Journal of Positive Psychology & Wellbeing http://journalppw.com
2022, Vol. 6, No. 3, 25 – 34 ISSN 2587-0130

Evaluation of the Influence of 6G Networks on Smart Cities: An Approach Towards Sustainability

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Abstract

With the extensive proliferation of virtual reality and smart channels, the need for higher-level wireless communication networks also elevates. The revolution of 6G networks is an imperative addition to this prototype that enables fast-speed mobility. This cutting-edge innovation also has greater implications for the emergence of smart cities. Thus, in order to delve deeper into this regard, the present research intends to assess the influence of 6G networks on smart cities. The study entails a review approach and explores the current findings pertaining to the given topic. It has been endeavored to overview the prerequisites of the 6G networks and their influence in building smart cities.

Keywords: 6G, 6G Networks, Networking, Smart Networks, Smart Cities, Sustainable Networks, Wireless Communication

1 Introduction

The dissemination of the 5G was inaugurated in the year 2019, eventually leading to the expectation of a 6G network in the 2021 era. It can be said that 6G is a successor and follower of 5G networks as it has been regarded that mobile networks will have the ability to utilize several IoT services, which are functionalities and designs of a particular network. These services have the capability of adapting to different amenities and requirements of the network being used, i.e., 5G or 6G. At the current time, many scientists are doing the investigation of the network of 6G. An increasing amount of lateral and indirect research has been conducted in the interest of future 6G wireless networks [1].

With the intention of building an open and intelligent 6G network, there should be a well-furnished and well-equipped node that has the minimum and enough amount of communication, computing, and resources for caching operations that provides intelligent evolution. The latency of the 6G network is ten times greater than that of the 5G network [2]. The data is multiplied three times in the 6G network as it is fifty times faster and quicker than 5G. Thus, the network is 100 times more reliable and can easily support devices that have a range of more than ten devices. Moreover, 6G has the ability to integrate different technologies that have the power and facility to support information based on holographic. Hence, the future network should be intelligent first, which can learn the characteristics of the service autonomously and be aware of their changes [3].

Much enforcement has been applied in the delivery of a 6G network that does not depend on the speed and distance of the Internet. Three modes of the 6G network are seen in the IoT services; policy lead (role of government), tech-push (technological advancements), and need-pull (societal requirement). These moves play an abundant role in the promotion of 6G correspondingly. Progressive services of IoT devices like smart traffic, environment monitoring and control, virtual reality (VR)/virtual navigation, telemedicine, digital sensing, high definition (HD), and full HD video transmission are used accordingly with the network of 6G [4], [5].

As described by Akhtar et al. [6], a 6G wireless communication network uses maximum frequency than any of its successors and provides capacity with a higher rate and lower latency. This feature helps in the communication in the land, water, and air all along one network with the reliability and speed acquiring higher rate. This is an essential requirement for the adoption of IoT on a large-scale premise. Afifi [7] stated that all of the devices which are connected to IoT infrastructure and depend on the connectivity and speed of the network are estimated to reach an account of billions. This is one of the main attributable reasons that the world should acquire faster communication techniques by implementing energy efficient 6G communication networks.

Different 6G trends are used in the innovation of smart cities. A. L. Imoize [5] has elaborated different driving trends of 6g, which have impacted the vast innovation industry. Some of the most effective 6g trends are "the convergence of Communications, Computing, Control, Localization and Sensing (3CLS) or Communication, Computation, Caching and Control (C4)". Figure 1 depicts some driving trends of 6g and how reflective surfaces have emerged the world of smart cities.

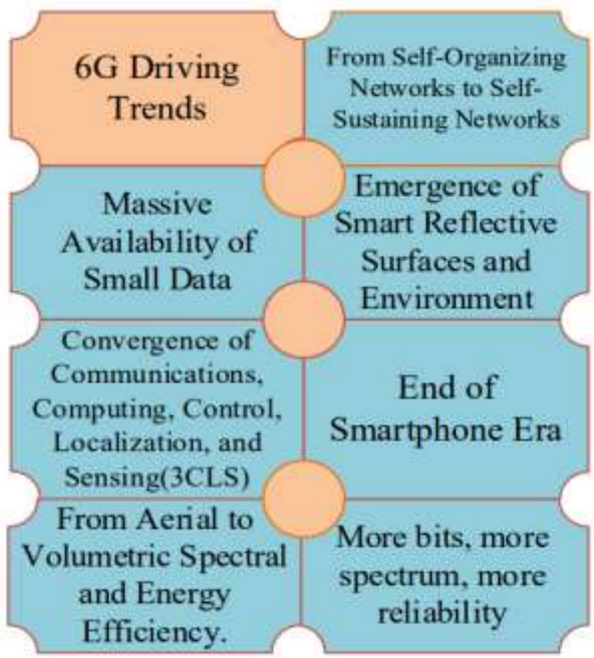

Figure 1. 6G driving trends [5]

