefits that are not captured by difficult measurements. "Smart Cities" that depend on security, technological measures, and advanced policies to combat crime, as well as smart surveillance and streetlights and cyber tracking of breaks, can prevent crime; inhabitants in more perilous cities can take back their lanes and make full utilization of open spaces they once maintained a strategic distance from. The picks up are more intangible: the opportunity for development, opportunity from fear, and peace of intellect. Over time, more secure communities are way better able to pull in unused inhabitants and new business investments, and on the other hand, indeed the recognition that a city is hazardous can hurt its economic prospects. Tourism may take a hit if a crime spike gets universal media scope, but it may climb in case a city gets crime beneath control and wins notoriety as a secure put to visit. (Bughin et al, 2018).

The Quality of life in Smart City.

The essence of a smart city is to utilize IoT, Big Data, and other specialized means to advance the natural coordination of urban benefit components and residents' needs and to progress people's quality of life. At the show, various researchers centered their inquiries on the perspective of the impacts of smart city construction. Smart Cities have a critical boosting impact on economic development in those increments with the level of urban human capital, higher levels of monetary development, and lower levels of government mediation (Zhou & Li, 2020). Nie (2019) uncovers the rationale of the "binary margin" extension of smart city development and foreign investment and contends that the development impact of foreign investment in smart city pilots is

accomplished basically by decreasing inputs and improving infrastructure development.

Tang (2020), experimentally analyzed smart city development as an intermediary variable for the digital economy and concluded that it can advance high-quality urban improvement. In any case, smart and effective approaches will protect big data since smart arrangements and practices have the potential to control mechanical surveillance whereas strengthening the protection of mental property. To create this possible, increased foreign direct investment is the finest approach because organizations working globally will gradually move to and grow in nations that give absolute protection of their mental property. This will promote inventiveness and attempts to discover modern approaches to overcome cyber threats.

Cybersecurity and privacy in smart city.

Cybersecurity investigates and resolves the most sensitive frameworks in smart cities as a denial of benefit from the most critical administrations. In expansion, cybersecurity solves basic risks such as privacy assurance, eavesdropping, pernicious attacks, and numerous others. The profound learning of Artificial Intelligence is included broadly in smart city cybersecurity to distinguish any strange behaviors. Deep learning is especially important in urban modeling because it can be used as the leading course for traffic based on cameras and as leading parking. Framework, transportation, urban administration, flexibility and sustainability, instruction, health, security, and privacy (Ma, 2021).

Expanded surveillance and data-driven policing raise concerns that are almost continuously observed and have the potential to hinder political disagreement. Governments and private-sector players now hold and share sensitive personal information, necessitating the establishment of astute conventions and safeguards around its handling and protection. ((**Figure 14, Appendix K, Bughinand** et al, 2018) determines the potential effect related to each safe application and Smart surveillance and prescient policing)

Experts around the world are concerned about cybersecurity vulnerabilities in "smart cities." The Internet of Things (IoT) gives hackers a broad "surface area" to assault. Cities will need to develop cybersecurity skills to keep up with the ever-changing, dangerous environment. They will practice how to respond to breaches, including not only specialized remediation but also how to remain calm and communicate**. (James, 2015, McKinsey, 2017.)

"Cybercrime may be full-time work, and battling it requires both a strong center and a sweeping vision." The frequency of cyberattacks is expanding violently, and there's no one book or activity to solve them all. To begin, framework merchants must secure, encrypt, and report their framework to smart city leaders. Other activities, such as vulnerability assessment and treatment with infiltration testing, must be accessible within the leader's plans (Vignoli, 2021). Composed of a socio-technical system (STS) (Baxter & Sommerville, 2011)) and a cyber-physical system (CPS) (Rajkumar et al.,2010)). Representing these two frameworks in a Venn graph, the covering range would incorporate the pure ICT cyber components. STS is defined as the framework that includes the clients and/or human resources who are connected with a city's digital frameworks to gain a benefit or contribute to the city's work. The exchange of data between the physical and cyber worlds is linked to intelligent behavior among users and humans.

Intelligent resources, advanced foundations, and physical resources that receive both physical and cyber measurements are all part of a cyber-physical system. Intelligent resources are assigned different levels of significance in the cyber-physical system, depending on their purpose and the importance of the benefit that they promote. CPSs promote mechanical control frameworks and basic frameworks and have been used to encourage other spaces, including smart cities. The cyber-physical systems are connected and perform their functions in a way to guarantee the conservation of sustainability, security, and safety. ((**Figure 15, Appendix L, Ideal**-Cities, 2018)

Currently, the worker and the client are the weakest interfaces. Information security is changing from data security to data security culture. This way, we can ensure that we, as smart city clients, are safe from social engineering attacks that make cybersecurity attacks easier. There's little regulation for the cryptocurrency that oversees its utilization; that's why it'll be a weakness and a big risk in its use. (Hanson, 2021).

