Mesopotamian journal of Computer Science
Vol. 2024, **pp**. 110–121
DOI: https://doi.org/10.58496/MJCSC/2024/009 ; ISSN: 2958-6631
https://mesopotamian.press/journals/index.php/cs

Research Article

Introduction to Wi-Fi 7: A Review of History, Applications, Challenges, Economical Impact and Research Development

Sallar Salam Murad [1, *], Rozin Badeel[2], Banan Badeel Abdal[3], Tasmeea Rahman[4], Tahsien Al-Quraishi[5]

[1] *Institute of Informatics and Computing in Energy Universiti Tenaga Nasional (UNITEN) Kajang, 43000, Malaysia*
[2] *Department of Communication Technology and Network University Putra Malaysia (UPM) Seri Kembangan, 43300, Malaysia*
[3] *College of Administration and Economics, University of Duhok, Duhok Kurdistan region -Iraq*
[4] *Electrical and Electronics Engineering, Faculty of Engineering, Universiti Putra Malaysia,43400, Serdang, Malaysia*
[5] *Information Technology and Systems, Victorian Institute of Technology (VIT), Melbourne 3000, Australia*

ARTICLE INFO

Article History
Received 04 May 2024
Revised: 03 Jun 2024
Accepted 05 Aug 2024
Published 26 Aug 2024

Keywords
WiFi7
IEEE 802.11be
Wireless communication
Home networking

ABSTRACT

Wi-Fi 7, commonly referred to as IEEE 802.11be, is the most recent development in wireless communication technology. It provides significant improvements in terms of speed, capacity, and efficiency. The purpose of this study is to investigate Wi-Fi 7, a standard for wireless communication technology, with a particular focus on the technological advancements and security issues associated with it. In addition, it offers historical perspectives and investigates the institution's present capabilities as well as its potential for the future. The purpose of this study is to provide a complete examination of the development of Wi-Fi technology and its influence on a wide range of industries. This will allow researchers to look forward to and anticipate future advancements and breakthroughs. In addition, it made it possible to integrate Wi-Fi 7 in smart homes, intelligent transportation systems, healthcare services, and industrial automation by providing high-speed connectivity and lowering the amount of latency that occurs during interactions. Both positive and negative aspects, as well as future trends and developments, as well as economic consequences for a wide range of sectors, are investigated simultaneously. The findings of this study shed light on the possible uses of Wi-Fi 7 and its ability to transform a number of different industries, such as training and essential infrastructure. This review aims to enlighten developers and decision-makers about the capabilities and consequences of Wi-Fi 7. The objective is to provide a comprehensive understanding of the technology and promote its appropriate adoption in the current era of digital technology.

1. INTRODUCTION

Our ability to connect, communicate with one another, and engage with our surroundings has been fundamentally altered as a result of the proliferation of Wi-Fi technology. Over the course of its history, which began in the late 1990s with the introduction of the IEEE 802.11 standard, Wi-Fi has undergone several generations that have continuously improved in speed, capability, and dependability. Wi-Fi 7, also known as IEEE 802.11be, is the next step forward in wireless communication, and it offers some advantages that have never been seen before[1-3].

Owing to the ever-increasing requirements of today's networked world, Wi-Fi 7 was explicitly designed to meet those requirements . These demands are the consequence of the widespread use of intelligent devices, high-quality information, and applications that require rapid responses; thus, there is a need for networks that are quicker, more effective, and more dependable. The goal of Wi-Fi 7 is to revolutionise wireless communication by utilising technologies such as multilink operation (MLO) and 4096-QAM, which allow for data transfer speeds of up to 46 gigabits per second[4].

The purpose of this review article is to offer a detailed study of Wi-Fi 7, including its historical evolution, significant technological developments, possible uses, and some of the challenges that it confronts. This research provides a detailed account of the development of Wi-Fi, beginning with its earliest incarnations and continuing to the present day. It focuses on the significant advancements and breakthroughs that have laid the groundwork for Wi-Fi 7. For the purpose of accurately grasping the significance of the technical breakthrough that Wi-Fi 7 reflects, it is essential to have a solid understanding of the historical background.

