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On the Implementation and Development of Smart Cities based on IoT Technology

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Abstract

The great consumption of the Internet of Things is essentially permitting Smart City projects and proposals to the entire humanity. Entities that apply in everyday life are being prepared with electronic devices and procedure suites to formulate them interrelated and associated through the Internet. According to a modern study, 50 billion associated entities will be organized in smart cities by 2025. Scientific techniques are influencing the amount of Smart Cities, renovating the whole thing from traffic administration to devastate assortment. Over half the globe's residents presently exists in metropolitan areas, by 2050 that count is predicted to jump to 68%, per the United Nations. All along with mounting residents, innovative disputes are promising as cities look to progress the whole thing from intercommunications to connectivity. A variety of smart city proposals and projects have been commenced in topical years, as well as have eye-witnessed not only the predictable benefits but the risks established. The massive demands towards well-organized city management have generated several Smart City initiatives together with government as well as classified enterprise sectors to endow in statistic and communication methodologies to discover maintainable clarifications to the assorted chances and disputes. Several research investigators have endeavored to describe and differentiate Smart Cities and recognize prospects and disputes in constructing Smart Cities. This research study communicates the enduring association of the Internet of Things and its connection to Smart Cities.

Disciplinary: Modern/Smart Cities, Information and Communication Technology, Sustainable Development.

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1 Introduction

The Internet of Things (IoT) in current trends has emerged as a novel communication platform with intends to bridge an innovative framework to the massive digital device network with the use of the internet. IoT promotes various sensing, actuation, and computing abilities to remote devices and sensors with the Internet giving rise to new services in the landscape of Smart Cities. Smart city concepts are either being adopted or looking forward to being adopted due to their functionalities, Big Data Analytics, and fascinating possibilities. The current challenges such as traffic congestion and waste management will be addressed easily, added to this, better infrastructure, more efficient transport structures reduced traffic jamming and overcrowding, proper waste managing, and improve human life eminence can be achieved. A smart city is an ecosystem of complicated units involving statistics and message passing technologies intending to recover cities sustainability, livelihood as well as standard of living.

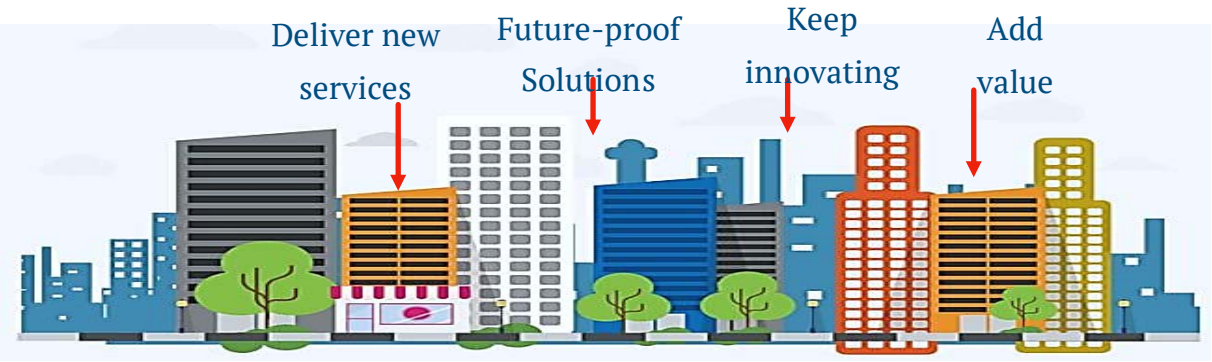

Figure 1: Internet of Things with Smart Cities [2].