As the decision became public, advanced cybersecurity threats can quietly penetrate frameworks and change anything hackers require; more controls and cybersecurity methods must be implemented to anticipate such attacks. (Marks, 2021). Hence, this research will center on exploring how the cyber security technique will maintain Dubai's a smart city and educational security. Moreover, through societal awareness, the Dubai Electronic Security Center ensures that compliance with laws and directions is connected to all cyberspace missions to upgrade the cybersecurity of the whole region. All vital plans incorporate setting up initiatives to combat cyberattacks, cybercrime, and other dangers. (Zaatari, 2017).

Conclusion

The present paper aims to investigate the interplay of Information Communication Technology (ICT), IoT, Big Data, Blockchain, AI, and Cybersecurity in the development of Smart City urbanization. The findings reveal that these interconnected domains play a crucial role in shaping the success and sustainability of smart cities. Cyber security and AI in particular, have emerged as a vital mediator influencing the effectiveness of ICT, IoT, and Big Data applications.

Cities have changed significantly due to the innovation and implementation of different concepts such as flexible cities, economical cities, and comprehensive cities. AI and the IoT are two critical technologies that have the potential to turn cities into sustainable smart cities. It is concluded that cities can advantage from joining AI into smart cities by robotizing operations, reducing human mistake, making successful data-driven decisions, improving the environment through diverse frameworks, executing new commercial possibilities, and automating proficient urban management. On the other hand, they also posture regulatory challenges, such as discrimination in benefit delivery, protection, legal and moral contemplations. Besides, data accessibility, lack of qualified experts, cost and duration of AI activities, and a high unemployment rate have all been recognized as dangers and obstructions to AI usage in smart cities. The healthcare (23%), mobility (19%), security and privacy (11%), and energy (10%) sectors have a more prominent affect on AI selection in smart cities, according to our findings.

The smart city includes a major effect on the country's economy. AI collects intelligence in data using installed cameras and IoT-enabled sensors. The intellect is then disseminated to the relevant bodies to make informed decisions. Although urbanization is viewed as wrong by some environmentalists, AI in urbanization

makes it more beneficial. A solid and smart city framework helps in taking fast and clever choices. This paper centers on the execution of the smart city by the utilize of the IoT-based smart framework. Different smart systems are utilized to urge real-time city information to create a decision. The ecosystem is utilized to handle Big Data created by all the smart frameworks conveyed within the city. The Framework is essentially actualized and tried on genuine information. Within the future, we are arranging the real sending of all Smart frameworks, testing the precision of the framework, considering security issues.

Conclusively, the development of smart cities is promising to improve the standard way of life in urban centers within the public sector and the private sector. However, developing smart cities needs careful consideration of the technology to enhance their sustainability. Artificial intelligence plays a vital role in smart cities by ensuring improved security, smart policing, proper waste management, efficient energy use, and smart infrastructure.