*Corresponding author. Email: sallarmurad@gmail.com

Moreover, it investigates the many uses of Wi-Fi 7, explicitly analysing how its expanded capabilities have the potential to transform a number of different industries, such as telemedicine, gaming, industrial automation, and smart home systems. The ability of Wi-Fi 7 to provide ultralow latency, high data rates, and the ability to support a greater number of connected devices makes it a vital enabler of future technologies and services. Despite this, many challenges need to be overcome before Wi-Fi 7 can receive mainstream acceptance. To make full use of the opportunities presented by Wi-Fi 7, this article provides an analysis of the technological and legislative challenges that need to be overcome first. To enable a seamless transition to this new standard, it is necessary to address critical aspects such as spectrum control, infrastructure upgrades, and security concerns. These measures are crucial factors that must be addressed.

Finally, it examines the most recent research and development efforts made to enhance the performance of Wi-Fi 7 and resolve any problems it may face. This research focused on maximising the advantages of Wi-Fi 7 while simultaneously minimising its disadvantages. It is widely believed that Wi-Fi 7 will be the most advanced wireless technology of the future, as it has the potential to bring about significant changes in a wide variety of applications and industries. This study aims to provide comprehensive knowledge of Wi-Fi 7, covering its promise and the challenges it needs to overcome. It offers essential perspectives for academics, industry experts, and legislators as they navigate the future of wireless communication.

This paper is structured as follows: Wi-Fi 7 is introduced in Section 1, which emphasises its importance in the field of wireless communication technology. Section 2 discusses the historical development of the technology. Section 3 provides a review of pertinent work, including antecedent research and advancements in the field. Section 4 investigates the challenges associated with the implementation of Wi-Fi 7. Section 5 examines the numerous applications of Wi-Fi 7. Section 6 discusses the economic impact on various sectors. Section 7 delves into the anticipated future trends and developments in Wi-Fi 7 technology. Finally, Section 8 presents the conclusions of this work.

2. HISTORICAL BACKGROUND OF WIFI DEVELOPMENT

The development of Wi-Fi technology has been characterised by notable milestones and developments that have consistently expanded the limits of wireless communication. The inception of Wi-Fi can be traced back to 1997, when the IEEE 802.11 standard was introduced[1], [2], [5]. This standard established the groundwork for Wi-Fi by offering a relatively low data rate of 2 Mbps at a frequency of 2.4 GHz.

In 1999, the 802.11b standard was established, which took the lead in wireless networking almost immediately after its introduction [6]. The adoption of Wi-Fi became a feasible alternative for widespread consumer acceptance as a result of this standard, which increased internet speed to 11 Mbps. Moreover, the 802.11a standard was introduced, which provides increased download speeds of up to 54 megabits per second inside the 5 GHz frequency band[7]. As a result, the establishment of commercial networks that were both more robust and more efficient was made more accessible. With the introduction of the 802.11 g standard in 2003, the benefits of earlier technology were incorporated into the new standard. It was able to produce a speed of 54 Mbps in the widely used 2.4 GHz band, which led to its widespread popularity because it was compatible with other devices and performed exceptionally well. In 2009, the technical advancement known as 802.11n introduced a technique known as MIMO, which stands for multiple inputs and multiple outputs. [8].