Figure 1 describes the innovative concepts of delivering new services, future-proof solutions, keep innovations as well as adding values of IoT with Smart cities. The smart city also aims to promote more innovations and entrepreneurship. The concerned components of a smart city include the services of Application Developers, Service Providers, Citizens, Government, and Public Service Providers, Research Community, and Platform Developers. Additionally, the Smart City cycle comprises plentiful ICT Technologies, Development Platforms, Maintenance and Sustainability Apps for evolving citizens, and technical, Social as well as Economic Key Performance Indicators. For large-scale infrastructures, IoT can be of at most help. Applications are a major part of the Internet of Things-based Smart City and they can be categorized in terms of web category, exposure, versatility, heterogeneity, repeatability, and end consumer contributions. Furthermore, apps could be collecting into individuals and quarters, practical, portable, and businesses [1]. For illustration, individual and residence apps comprise omnipresent e-medical care services to survive autonomously through Body Area Networks (BANs) that facilitate physicians to examine the patients without actual or physical contact. Utility apps take in smart grid, smart metering or monitoring, water network monitoring, and based on video surveillance. Correspondingly, remote applications comprise Intelligent Transportation System (ITS) and organization, traffic administration, overcrowding management, and waste product administration.

In addition, IoT-related firm applications frequently contain a web of things inside work surroundings.

The Smart City is a pioneering initiative that endeavored at moderation the troubles produced by the speedy enlargement of urbanism in the cities. To handle the crisis strategy of decision-makers are financially supporting Smart Cities enterprise targeted at maintainable enlargement and enhancing the standard of human life for inhabitants along with vacationers. Information and Communication Technologies (ICT), wireless sensor network (WSN) as well as Internet of Things (IoT) are the primary and essential future concepts for Smart Cities. The widespread explanation of the Smart City as well requires to be described to integrate and evaluate Smart Cities indeed. Smart Cities change has prearranged users have the capability to boundary the number of urban development issues and explain it. For the previous ten years, the public people works are appropriate, even more, contemporary and information related, but there is an insightful change in the living surroundings of residents and the authority of societies. Infrastructure, population, transport, diversion, and other aspects of societies are confidentially connected to Smart Cities and the web is flattering a huge section of people's on a regular basis routine. The various accomplishments of the digitization of the city register not only to afford the society with daily suitability. Smart City's scheduling effort has donated to a complete perceptive of the findings needed to construct an elegant society. With the assortment of theories recommended through a variety of social gatherings, there is still an extensive assortment of Smart City technologies right through the research. A lot of technologies make it obvious that Smart Cities are powered and permitted by interconnected technologies. Generally, the theory of a Smart City is to formulate a governing authority, medical system, transit, and many more on smarter along with better efficiency.

The vision of Smart City is to incorporate information and communication technology along with the Internet of Things to deal with perspectives of urban life similar to tech systems in narrow management, school, hospitals, libraries, carrying structure, energy units, water delivery techniques, and infrastructure, waste product administration, defense administration, and other society-oriented services. This will show the way to the progression of Smart Cities along with elegant characteristics that comprise a well-groomed economy, elegant buildings, elegant mobility, elegant energy, elegant information communication and technology, and elegant governance. In Smart City, new and innovative technology is utilized to enhance service effectiveness. The technology permits city executives to work together in a straight line with the society and city outlook and examine the city advances and facilitate an enhanced eminence of living.

2 Smart City

Generally, a city is comprised to be a Smart City when it can be capable of accumulating and investigate mass quantities of statistics from an extensive assortment of industries from urban planning to garbage assortment.

Figure 2: An instance of a smart city [3].

In a Smart City, a composite network of interrelated sensors, devices, and software must be constructed and preserved. This should permit the city to become a more maintainable and proficient atmosphere for its residents.

Smart cities are sustained through quite a lot of kinds of technologies, including:

ICT – Information and communications technology

IoT – Connected physical devices using the Internet of Things network

GIS – Geographical information systems

Each work mutually accumulates and contextualizes massive counts of statistics that can be utilized to grow and enlarge the components and schemes running inside a city [2]. The skeleton of ICT, for instance, is ready up of an assortment of devices as well as sensors that entirely bonded to the perception of IoT network and can immediately convey data utilizing wireless technology along with the cloud. Traffic in a prearranged region, for illustration, can be observed using sensors. The novel concept of Cloud-based IoT applications can then obtain, examine, and control that traffic information in real moments. This information can also be utilized to healthier recognize and respond to a city's continuously varying needs over time and can even be utilized to better optimize for protection.