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APPENDIXES

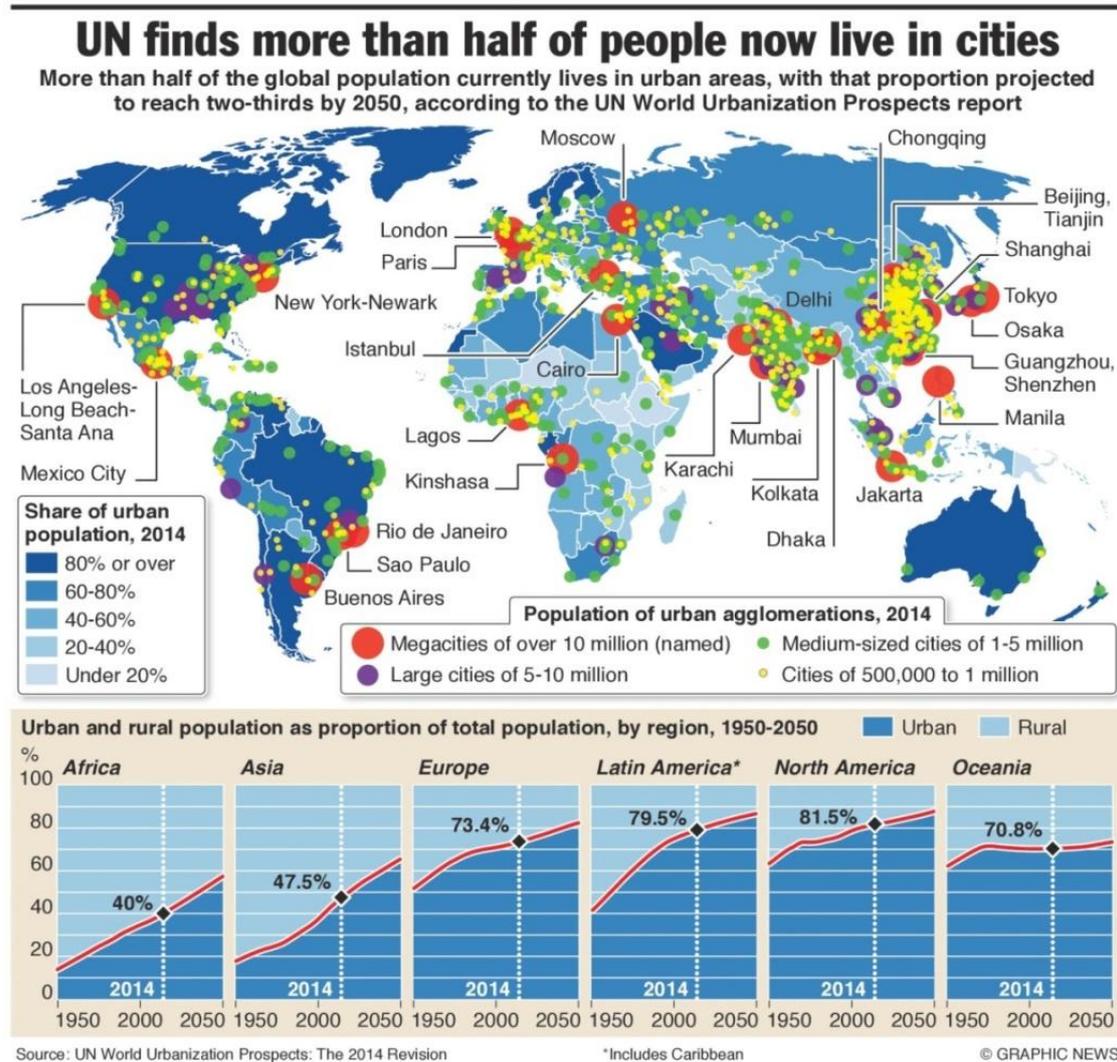**APPENDIX A: The Projections of Urban Populous Areas by the Year 2050**

Figure 1: This figure reflects the projection of Urban populous by the year 2050

Figure 2: *This figure reflects the projection of the Urban populous by the year 2050*

https://unctad.org/system/files/official-document/CSTD_2015_Issuespaper_Theme1_SmartCitiesandInfra_en.pdf

APPENDIX B: Hierarchical Structure of Application Areas Related to "Smart Cities"

Figure 3. Hierarchical Structure of application areas related to Smart Cities/ Source: (Lim et al., 2018).

APPENDIX C: *SMART CITIES: THE DIGITAL TRANSFORMATION*

| *Fig. 4 Smart city components* | *Fig. 5 Two layers of smart city, and the key points that turn a city into a smart city.* |

IBERDROLA, 2016 *SMART CITIES: THE DIGITAL TRANSFORMATION OF OUR CITIES*

APPENDIX D: The double network permits the macro-cellular arrangement to act as the control plane and the little cells to act as the client plane.
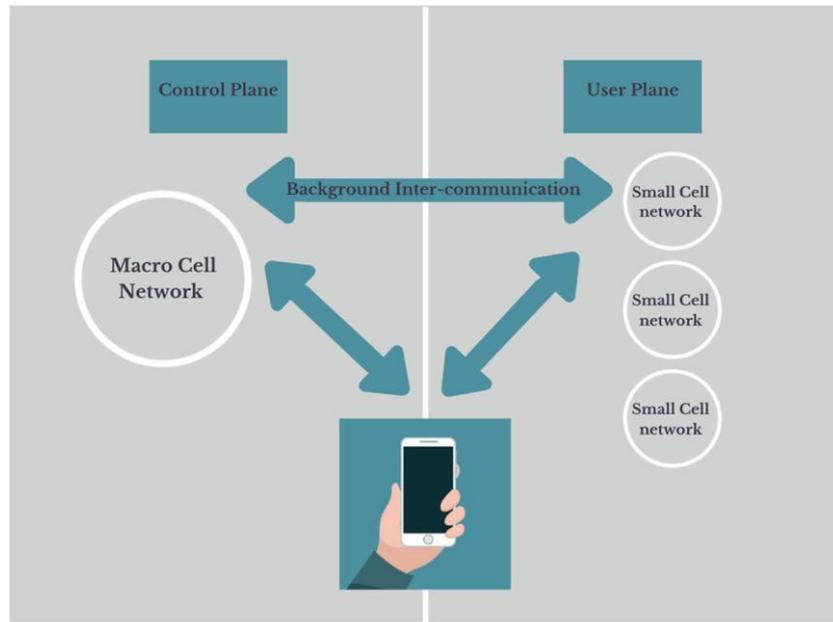
Figure 6 : Schematic permits clients to connect to two systems at the same time (Authority ACMA, 2016).