This innovative technology was capable of providing astounding data speeds of up to 600 megabits per second (Mbps) and functioned on both the 2.4 GHz and 5 GHz bands. The Wi-Fi networks achieved significant improvements in terms of speed, reach, and reliability. Wi-Fi 5, also known as the 802.11ac standard, was introduced in 2014 and brought about a significant improvement by making use of the 5 GHz band to achieve data transfer speeds that were greater than 1 gigabit per second. Wi-Fi 5 emphasised increased data transfer speeds and assured compatibility with a broader number of devices. This was essential for the Internet of Things (IoT) ecosystem, which was rapidly expanding. At the beginning of 2019, the adoption of Wi-Fi 6 (802.11ax) resulted in significant improvements in both the capacity and efficiency of the network. [9,10]. Features such as OFDMA and MU-MIMO, which are especially useful in areas with high population density, were integrated into this update. [11].

Wi-Fi 6E was announced in 2020, extending into the 6 GHz range. This expansion offered an additional spectrum to alleviate congestion and enhance performance further [12]. The foundation for the development of Wi-Fi 7 (802.11) was established in 2021. Wi-Fi 7 is anticipated to deliver unprecedented rates of up to 46 Gbps over the 2.4 GHz, 5 GHz, and 6 GHz frequency bands. It also has sophisticated features such as multilink operation and 4096-QAM[13]. The preliminary specifications for Wi-Fi 7 were released in 2023, with full certification expected by 2024. This advancement signifies the onset of a new era defined by rapid and agile wireless networking[14]. The evolution from the basic 802.11 standard to the advanced capabilities of Wi-Fi 7 illustrates a significant progression in technology, continually enhancing our connectivity in an increasingly digital world. Refer to figure 1.

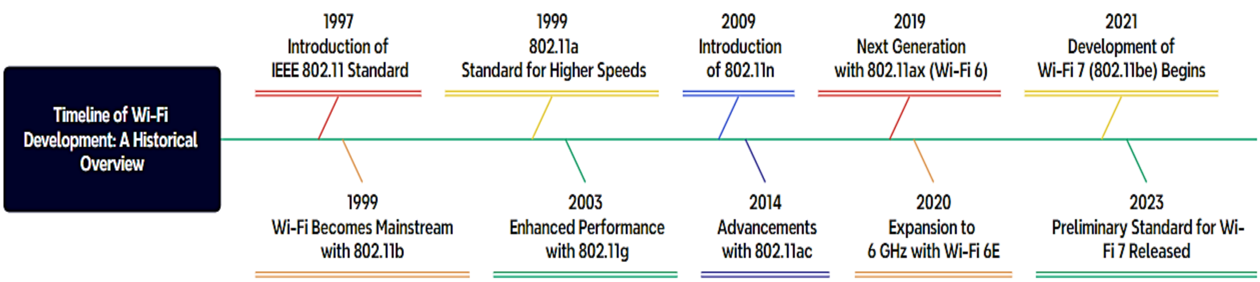

Fig .1. The timeline for the development of Wi-Fi technology during this time frame.

3. RALATED STUDIES

Within the scope of this field, many studies have been carried out to comprehensively study and highlight various elements of the problem. The results of these studies have provided crucial insights into the complexity of the matter, which has resulted in an improvement in our general comprehension. Both scholars and practitioners have benefited from these insights, which have enabled them to make more informed judgments and design more successful techniques. In addition, the wide variety of viewpoints presented by this research has contributed to the enhancement of the conversation around this subject.

Authors investigated the possibilities of Wi-Fi 7 across a variety of industries, highlighting the importance of strategic planning and creative solutions to the challenges associated with adoption. It is anticipated that the deployment of Wi-Fi 7 will result in breakthroughs in wireless communication, which will make it possible to develop creative apps and increase connections in a variety of applications and locations. This paper places a strong emphasis on the need for industry leaders to participate in collaborative research and development activities and invest resources in essential infrastructure. The issues that are linked with the introduction of new capabilities of IEEE 802.11be Wi-Fi 7, such as increased data transfer speeds and decreased latency, are also investigated in this study [1].