Smart Cities can also influence GIS for scheduling and charting purposes as well as for enhanced enlargement and expansion of cities. As a consequence, urban areas are capable to better administer concerns from water administration to extreme energy expenditure to inadequate waste management. Smart Cities could also employ the current concepts of Artificial Intelligence (AI) as well as BlockChain Technology for certain systems. Several firms, for illustration, are functioning to formulate parking easier and further proficient using AI heading for amenities.

3 Characteristics of a Smart City

Features of a Smart City thick atmosphere, similar to that of cities as well as capitals, involve its sub-branches to process as a single system with the intellect being inundated into every sub-branches. Research investigators who sustain this incorporated outlook pressure the consequence of the natural combination of a metropolitan area's assortment of sub-branches like transportation, energy, education, healthcare, buildings, physical infrastructure as well as public safety into one

joined structure to generate a smart city, the authors, describe the attributes of a smart city, which shows that there are various prospects in the smart city: smart economy, smart people, smart governance, smart mobility, smart environment along with smart living as represented in Figure 3.

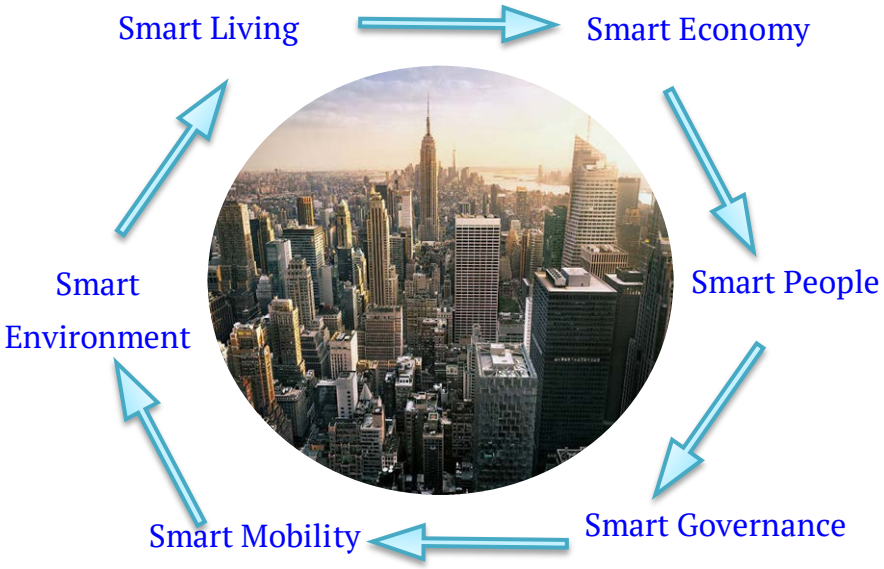

Figure 3: Characteristics of Smart City [5].

A skeleton by Nam and Pardo (2011) reflects that there are 3 important components of a Smart City: technology, people, and institutions. Considering the association among the elements, the metropolitan area will be elegant after assets in human social capital and IT infrastructure energy sustainable enlargement and augment the excellence of life throughout the governance [3].

4 Components of a Smart City

The vision of Smart City is to incorporate Information and Communication Technology along with IoT to direct features of the whole urban life which demonstrates in figure 4 like information systems in local administrations, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, security management as well as other community services. This will show the way to the progression of Smart Cities consisting of innovative elements that comprise smart economy, smart buildings, smart mobility [6], smart energy as well as elegant information communication along with technology and smart governance. In Smart City, innovative technology is employed to progress work effectiveness. It permits city officials to work together straightforwardly with the society and infrastructure of the city also monitor how the city advances in addition to how to facilitate a healthier quality of life. The purpose of sensors incorporated with live observing systems, statistics are composed of general public and systems then process and investigates to get better the effectiveness of work.

One of the foremost IoT applications in Smart City is elegant power for profitable and environmental motivation. The Internet of Things facilitates power utilization observing, organization of power plants. Furthermore, authorizes smart meters to scrutinize utilization

procedures addressed in [8]. Furthermore, sustains the dimension of radiation factors in nuclear power stations' surroundings to produce outflow warnings and comfort public security.