APPENDIX E: The volume of M2M traffic approaches 5013 petabytes by 2019.
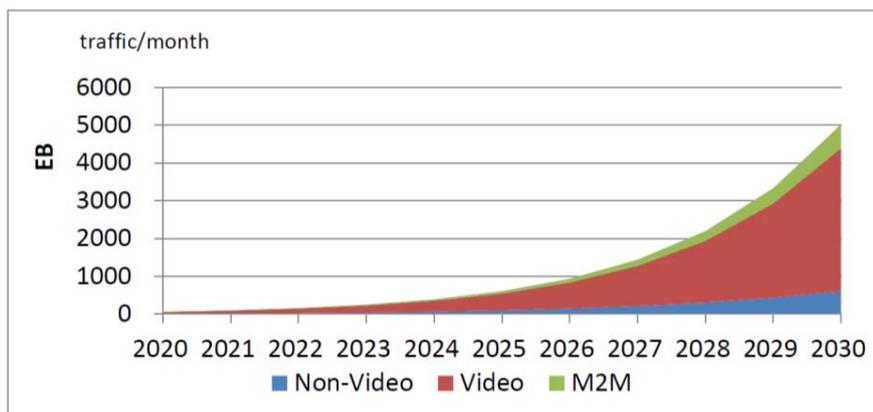
Figure 7:Mobile Estimation. (Report ITU- Report M.2370-0 , 2015.)

APPENDIX F:The Difference between IoT and M2M
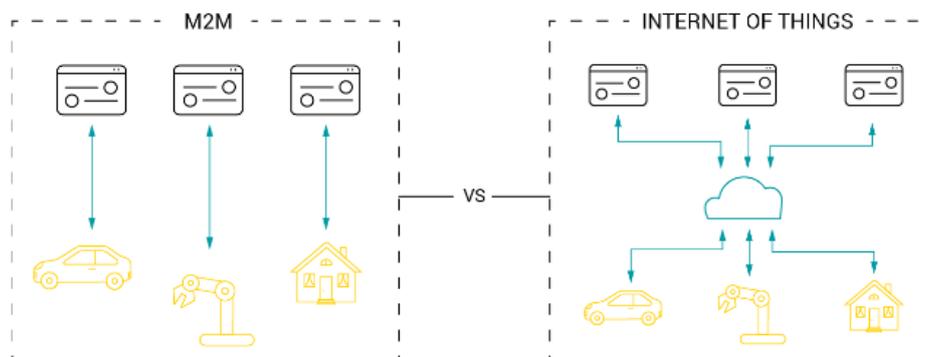
Figure 8: Difference between IoT and M2M. (Avsystem.com, 2019)