Authors focused on incorporating time-sensitive networking (TSN) elements into the IEEE 802.11 standard, which is the foundation for Wi-Fi 7 and is becoming increasingly common. For applications that require real-time data transmission, such as industrial automation, virtual reality, and autonomous systems, this underscores the necessity of the TSN in providing minimal latency and predictable communication. This is especially true for applications that require them. Concerns regarding latency, jitter, and dependability have been efficiently addressed by the significant advancements made in IEEE 802.11be. These advancements include multilink operations, enhanced modulation algorithms, and improved resource allocation. Wi-Fi 7 is now a viable option for circumstances that call for stringent performance assurances as a consequence [15].

In addition, studies have provide a synopsis of the forthcoming Wi-Fi 7 technology, which is sometimes referred to as IEEE 802.11be, and highlights the essential characteristics of this technology. The objective is to transform wireless communication by addressing the constraints of prior standards, enhancing the data transfer rate, minimising delay, and optimising performance in crowded settings [2].
[5] examined the progress of IEEE 802.11be (Wi-Fi 7) and its potential advantages for applications such as augmented reality/virtual reality, 8K video streaming, and the industrial Internet of Things. The main characteristics include a bandwidth of 320 MHz, modulation via 4096-QAM, the ability to operate with multiple links, and enhanced OFDMA. The essay highlights the importance of ensuring that new wireless technologies are able to work with and communicate effectively with older technologies.
In [16], the work emphasised the importance of sophisticated communication technologies in the upcoming era of industrial automation and intelligent manufacturing. This analysis explores how these technologies improve manufacturing

productivity, dependability, and scalability by facilitating speedy response times, significant data transfer rates, and predictable communication, all of which are essential in contemporary industrial settings.
[17] investigated the utilisation of Wi-Fi networks for tactile interactions, with a specific emphasis on attaining minimal delay, exceptional dependability, and synchronisation for real-time tactile internet applications. Wi-Fi might function as a fundamental infrastructure for haptic internet services, facilitating novel applications in teleoperation, gaming, and remote healthcare.
In [18], the authors examine the use of Wi-Fi technology for immediate haptic communication, with a specific emphasis on determining its practicality and technological prerequisites. The goal is to achieve extremely low latency and excellent dependability for tactile interactions. The authors underscore the profound influence of Wi-Fi improvements on remote education, telemedicine, and virtual reality, emphasising the possibility for immersive encounters and virtual "high-fives" among users.
[19] offers a comprehensive examination of upcoming applications and situations in which Wi-Fi 7 technology, sometimes referred to as IEEE 802.11, which is extremely high throughput (EHT), is anticipated to outperform other methods. This study seeks to examine the numerous applications of Wi-Fi 7 in several fields, emphasising its capacity to transform sectors such as smart cities, healthcare, transportation, and manufacturing by increasing the data transfer speed, decreasing delay, and enhancing dependability. Wi-Fi 7 has several critical technological aspects, such as multilink operation (MLO) innovative modulation. The Wi-Fi 7 standard incorporates a wide range of critical technological characteristics, including multilink operation (MLO), sophisticated modulation methods such as 4096-QAM, and effective spectrum use. In this research, significant insights are provided about the transformative potential of Wi-Fi 7 in terms of redefining the future of wireless communication.

The authors of [20] investigated Wi-Fi 7 technology, namely, IEEE 802.11be (EHT), with a particular emphasis on the system's speed, efficiency, and reduction in user latency. The assessment strongly emphasises essential characteristics such as increased channel bandwidths, sophisticated modulation techniques, and improved multiple access mechanisms. The purpose of this study is to fully understand the possible performance enhancements and practical uses of Wi-Fi 7 in areas with high demand. It will also establish a foundation for future wireless networking standards.

The purpose of research [21] is to increase the efficiency and fairness of wireless networks by evaluating numerous multilink channel access methods that are used in WiFi 7. Through this research, several multilink operational solutions are investigated with the goal of reducing delay and increasing throughput, particularly in environments with high population density. In addition to outlining the potential benefits that WiFi 7 technology may bring to future wireless networking standards, it highlights the importance of achieving a balance between the equity of users and the efficiency of spectrum utilisation.