Engineers with understanding and skillfulness in working, mounting, and preservation of IoT technology along with the systems are very essential aspects for the smart city maintainability. Consequently, incorporating the Internet of Things with electrical/computer engineering education is very essential to construct the IoT Smart Cities.

5 Level of Adaptability to Modern Technologies

Contemporary technologies are very much essential to the accomplishment of maintainable and Smart City applications. The stage of public flexibility to this model trend can influence numerous approaches like smooth evolution from the elderly existing system, for instance, none environmentally friendly practice to the inventive technology. For illustration, constructing procedures, transportation schemes, and waste administration can be very dynamic sectors of agreement such as original automatic structures and practices. The various Level of Adaptability to Modern Technologies of smart cities are stated clearly in [10]

On the other hand, approximately 30 % of applicants are hopeful about this stage of flexibility. In addition, several notified participants observations that if to start up a long term sketch including practical workshop and community direction and educating about the consequence of this matter, then the outcome will be so promoting and in turn will move enlargement promote to the direction of successful elegant cities and societies.

6 A Conceptual Model of Smart Sustainable Cities

Present and recent studies concerning Smart Cities worldwide like, however, there is a small number targeting Saudi Arabia. According to the nature of Saudi Arabia, the obtainable skeletons have not been proposed to address detailed disputes within the environment of Saudi[4]. On the other hand, according to the preliminary conclusions from the accomplished literature study and survey reports, this paper presents the initial conclusion that is a conceptual model for Smart Sustainable Cities in Saudi Arabia (SSCSA). In [4], the authors explain clearly the Conceptual Models of Smart Sustainable Cities

6.1 E-Government

The primary and most imperative dimension to ascertain the growth of SSC, Smart Governments is the stamina for the mainstream of SSC behavior leading to occupied consumption of services in the direction of s achieving SSC. It will continue as the influence of enforcing the law for diverse parties to make sure their teamwork is accomplished under an authorized and controlled atmosphere.

6.2 Smart Economy

The speedy evolution and wider association of the economy are crucial nowadays. This dimension will participate an essential responsibility in humanizing partnership, entrepreneurship, e-commerce, and interconnectedness nearby and globally.

6.3 Community and Living

This measurement could be classified into two folds the former one is individuals and the latter one is instituted. Individuals should be fine conscious of the nature of living in SSC. Furthermore, public physical condition as well as protection, entitlement along with other public programs will be input factors below this dimension.

6.4 Resilience

Cities in Saudi Arabia have to be finely fabricated to be more flexible and get better from universal natural disasters like floodings as well as dust storms. Consequently, a digital perception of city administration against natural disasters is needed to safeguard citizens and their belongings.

6.5 Smart Utility

This aspect refers to sustaining facilitates and services infrastructure like power network, water contribution, and waste administration. Those services are essential to elegantly deal with throughout the SSC and to be believed in the premature stages of SSC intend and accomplishment [5].

6.6 Smart Transportation

The direction of smart transportation embraces a variety of ways of transportation like railways, airplanes, buses, cars, bikes, etc. The country of Saudi Arabia is profoundly relying on petrol fuel for running transportation and still, now there is a lack of substitute transportation.

6.7 Smart Building

Building structure in Saudi Arabia is constructing in a technique that consumes elevated energy and is required the methodology of reengineered. Redesigning and rescheduling of building construction in the country of Saudi Arabia must believe the conditions of climatic, profitable as well as socio-cultural aspects of Saudi citizens.

6.8 Energy and Resources

Energy and recourses refer to all sources being employed to enlarge SSCs in Saudi Arabia. It comprises fossil fuel, water wells, seawater, agricultural, raw material, etc. Saudi Arabia endures from the resource of water deficiency, improved the population counts as well as an augmented number of mobility, which generates considerable disputes encountering the applications of SSC.

7 Internet of Things Technologies

The innovative technologies that consist of 5G for elevated faster telecommunications as well as video services moreover robotic process automation (RPA) in restoring regular efforts to condense the workforce as well as price. Apart from the novel techniques of virtual reality (VR), augmented reality (AR) will be a division of all enterprises in the standard of living.