A pictorial guide of driving 6G trends are shown in figure 1. It depicts that 6G system has the ability of converting big data into relatively distributed small data.The merging of Communications, Computing, Control, Localization, and Sensing (3CLS) has access to the provision of correspondence framework, regulation, localization, and sensing in accordance with Wireless Communication that was provided by previous generations. This supports application like XR, CRAS, and DLS. For the facilitation of wireless network in various vehicles like XR, BCI are also integrated with the approach of 6G. It has also resulted in ending the period of smartphone as haptics have recently emerged.

A pervasive autonomous system has been implemented by several researchers that use the amenities of a 6G wireless communication network. It is anticipated that the 6G will support smart cities, tactile devices, and the Internet of

Everything (IoE). The prerequisites of the 6G include "high data rate in the order of 1 Tb/s, ultra-low latency of less than 1ms, high energy and spectral efficiency, security and privacy, and ubiquitous connectivity that connects everyone, including people in rural areas". Ultra-Reliable Low-Latency Communication (URLLC) is used in 6G wireless communication networks as it is under significant conditions than that which are attained by the 5G network. It comprises of delay in jitters, no context of awareness, and the compatibility of UAV satellite being is also not being considered [8], [9]. Therefore, the current research is an attempt to join forces with the existing body of knowledge in this regard by evaluating the influence of 6G networks on smart cities and unveiling the underlying impacts.

1.1 6G Applications

New applications have been made possible by every generation of wireless networks, and 6G is no different. New wireless generation networks are being developed and implemented in response to the requirements for higher data rates, lower latency, high reliability, and more. Despite the fact that 5G has been proposed to enable these or similar applications, the requirements necessary to facilitate them seamlessly are not met at this stage of development. The limited bandwidth and high energy consumption of 5G are mentioned as limitations. Even though 5G tests have demonstrated the possibility of achieving data rates of 8 Gbps [10] and 1 Gbps over a distance of 6.5 km [11], these rates are still below the peak data rate of 20 Gbps that has been proposed in the literature.

As a result, high-speed intensive applications like holographic communication, which require 1 Tbps for seamless communication [12], cannot be served by the existing 5G networks. High levels of interference as a result of the extensive interconnection, inadequate computing power, and the absence of ubiquitous connectivity are additional drawbacks of 5G wireless networks. Holographic communication, teleoperated driving, the tactile internet, Industry 4.0, and other applications will all be made possible and fully enabled by 6G, which promises better features than 5G. IoBNT and Digital replica, two new applications not considered in the context of 5G, are also introduced in this paper. These applications are summarized in Table 1.

Table 1. Explanation of 6G Applications

6G Applications	Explanation of the Application
Communication in the Holographic approach	Holograms, three-dimensional images floating in space, are made possible by this to make remote communication more enjoyable as we move toward a borderless workplace. Holographic communication presents a number of challenges, some of which include high bandwidths and latency. These problems will be solved by 6G.
Tactile internet	Enables interactions between machines and humans as well as between machines and humans.
Future 4.0 Industry	Comprises IoT, cloud computing, and cyber-physical systems. In addition, the fourth industrial revolution will be driven by AI and lightning-fast wireless networks. This makes it possible to control automobiles from afar, one of the six-generation visions.