4. CHALLENGES FACING WIFI 7

Wi-Fi 7 technology provides faster speeds and greater efficiency. Despite this, it is confronted with challenges such as spectrum management, interference, congestion, and expensive infrastructure; therefore, governments, regulatory agencies, and industry participants need to collaborate effectively to ensure seamless transition [22]. Through accurate strategising, Wi-Fi 7 has the potential to completely transform wireless communication and unleash novel functionalities for both enterprises and consumers. By addressing these challenges collaboratively, Wi-Fi 7 can pave the way for a more connected and innovative future. With increased speed and efficiency, this technology can revolutionise how we interact with devices and access information. Figure 2 shows the main challenges facing WiFi7.

Fig .2. Challenges facing WiFi 7.

In terms of spectrum regulation and management, the implementation and extensive acceptance of this technology encounter certain substantial obstacles associated with spectrum regulation and control. It is essential to ensure compatibility and coexistence for Wi-Fi 7 since it is required to function seamlessly alongside a wide range of current technologies. These technologies include older versions of Wi-Fi as well as licenced services that already make use of the same or neighboring frequency bands. [20]. To accomplish this goal, it is necessary to apply sophisticated coexistence techniques, such as spectrum sensing and dynamic frequency selection, to reduce interference and provide dependable performance in a variety of situations. Compliance with laws across several countries is required for effective cohabitation[23]; each country has its own set of norms and criteria for spectrum usage, which makes global implementation more complex [24].

In addition, there is an additional challenge that belongs to the improvement of infrastructure, and that problem is compatibility and coexistence. To support the improved functions of Wi-Fi 7, which include the 6 GHz frequency range and greater channel widths, considerable investments in updated hardware and network infrastructure are needed. These expenditures are necessary to make the transition to Wi-Fi 7. For this purpose, it is necessary to update client devices, access points, and routers to make the most of the capabilities offered by Wi-Fi 7. In addition, extensive network planning and rearrangement are needed to support the increasing need for connections and the volume of data traffic. The complexity and expenses associated with these improvements may be significant, particularly for large businesses and service providers, which impedes the implementation of Wi-Fi 7[25][26].

In addition, the expanded capabilities of Wi-Fi 7 raise additional security problems, which in turn make the network more vulnerable to intrusions from malicious actors. Given the increased data velocity and connection possibilities, robust encryption and authentication methods are vital to protect against illegal access and data breaches. In addition, the incorporation of Wi-Fi 7 into the Internet of Things (IoT) and intelligent infrastructure creates increased risks, as these devices frequently have poor security capabilities. In regard to protecting sensitive data and preserving user confidence, implementing adequate security methods for a wide variety of devices and apps is indispensable [27].

In particular, the deployment of the 6 GHz spectrum presents a significant challenge in terms of effectively controlling interference and congestion[24]. Wi-Fi 7 intends to make extensive use of this band, which offers a broader range of frequencies with the purpose of facilitating faster data transfer.

On the other hand, this increased use also carries the risk of causing disruptions to preexisting services, such as satellite communications and conventional wireless networks. Complex interference mitigation measures, such as spectrum sharing and dynamic channel allocation, must be deployed to ensure that Wi-Fi 7 operates at its highest possible level while simultaneously limiting disruptions to other services [28]. It is vital to deploy advanced congestion control technologies such as network slicing and priority-based traffic management to provide stable and high-quality connections in locations that are highly inhabited and have several devices competing for bandwidth. [29]. To overcome these problems, industry stakeholders, regulators, and technology developers need to work together to build a framework that is both comprehensive and adaptive for the implementation of Wi-Fi 7.

5. APPLICATION OF WIFI IN SEVERAL INDUSTRIES

Wi-Fi 7 implementation is expected to revolutionize several industries by offering unparalleled data speeds and very low latency.