NEOM Smart City is comprised through full of highly developed technologies similar to the Internet of Things (IoT). Since the scientific progressions as well as rapid faster network, mobiles along with applicants will fabricate the NEOM citizen's life entirely digital and the ultramodern techs and elevated systems will pilot to digital services for every NEOM citizen. Further,

smartphones, drones, self-driving cars, AI, and robots are a few of the many expertise that formulates urban life additional sophistication and entirely automated. The inheritance technologies also contribute to the systems for endeavor systems integration performance, the oil technologies and space examinations are many chiefs and predictable feasible techs in the urban area [11]. The city is absolutely premeditated for complete automation; cybersecurity techniques will be predictable in all urban dimensional consumption and telecommunications.

8 Communication Technologies & IoT

The IoT affords a platform for sensors and actuator devices to converse effortlessly for the Smart City atmosphere and permits progressively more suitable statistics sharing crosswise platforms. The contemporary discrepancy of remarkable wireless technologies places IoT as the subsequent innovatory technology by promoting the occupied choices recommended by the technology of the Internet [6]. The Internet of Things has observed current accomplishments in the Smart City to enlarge smart systems similar to smart grids, smart retail, smart homes, smart water, smart transportation, smart healthcare, and smart energy.

On the other hand, a unanimously approved description of a Smart City is still to be conceiving along with identifying general comprehensive development is demanding. The Smart City focuses on pertaining the subsequent age information technology to entire walks of existence, implanting sensors and equipment in hospitals, power grids, railways, bridges, tunnels, roads, buildings, water systems, dams, oil and gas pipelines as well as other objects worldwide, thereby outlining the IoT.

The Internet revolt directed to the interrelations among users at an extraordinary extent along with speed. The upcoming revolt will be the interrelations among the objects to generate a Smart City. The Smart City accentuates the interrelation of intellection along with active systems, thus permitting fact sharing crosswise platforms during an incorporated skeleton. Such distribution of allocation is attained by faultless omnipresent detecting, information investigations as well as information illustration using cloud computing as the unifying skeleton. Big datasets are stocked, progressed, and extracted in smart cities professionally to fabricate data to augment dissimilar Smart City duties. In accumulation, big data can facilitate decision producers to sketch for development in Smart City services, resources, or areas. An assortment of the distinctiveness of big data exhibits its extensive prospective for expansion along with innovations.

The potentials are never-ending; though, surrounded by the accessibility of sophisticated technologies and tools. Big data can accomplish its objectives and can precede the services in Smart Cities employing the accurate apparatus and methodologies for well-organized and successful facts examination. Such efficiency will promote association and transmission among bodies and can make possible the formation of further products and apps that can even improve the Smart City. The applications of big data can provide various parts in a Smart City, thus affording improved consumer understandings and services, which facilitate enterprises, attain enhanced presentation

like superior gains or augmented stocks. Clinical care can be improved by humanizing defensive services, analysis and troubleshooting tools, medical records administration, and patient protection.

Transportation systems can seriously promote from big data to regulate directions and root plans, lodge unstable stipulates, and boost environmental responsiveness. Cloud computing is utilized to illustrate an assortment of dissimilar categories of calculating representations that absorb numerous clusters associated with the help of live message sharing web [7]. Cloud computing affords products to achieve intricate extensive range estimating assignments like mining gigantic communal network information produced through the applications of smartphones. The services of cloud computing like platform as a service, software as a service as well as infrastructure as a service can be united with the Internet of Things. Like a combination can renovate almost all the enterprise; with the preamble of big data technology, a substantial quantity of statistics could be developed without difficulty. Furthermore, cloud computing can afford the virtual infrastructure for utility computing that integrates monitoring devices, storage devices, analytics tools, visualization platforms, and client delivery. Cloud-based computing offers the primary machine through the big data examination concept like the Hadoop framework. Hadoop was commenced to offer a facilitating stand and coding structures for the disseminated operation of bulky datasets along with unusual clusters. Hadoop encompasses into 2 most important parts. The former component is termed as Hadoop Distributed File System and the latter component is MapReduce, which are intimately connected to each other. Though the live obligations of the information repository and dealing in the stylish city are measured, the embracing of construction will promise well-organized and faultless transmissions among sensors within the elegant metropolitan web.