Driving under Teleoperation	Semi-autonomous vehicles are another name for these automobiles. A fast, ubiquitous, and extremely low-latency wireless network is necessary for semi-autonomous vehicles.
Internet of Nano-bio things (IoBNT)	A network of biological nano-sized objects (nanomachines) interconnected. Primarily finds use in the healthcare industry. The ultra-low latency and perceptual requirements that IoBNT requires are proposed to be met by 6G.
XR devices following multisensory technique	Perceptual experience is incorporated into AR, MR, and VR. An excellent candidate for improving the gaming experience, supported by URLLC and eMBB, as well as perceptual factors that will be supported by 6G.
Innovation in Blockchain and Distributed ledger	It is proposed that blockchain will safeguard 6G networks. In addition, they require low latency, dependable connectivity, and scalability, all of which will be provided by 6G networks.
Connected robotics and autonomous systems (CRAS)	Utilizing robots and autonomous systems for industrial operations necessitates CRAS in order to advance industrialization. They require low latency and high reliability.
Wireless brain-computer interface (BCI)	BCI makes it possible for electronic devices and the brain to communicate. This necessitates a high data rate, high reliability, and extremely low latency.
Digital replica	These are also known as digital twins because they produce a digital replica to take the place of people, places, systems, and things.6G will make this possible because this requires a very high data rate.

Additionally, these applications' desirable features are taken into account. This section focuses on these applications, the limitations of 5G, and how 6G wireless networks will make them possible. It has been established in this literature that the current 5G features are not efficient enough to meet these technologies' requirements.

2 Methodology

The given study proceeds by adopting a qualitative research design. In order to get an optimal insight into the issue, the current body of knowledge has been reviewed and evaluated. A thorough literature search was conducted. Data was gathered from various open-access online databases. Furthermore, multiple websites, search engines, and a collection of databases were sorted to accumulate the most pertinent research studies. Some of the major platforms used for extracting data included: ScienceDirect, Google Scholar, PubMed, and other articles, books, and research papers from some authentic sites. The resources cited in the selected publications were further examined to get an inclusive understanding of the topic

3 Results and Discussion

3.1 6G and Smart Cities: The Underlying Influence

Smart cities are primarily intended to manage the next-level issues prompted owing to overpopulation [13]. However, the futuristic smart cities are somewhat distinct and are grounded upon even dense and artificial-intelligence-centered cities [14], [15]. Hence, the enormous device connectivity with the massive data traffic is expected in the forthcoming era where the communication channels or networks are likely to offer high-quality service, ubiquity, and on-demand content to run and manage a significant sum of interlinked devices [16], [17]. All these likelihoods necessitate intelligent approaches to endure the progression of cities within the modern-day arena and further affirm the notion of smart cities [18]–[20]. Thus, smart cities have the potential to bring opportunities for solving the challenges associated with the future traffic among communication channels by providing high-quality lifestyles via IoT intelligent services and ICT [21]. Figure 2 demonstrates the distinct applications of smart cities with regard to specific scenarios with IoT-envisioned applications.

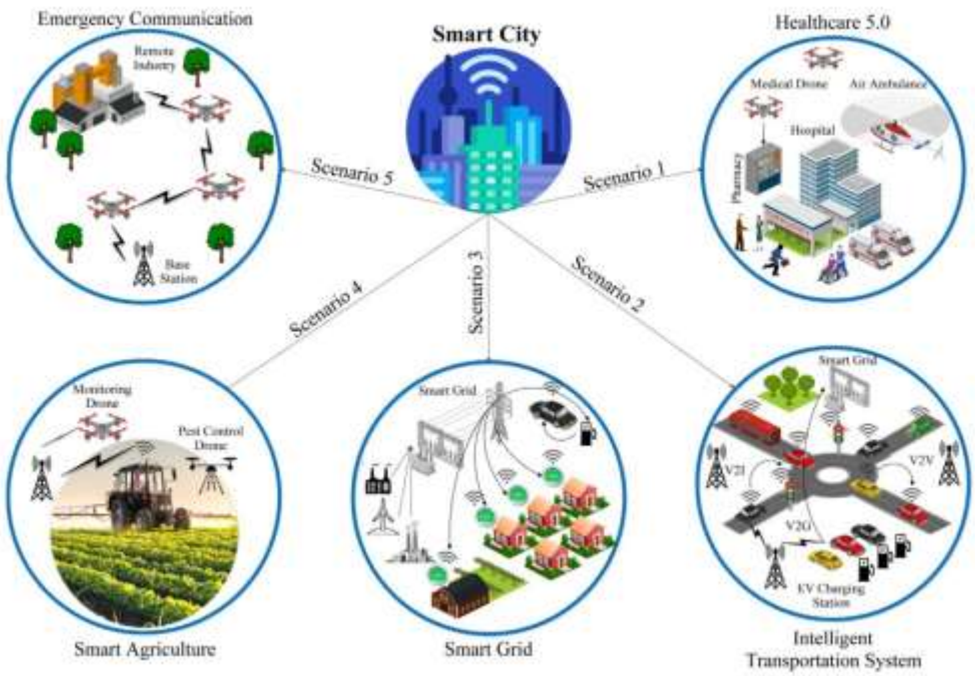

Figure 2. Application-specific view of smart cities [21]