APPENDIX G: How BlockchainWorks
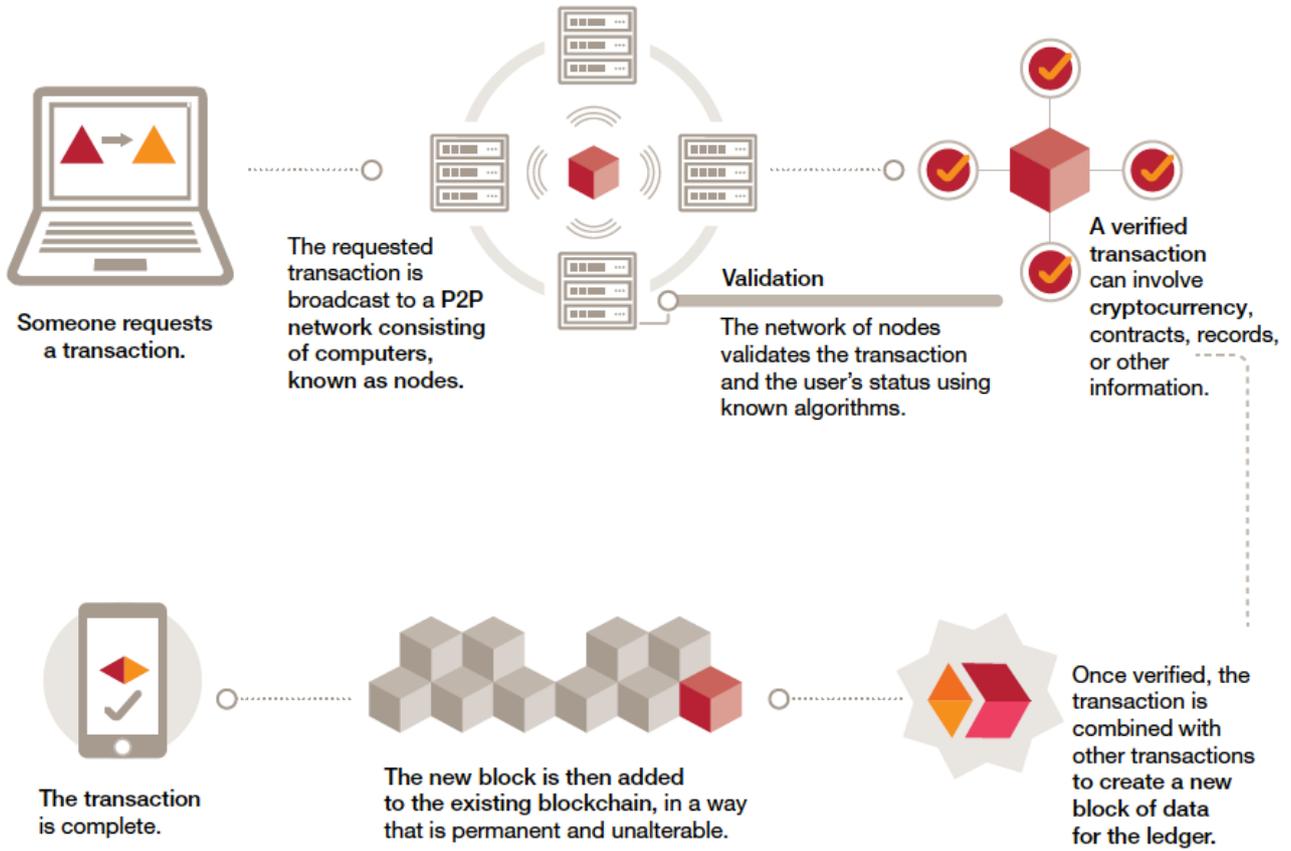
FIGURE 9: How BlockchainWorks (Baru, 2018)
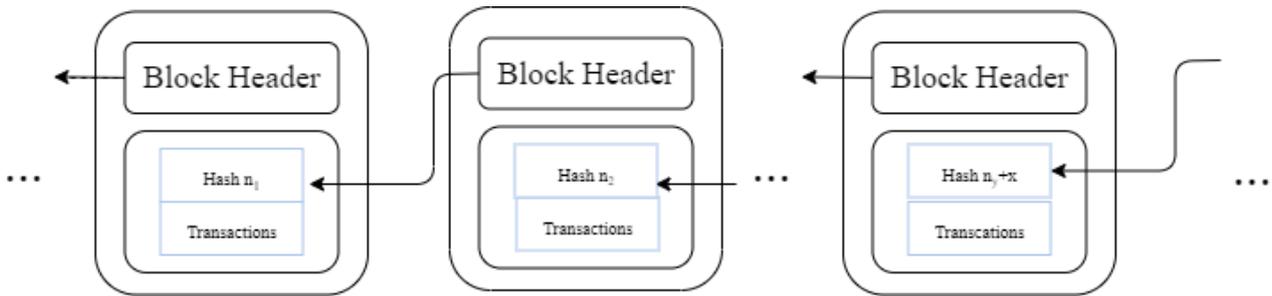
FIGURE 10: Block sequence in the chain (Blockchain-based frameworks)