A mounting number of novel promising cities are an excessive case as they frequently follow a corporate model. The motivating factors following the latest stylish cities are primarily economic and political; the cities are migrating in the direction of a knowledge economy and rebranding the nationalized image. Prominently, the majority of these cities have not achieved the targeted population and a few of them survive only in PowerPoint presentations and websites. Attracting human inspiration has been employed as a municipal enlargement approach that aspires at financial expansion in the era of postindustrial. This has produced innumerable viewpoints. In general, the Smart City project recognized the following economic part for improvement:

1. Energy & Water
2. Mobility
3. Biotech
4. Food
5. Technology & Digital Sciences
6. Advanced Manufacturing
7. Media & Media Production
8. Entertainment

The recent innovations along with sciences concerning the digital world sector of artificial intelligence, virtual reality, augmented reality technologies, data centers, Internet of Things (IoT) as well as e-commerce are associated with constructing the elevated cities. Furthermore, the metropolitan region will present an open-source platform for project innovators and originators to employ the scheme atmosphere for innovation along with assessments of inner-city transformations. Internet of Things is a prominent tool for scrutinizing and organizing computers in Smart Cities. The scientists who are proficient to handle the Internet of Things innovations along with software are among the crucially essential factors of the maintainability of Smart Cities. The majority of big data software for Smart Cities needs elegant structures that attach their elements together with the inhabitant utensils like vehicles, smarter homes devices, and smartphones. The following discussions are about the required components of IoT.

8.1 RFID (Radio Frequency Identification)

RFID (Radio Frequency Identification) activates in the context of Electromagnetic Fields to mechanically classify and follow labels included in articles. The label holds digitally accumulated data and can be operative, submissive, or battery-aided passive types. It is the kind of battery-powers and broadcasts the ID signal associated with it occasionally. The submissive types are not powered by a battery. The final category of battery-aided passive comprises an onboard battery and broadcasts when the RFID reader is found to be existing. The RFID technology symbolizes a get through in implanted message passing as well as could be utilized to recognize virtually any object, including animals, clothes, and even human beings. This forceful implementation of RFID (Radio Frequency identification) has finished the innovation appropriate for Smart Cities; RFID could also be functional in hospitals, libraries along with monitoring cargo. Contrasting a conventional method, that is a barcode, an RFID tag could be implemented within any articles or items and the identifier can still study the signals regardless of the tags visibleness [8]. This potential that RFID had has helped IT an ace at the list of construction embedded devices with complete following operations. For illustration, RFID tags could be implanted in an indicator, thereby constructing it a smart reading device.

8.2 Wireless Sensor Network (WSN)

WSN is one of the many dispensed independent sensor junctions which utilizes low power integrated circuits and wireless communication technology to dispense statistics between the associated sensor tools. This network holds from hundreds to thousands of minimal prices along with the least energy tiny tools which are linked to either single or multiple sensors. These sensors are included with a radio transceiver to send along with receiving signals, along with a microcontroller, that is an electronic circuit board to manage with the sensors and a power source, frequently a power system or an implanted outline of power harvesting. The WSN can attach tools with the least expenditure and amount has enhanced the opportunity of utilizing a sensor network with frequent intelligent sensors.

This network allows the faultless correlation and distribution of expensive data from dissimilar situations, which can be enhanced and evaluates resourcefully[9]. This characteristic of WSN facilitates it to be helpful in numerous fields, like industrial process monitoring as well as control, machine health monitoring, and natural disaster prevention along with water quality monitoring. The WSN can survive with big system consumption in any surroundings and so it is appropriate for the Smart City combination. The collective systems make available an undemanding profitable approach for arranging disseminated monitors, in addition to control devices, in that way keep away from the overhead expenditure that may be acquired in systems that rely on wires. The WSN be capable of observing substantial and environmental situations in live time similar to temperature, pressure, light in addition to humidity. The devices like switches, motors, or actuators control these environmental conditions via well-organized wire-free transmissions. These features facilitate WSN to be appropriate for smart homes, smart buildings, and smart health.