Within this context, the Internet of things (IoT) can enable smart cities to attain the vision of the "Internet of Everything (IoE)" by designing an intelligent connection between devices without the need to involve human interventions. The continually expanding development of IoT devices accounts for a significant proportion of business data generated by machine-type communications (MTC) in the overall stance. Thus, in relation to this, the massive machine type communications (mMTC), as well as ultra-reliable low latency communications (URLLC), are among the leading application scenarios that require higher reliability and low latency communications that can only be efficiently offered by 6G technology. Being beyond fifth-generation networks, 6G has even stronger URLLC and mMTC scales that can co-exist within the machine-type communications (MTCs) to make possible 6G-enabled smart cities [22].

The energy-proficient 6G innovation can possibly make smart communities more productive and compelling. The utilization of 6G by IoT gadgets can change smart cities into super smart communities. The current upheaval in the eighteenth century evaluated and changed cities worldwide. It was expressed by researchers of research and markets [23] that smart cities that were built have the ability to enhance connectivity. Still, some contemporary connections were not able to accomplish the demands of smart cities. Afifi [7] declared that the IoT foundation is supposed to arrive at a billion gadgets, subject to network.

Nonetheless, the network given by 2G-5G is not sufficient to fulfill the high needs for IoT gadgets, particularly in smart urban communities. Like this, it is exceptionally vital to distinguish the key IoT advancements for 6G in smart urban areas that can be utilized to satisfy the high network needs. Allam et al. [24] examined the expression '15-Minute City', alluding to the smart urbanization in a post-pandemic time that offers better expectations for everyday comforts and further developed metropolitan wellbeing amenities.

Improvement of the network level of 6G communication can be considered reliable on machine learning and policies of self-organization. They basically need ordinary AI operations, but for revolutionizing the world, there is a need to utilize the technique of collaborative AI. Some scholars have reported that Blockchain is the most disordered sort of technology as it lacks the capability of enabling the seamless technique of a 6G network. One characteristic which can be provided by blockchain to the 6G network is Intelligent resource management. Another technology that cannot be left behind when studying for a 6G network is VLC technology. It has the functionality of transferring and receiving data by using visible light [25]. It has the ability to carry data of 400 to 750 THz as it falls under the category of optical wireless communication. All these 6G technologies and features add various benefits to the IoT system, which can become highly competitive and optimized based on their speed and bandwidth.

A. L. Imoize [5] gave a robust discusion of explaining of the vast 6G enabling technologies. A pictorial understanding of differrent 6G enabling technologies are portrayed in figure 3. One of the basic 6G technology is Artificial intelligence which was eventually introduced in 5G but has increasingly achieved an absolute intelligent 6G network. For the reflecting of signals and maintenance of Line of Sight (LoS), reconfigurable Intelligent surfaces are used on the windows, buildings and doors. 6G has also highlighted its impact on the technology of Cell-free Massive MIMO, TeraHertz, and Optical Wireless Technology. Although some of the technologies are undeveloped, like Quantum communication, 6G has facilitated it for utilization in future wireless networks. In the literature on Space of things, space communication has executed technologies like Unmanned Aerial Vehicles (UAV) and CubeSats. Another vast technology of a 6G network is the Ambient Backscatter Communication System (ABCS), which has desirably changed the wireless communication network.

Figure 3. 6G Enabling Technologies [5]

Zhao [26] stated that a vast literature on IoT key technologies related to the wireless communication of 6G networks affiliated with smart cities had been done by many scholars and scientists. According to this report, Zhang [27] invented key technologies such as the transformation of power and wireless information to be utilized in smart cities by incorporating the wireless communication of the 6G network. Kohli proposed that apart from 6G communication, there are other various technologies that use a brain-computer interface. It uses human stability more than exterior sources for better interaction. According to Kohli et al. [28], there are numerous technologies, such as 6G wireless communication in smart cities, that comprise a brain-computer interface. Since this is one of the emerging technologies, it uses human consciousness more than external sources for better interaction.