APPENDIX H: The life cycle of a sustainable smart city empowered by technologies.
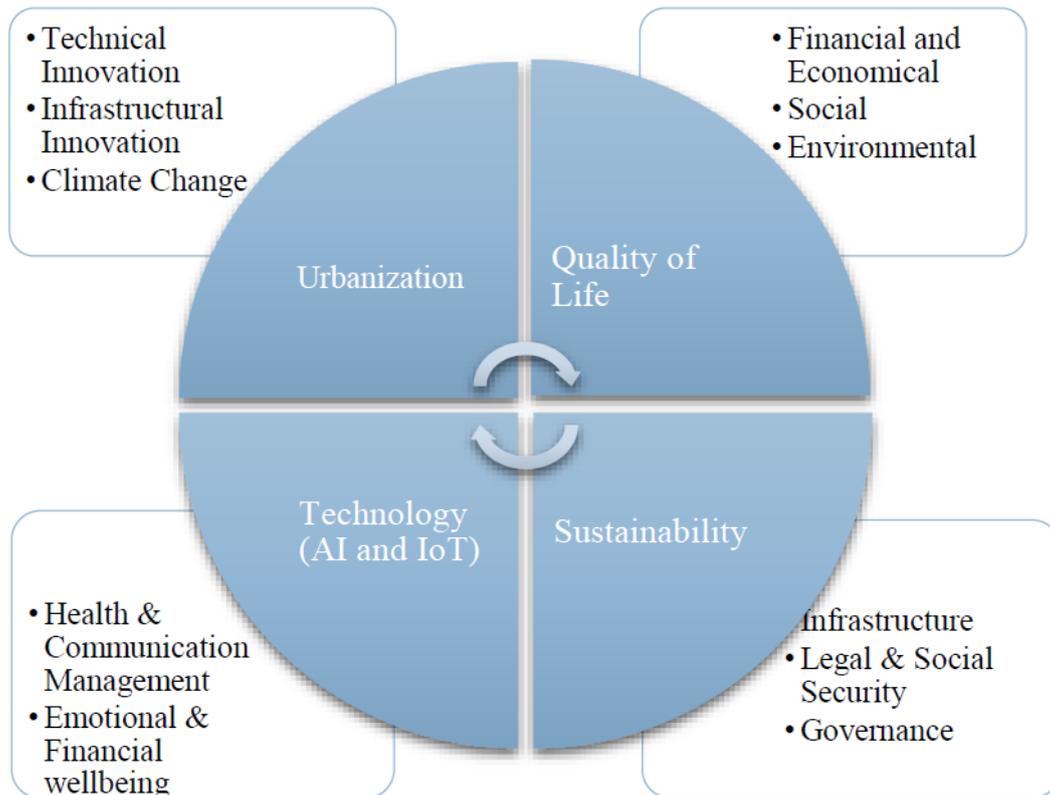
Figure 11: Life cycle of sustainable smart cities

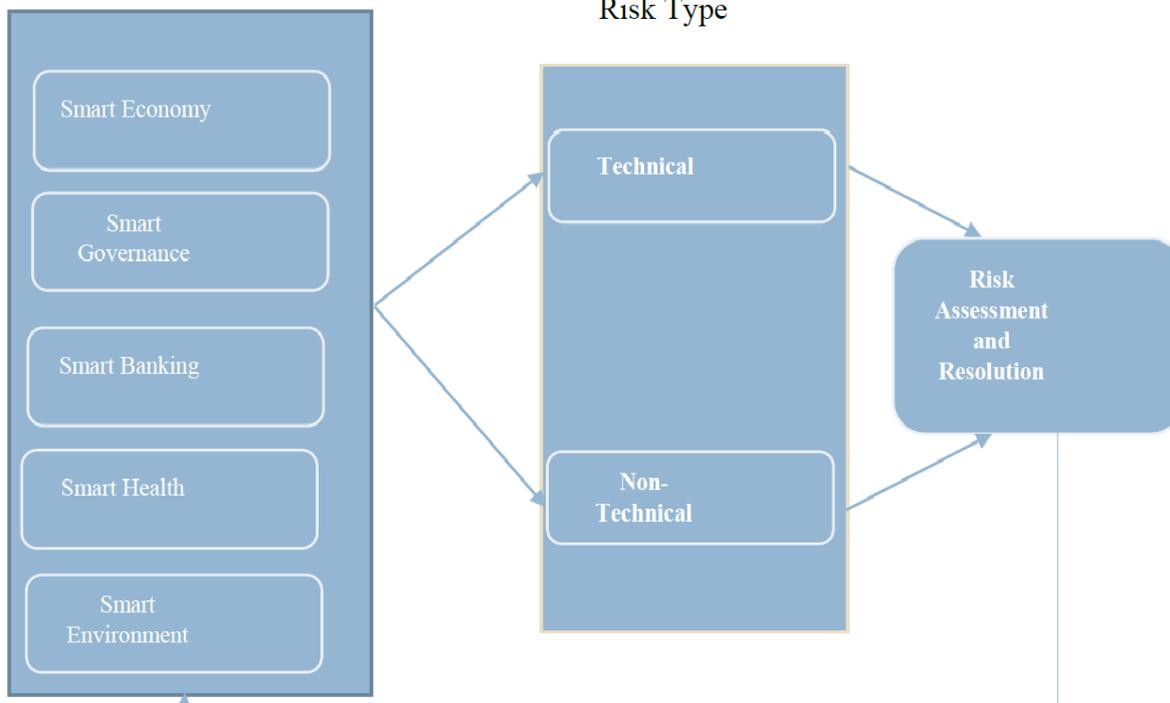**APPENDIX I:A model for risk acescent and resolution tool in smart cities**