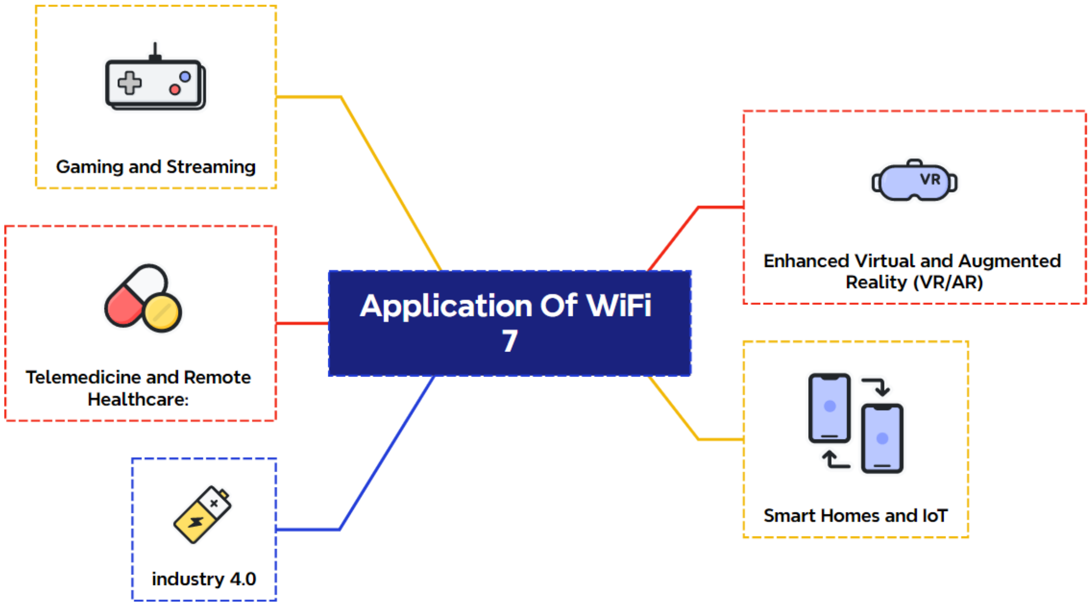

Fig .3. Application of WiFi 7.

As shown in Figure 3. Several noteworthy uses of WiFi 7 include the following:

1. Enhanced Virtual and Augmented Reality (VR/AR): The fast data transfer rate and minimal delay of Wi-Fi7 are essential for providing smooth virtual and augmented reality (VR/AR) experiences. This technology allows real-time engagement and helps minimise the discomfort of motion sickness in users[30].

2. Smart Homes and IoT: Wi-Fi 7 can handle many connected devices and enhance network efficiency. This will contribute to the expansion of smart homes and IoT ecosystems[31][32].

3. Industry 4.0: Wi-Fi 7 is anticipated to have a crucial impact on industrial automation by facilitating fast data transmission and immediate communication in the fields of manufacturing and logistics[8][33].
4. Telemedicine and Remote Healthcare: Wi-Fi 7's strong capabilities may improve telemedicine applications by enabling high-quality video consultations and real-time monitoring of patients' health data[34][35].

5. Gaming and Streaming: Wi-Fi 7 has the advantages of providing gamers and content consumers with the opportunity to enjoy ultrahigh-definition video and immersive gaming experiences without delays[4].

6. ECONOMICAL IMPACT OF WIFI 7 ACROSS VARIOUS SECTORS

It is expected that Wi-Fi 7 (IEEE 802.11) will have positive economic implications across a variety of businesses, including those in the transportation and healthcare sectors [36]–[38]. Through the facilitation of quicker data transmission and the establishment of more dependable connections, this new standard will increase the level of productivity in industries such as retail and manufacturing. Furthermore, it is projected that Wi-Fi 7 will make it possible to utilise upcoming technologies such as augmented reality and virtual reality, which will result in the creation of new opportunities for innovation and growth [39]. Figure 4 presents an illustration of the many economic benefits that WiFi 7 has had across a variety of industries.