Optimizing the 6G method in smart cities can revolutionize the ordinary lifestyle of individuals. It can facilitate autonomous systems along with the connectivity of robotics which follows the drone delivery UAV systems. This strategy, named drone-delivery system, can ensure the delivery of packages on accurate time. Moreover, if a 6G network is implemented in smart cities, it can enable people to be safe from the hustle and severe traffic accidents [29]. A smart and sustainable city approach has already been considered, and it involves an area named "Industrial town," which is situated in the "Bangkok Metropolitan Region (BMR)." Chimmanee and Jantavongso [30] testified that this town has the ability to emplacement of 6G network with all the facilities which are enabled by IoT services along with faster connectivity to the Internet.

Using these advancements, IoT frameworks in smart urban areas can work productively to offer top-notch types of assistance of the traffic board, security, exploration, etc. This exploration focuses on IoT advances, applications, and patterns for energy-proficient 6G remote communication in smart urban areas. These frameworks are potentially going to take care of manageability issues and make smart urban communities ecologically approachable. Other than this, the patterns in innovative work in IoT and 6G innovation show that future smart urban areas will be more productive and powerful, as they will actually want to deal with information at extraordinary velocities.

3.2 Implications of 6G for Sustainable Future

Being one of the foremost technologies within the smart network arena, 6G has the potential to go beyond the existing networks of cell towers to embrace more advanced connectivity methods [31]. In the near future, the impacts of 6G are going to artistically shape the concept of a sustainable future. It is anticipated that:

- Internet of Things (IoT), as well as Internet of Everything (IoE), will take over the appliances, consequently alleviating electricity usage and contributing to optimization for connected vehicles, automated manufacturing, drone agriculture, and so forth.
- 6G would have greater efficiency and less power consumption in contrast to 5G and prior generations. This, in turn, will lead to power future applications and assist in achieving energy efficiency through digitization.
- 6G will also eventually enable smart transportation in a setting where interconnected cameras, electric vehicles, and roads communicate for optimizing the traffic flow.
- Smart agriculture would be able to make use of smart sensors for monitoring livestock, controlling water, and providing accurate pesticides that could lessen carbon emissions.
- The interlinked robotic equipment and smart machines will be managing supply chains even more efficiently to induce reduction in water and energy usage alongside carbon emissions.
- Lastly, 6G will prove to be valid in assisting with the move to renewable energy, and the smart grids could optimize energy distribution.

4 Conclusion

From the above findings, it has been observed that the vision for smart cities and machine-type communication networks is only appropriately thinkable in the presence of 6G technologies. The outlook for a sustainable future, smart devices and other cutting-edge networking technologies call for great deliberation from an intelligent perspective, requiring innovative connections to enable the management of the massive data traffic that is expected to arise in the near future. Hence, in order to further affirms the imminent demands, innovative and more recent modulation and cryptography techniques ought to emerge. Moreover, prior to moving forward towards new developments, it must not be disregarded that the high-power frequencies also have several detrimental health-related effects that require to be effectively tackled. Besides, before the official inauguration of 6G services, the integration of mobile networks as well as terrestrial satellite into an even wireless system also calls for practical measures to be taken into account.

To sum up, since smart cities look forward to enhancing operational efficiency in order to reach high-level sustainable developments, intending to overcome the challenges induced by expanding urbanization, 6G networks are indubitably an optimum technology that can adequately lead to a hyperconnected future in this regard.

References

[1] R. Kulkarni and S. Kulkarni, “How 6G has an Influence on Smart Cities An Overview.,” *Int. J. Eng. Res. Technol.*, vol. 10, no. 5, 2021.

[2] A. L. Imoize, O. Adedeji, N. Tandiya, and S. Shetty, “6G enabled smart infrastructure for sustainable society: Opportunities, challenges, and research roadmap,” *Sensors*, vol. 21, no. 5, p. 1709, 2021.

[3] M. M. Kamruzzaman, “Key Technologies, Applications and Trends of Internet of Things for Energy-Efficient 6G Wireless Communication in Smart Cities,” *Energies*, vol. 15, no. 15, p. 5608, 2022.

[4] X. You *et al.*, “Towards 6G wireless communication networks: Vision, enabling technologies, and new paradigm shifts,” *Sci. China Inf. Sci.*, vol. 64, no. 1, pp. 1–74, 2021.

[5] A. L. Imoize, O. Adedeji, N. Tandiya, and S. Shetty, “6G enabled smart infrastructure for sustainable society: Opportunities, challenges, and research roadmap,” *Sensors*, vol. 21, no. 5, p. 1709, 2021, doi: 10.3390/s21051709.