Figure 12: Risk acescent and resolution tool in smart cities

APPENDIX J: The relationship between information communication security, information security, and cyber security
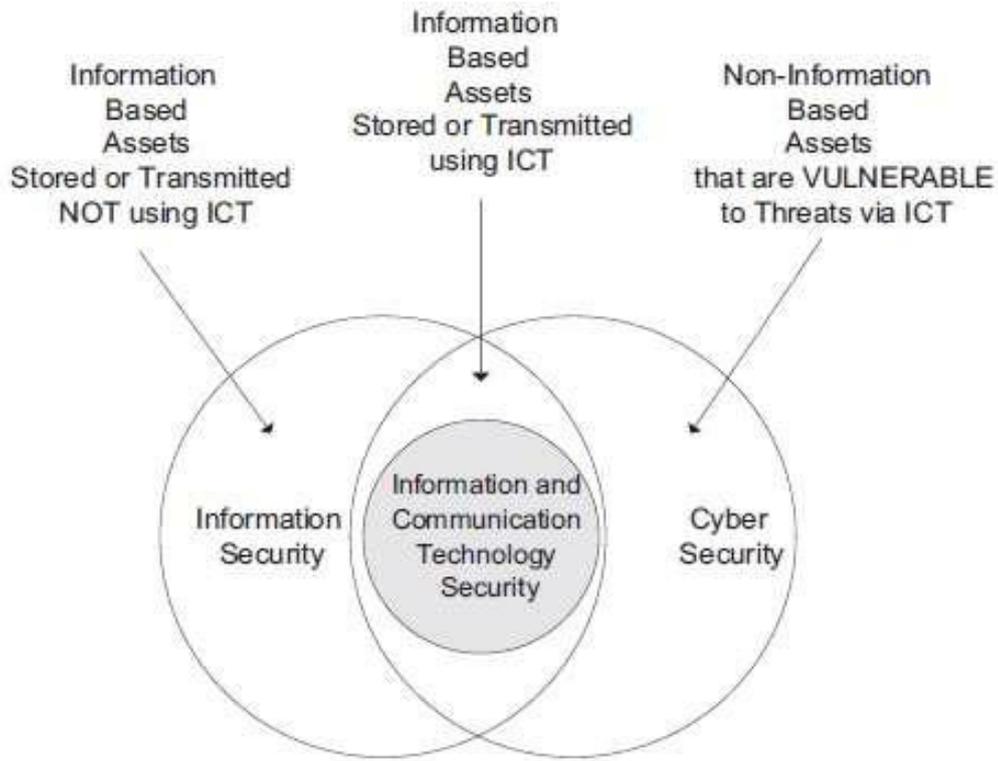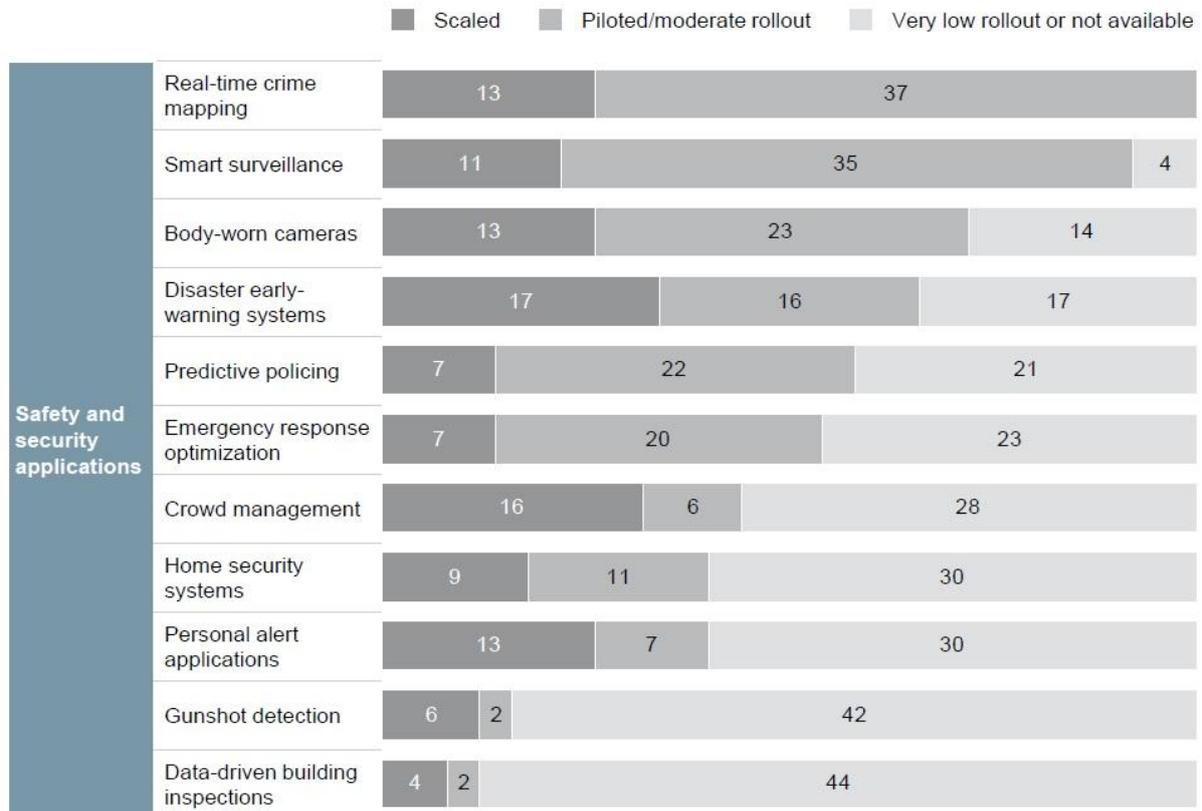
Figure 13: the relationship between information communication security, information security, and cyber security (Von Solms & Van Niekerk, 2013, p.101)