8.3 Wifi, Ultra-Wideband, ZigBee & Bluetooth

A town is classified as smart if it has incorporated wire-free transmission platforms. Wire-free transmission is a rapid mounting technique that affords escalating versatility and flexibility. Wireless technology suggests an energetic network structure, least expenditure, and simple consumption. One of the wire-free protocols that work as a substitution for the conventional cable or wire networks and permits customers to access the internet at decent speeds when associated with an access point otherwise when in ad-hoc mode is Wifi. Ultra-wideband is according to increased indoor bandwidth undersized assortment wireless networks over multimedia links. ZigBee is in addition with intended for wireless communication of short-range through stipulation for extensive long-lasting battery convention potential[10]. Bluetooth is one of the standards that is concerned with wireless radio systems intended for short-range and inexpensive tools.

9 Conclusion

The potential outlook of IoT is infinite. It affords clarification in the entire sectors together with manufacturing, fashion, restaurant, health care, education, etc. Smart cities can share a common elegant city platform, which formulates sense, especially for Small Cities. The combination of the cloud-based nature of IoT explanations for Smart Cities is appropriate by sharing a platform based on open statistical information. Small cities can outline an ordinary urban ecosystem. In this approach, solutions of undersized and huge elegant cities are systemic and proscribed through the innermost and essential cloud platform. Prominently, the dimension of a city is not an obstruction on the way to becoming Smart Cities in each group can promote from intelligent technologies.

10 Availability of Data and Material

All information is included in this study.

11 References

[1] Farag AA. The story of NEOM city: opportunities and challenges: New cities and community extensions in Egypt and the Middle East. Zagazig University, 2019; 35-49. DOI: 10.1007/978-3-319-77875-4_3.

[2] Doheim RM, Farag AA, Badawi S. Smart city vision and practices across the Kingdom of Saudi Arabia: A Review. Smart Cities: Issues and Challenges, 2019. DOI: 10.1016/B978-0-12-816639-0.00017-X.

[3] Alam T, Khan MA, Gharaibeh NK, Gharaibeh MK. Big Data for Smart Cities: A Case Study of NEOM City, Saudi Arabia. Lecture Notes in Intelligent Transportation and Infrastructure, 2021. DOI: 10.1007/978-3-030-60922-1_11

[4] Madakam, S., Bhawsar, P. Springer Nature Switzerland AG Handbook of Smart Cities, 2021; J. C. Augusto (Ed.). DOI: 10.1007/978-3-030-15145-4_86-2

[5] Hassan, O. Artificial Intelligence, Neom and Saudi Arabia's Economic Diversification from Oil and Gas.The Political Quarterly, 2020; 91.

[6] Saleh. H. Alyami, Holistic IoT Architecture for Smart Sustainable Cities - Current Perspective and Future Directions. IEEE, 2019.

[7] Alharbi, F. Integrating Internet of Things in electrical engineering education. International Journal of Electrical Engineering & Education. DOI: 10.1177/0020720920903422.

[8] Mehmood Y, Ahmad F, Yaqoob I, Adnane A, Imran M, Guizani S. Internet-of-things-based smart cities: Recent advances and challenges. IEEE Communications Magazine. 2017; 55(9):16-24. DOI: 10.1109/MCOM.2017.1600514

[9] Boretti A. Integration of solar thermal and photovoltaic, wind, and battery energy storage through AI in NEOM city. Energy and AI. 2021; 3:100038. DOI: 10.1016/j.egyai.2020.100038

[10] Hashem IA, Chang V, Anuar NB, Adewole K, Yaqoob I, Gani A, Ahmed E, Chiroma H. The role of big data in a smart city. International Journal of information management. 2016; 36(5): 748-58. DOI: 10.1016/j.ijinfomgt.2016.05.002

[11] Aly H. Royal Dream: City Branding and Saudi Arabia's NEOM. Middle East-Topics & Arguments. 2019; 12:99-109. DOI: 10.17192/meta.2019.12.7937

[12] Nam T, Pardo TA. Conceptualizing smart city with dimensions of technology, people, and institutions. In Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times. 2011; (pp. 282-291).

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