[6] M. W. Akhtar, S. A. Hassan, R. Ghaffar, H. Jung, S. Garg, and M. S. Hossain, “The shift to 6G communications: vision and requirements,” *Human-centric Comput. Inf. Sci.*, vol. 10, no. 1, pp. 1–27, 2020.

[7] M. A. M. Afifi, T. M. Ghazal, and D. Kalra,

"The impact of deploying the internet of things and how will it change our lives," *Solid State Technol.*, vol. 64, no. 2, pp. 2049–2055, 2021.
[8] S. Zhou, W. Xu, K. Wang, M. Di Renzo, and M.-S. Alouini, "Spectral and energy efficiency of IRS-assisted MISO communication with hardware impairments," *IEEE Wirel. Commun. Lett.*, vol. 9, no. 9, pp. 1366–1369, 2020.
[9] M. Wang, T. Zhu, T. Zhang, J. Zhang, S. Yu, and W. Zhou, "Security and privacy in 6G networks: New areas and new challenges," *Digit. Commun. Networks*, vol. 6, no. 3, pp. 281–291, 2020.
[10] Nokia, "Elisa and Qualcomm Achieve 5G Speed Record in Finland," 2020. https://www.nokia.com/about-us/news/releases/2020/11/18/nokia-elisa-and-qualcomm-achieve-5g-speed-record-in-finland/#:~%7B%7D:text=Espoo%2CFinland- -Nokiahttps%2CElisa,5GmmWavede.
[11] "Qualcomm TIM, Ericsson and Qualcomm Set World Record for Long Distance Speed with 5G mmWave Applied to FWA.," 2020. https://www.qualcomm.com/news/releases/2020/12/04/tim-ericsson-and-qualcomm-set-world-recordlong-distance-speed-5g-mmwave (accessed on 8 December 2020).
[12] S. Nayak and R. Patgiri, "6G Communication: A Vision on the Potential Applications," in *Edge Analytics*, Springer, 2022, pp. 203–218.
[13] A. R. Javed *et al.*, "Future smart cities requirements, emerging technologies, applications, challenges, and future aspects," *Cities*, vol. 129, p. 103794, 2022, doi: 10.1016/j.cities.2022.103794.
[14] M. Batty, "Artificial intelligence and smart cities," *Environment and Planning B: Urban Analytics and City Science*, vol. 45, no. 1. SAGE Publications Sage UK: London, England, pp. 3–6, 2018, doi: 10.1177/2399808317751169.
[15] A. J. Jara, D. Genoud, and Y. Bocchi, "Big data in smart cities: from poisson to human dynamics," in *2014 28th International Conference on Advanced Information Networking and Applications Workshops*, 2014, pp. 785–790, doi: 10.1109/WAINA.2014.165.
[16] M. S. Farooq, R. M. Nadir, F. Rustam, S. Hur, Y. Park, and I. Ashraf, "Nested Bee Hive: A Conceptual Multilayer Architecture for 6G in Futuristic Sustainable Smart Cities," *Sensors*, vol. 22, no. 16, p. 5950, 2022, doi: 10.3390/s22165950.
[17] P. Rizwan, K. Suresh, and M. R. Babu, "Real-time smart traffic management system for smart cities by using Internet of Things and big data," in *2016 international conference on emerging technological trends (ICETT)*, 2016, pp. 1–7, doi: 10.1109/ICETT.2016.7873660.
[18] J. Sun, J. Yan, and K. Z. K. Zhang, "Blockchain-based sharing services: What blockchain technology can contribute to smart cities," *Financ. Innov.*, vol. 2, no. 1, pp. 1–9, 2016, doi: 10.1186/s40854-016-0040-y.
[19] R. Rivera, J. G. Robledo, V. M. Larios, and J. M. Avalos, "How digital identity on blockchain can contribute in a smart city environment," in *2017 International smart cities conference (ISC2)*, 2017, pp. 1–4, doi: 10.1109/ISC2.2017.8090839.
[20] E. Tabane, S. M. Ngwira, and T. Zuva, "Survey of smart city initiatives towards urbanization," in *2016 international conference on advances in computing and communication engineering (ICACCE)*, 2016, pp. 437–440, doi: 10.1109/ICACCE.2016.8073788.
[21] A. Kumari, R. Gupta, and S. Tanwar, "Amalgamation of blockchain and IoT for smart cities underlying 6G communication: A comprehensive review," *Comput. Commun.*, vol. 172, pp. 102–118, 2021, doi: 10.1016/j.comcom.2021.03.005.
[22] H. Han, J. Zhao, W. Zhai, Z. Xiong, and W. Lu, "Smart city enabled by 5G/6G networks: An intelligent hybrid random access scheme," *arXiv*. 2022, doi: 10.48550/arXiv.2101.06421.
[23] Research and Market, "6G and Smart Cities: Transformation of Communications, Services, Content, and Commerce 2025–2030," *Mind Commerce*, 2021.
[24] Z. Allam, S. E. Bibri, D. S. Jones, D. Chabaud, and C. Moreno, "Unpacking the '15-Minute City'via 6G, IoT, and Digital Twins: Towards a New Narrative for Increasing Urban Efficiency, Resilience, and