APPENDIX K: Smart surveillance and prescient policing.

Rollout status of safety and security applications
Number of cities (out of 50)

SOURCE: McKinsey Global Institute analysis

Figure 14: This figure shows that whereas smart surveillance and prescient policing have been at least somewhat guided in most cities, gunshot location, and data-driven building reviews are less prevalent.

*Figure 14 appears to show that cities in the developing world lag behind wealthier cities in terms of the number of applications implemented in most spaces. But since numerous of them have high rates of violent crime, security applications have vaulted to the top of the list of needs. Cities like Rio de Janeiro and Cape Town are at the forefront of implementing security and security applications. At the very least, a few fundamental frames of wrongdoing mapping are now standard practice for police departments worldwide. (*Source: Bughinand et al, 2018).

APPENDIX L: Coexistence of Cyber-physical and Socio-technical Systemswithin a smart city environment
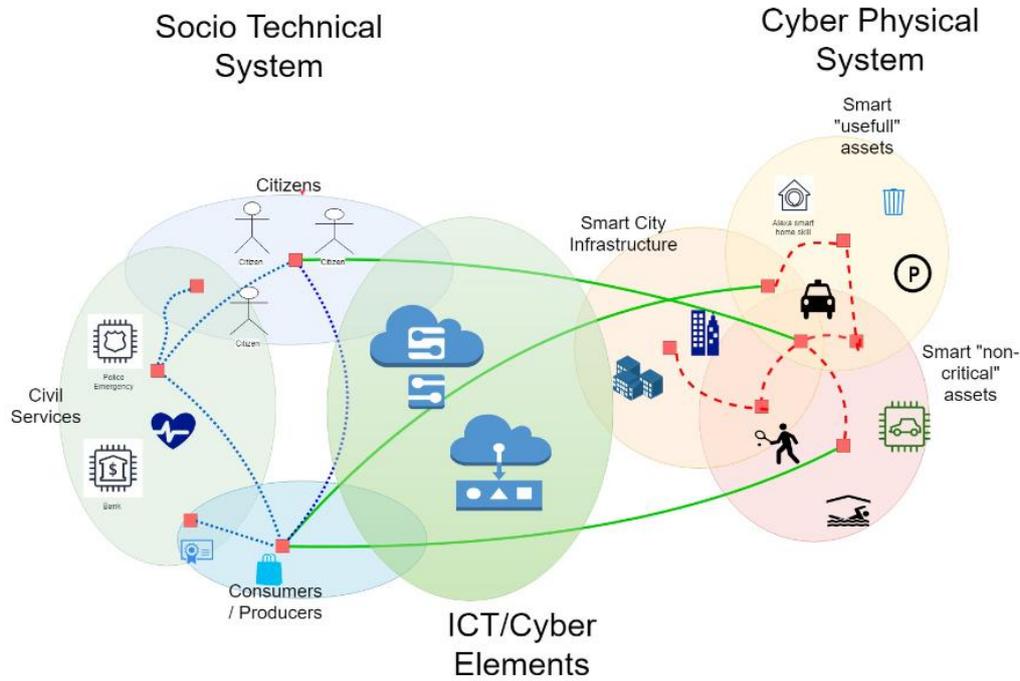

Figure 15: Coexistence of Cyber-physical and Socio-technical Systemswithin a smart city environment (Ideal-Cities (2018)