Sustainability," *Sensors*, vol. 22, no. 4, p. 1369, 2022.

[25] N. Chi, Y. Zhou, Y. Wei, and F. Hu, "Visible light communication in 6G: Advances, challenges, and prospects," *IEEE Veh. Technol. Mag.*, vol. 15, no. 4, pp. 93–102, 2020.

[26] Y. Zhao, J. Zhao, W. Zhai, S. Sun, D. Niyato, and K.-Y. Lam, "A survey of 6G wireless communications: Emerging technologies," in *Future of Information and Communication Conference*, 2021, pp. 150–170.

[27] R. Zhang, R. G. Maunder, and L. Hanzo, "Wireless information and power transfer: From scientific hypothesis to engineering practice," *IEEE Commun. Mag.*, vol. 53, no. 8, pp. 99–105, 2015.

[28] V. Kohli, U. Tripathi, V. Chamola, B. K. Rout, and S. S. Kanhere, "A review on Virtual Reality and Augmented Reality use-cases of Brain Computer Interface based applications for smart cities," *Microprocess. Microsyst.*, vol. 88, p. 104392, 2022.

[29] M. Z. Chowdhury, M. Shahjalal, S. Ahmed, and Y. M. Jang, "6G wireless communication systems: Applications, requirements, technologies, challenges, and research directions," *IEEE Open J. Commun. Soc.*, vol. 1, pp. 957–975, 2020.

[30] K. Chimmanee and S. Jantavongso, "Practical mobile network planning and optimization for Thai smart cities: Towards a more inclusive globalization," *Res. Glob.*, vol. 3, p. 100062, 2021.

[31] European Commission, "Smart Cities." European Commission Website, [Online]. Available: https://ec.europa.eu/info/es-regionu-ir-miestu-pletra/temos/miestai-ir-miestu-pletra/miestu-iniciatyvos/smart-cities_en#:~:text=Related links-,What are smart cities%3F,resource use and less emissions.

[32] Naresh VS, Nasralla MM, Reddi S, García-Magariño I. Quantum Diffie–Hellman Extended to Dynamic Quantum Group Key Agreement for e-Healthcare Multi-Agent Systems in Smart Cities. Sensors. 2020 Jul 15;20(14):3940.

[33] Singh N, Gunjan VK, Nasralla MM. A parametrized comparative analysis of performance between proposed adaptive and personalized tutoring system "seis tutor" with existing online tutoring system. IEEE Access. 2022 Apr 11;10:39376-86.

[34] Nasralla MM, García-Magariño I, Lloret J. MASEMUL: A simulation tool for movement-aware MANET scheduling strategies for multimedia communications. Wireless Communications and Mobile Computing. 2021 Mar 18;2021.

[35] Nasralla M, Rehman I, Sobnath D. Computer Vision and Deep Learning-Enabled UAVs: A Proposed Use Case for Visually Impaired People in a Smart City: Workshop in conjunction with the 18th International Conference on Computer Analysis of Images and Patterns, Salerno, Italy, September 6th, 2019. The proceedings of the conference will be published in the Springer LNCS series. InWorkshop in conjunction with the 18th International Conference on Computer Analysis of Images and Patterns 2019 Sep 20. Springer.

[36] Khattak SB, Nasralla MM, Rehman IU. The Role of 6G Networks in Enabling Future Smart Health Services and Applications. In2022 IEEE International Smart Cities Conference (ISC2) 2022 Sep 26 (pp. 1-7). IEEE.