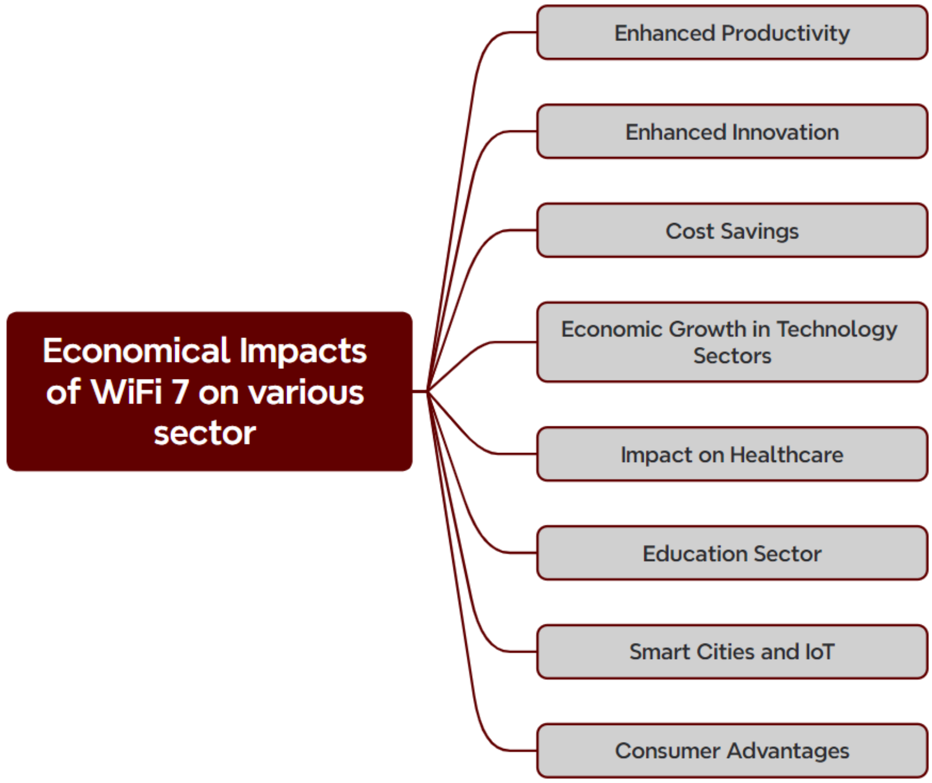

Fig .4. Wi-Fi 7's Economic Impact on Different Industries.

1. ***Enhanced productivity:*** The productivity of consumer and commercial settings may be significantly enhanced by the reduced latency and increased throughput of Wi-Fi 7. Improved connections and accelerated data transfer enable real-time collaboration, remote work, and enhanced processes. [21][40].
2. ***To increase the level of innovation***, the enhanced capabilities of Wi-Fi 7 make it possible to develop innovative applications and services, particularly in the fields of augmented reality (AR), virtual reality (VR), the Internet of Things (IoT), and smart cities. This has the potential to encourage innovative ideas and open new opportunities for commercial enterprises. [41]–[43].
3. ***Cost savings:*** Enhancing network efficiency and capacity may reduce the need for frequent infrastructure additions, leading to cost savings. Enhancing network performance and reliability enables organisations to reduce maintenance expenditures and prevent disruptions, eventually leading to cost savings.
4. ***Economic Growth in Technology Sectors:*** There is a good chance that businesses that are engaged in the creation, manufacture, and deployment of Wi-Fi 7 technology will experience growth. This comprises companies that manufacture semiconductors, those that produce software, and those that supply network infrastructure [44][45].
5. ***Impact on healthcare:*** The launch of Wi-Fi 7 may change the delivery of healthcare by further improving remote patient monitoring and telemedicine, which will ultimately result in considerable cost savings [46]. It may be possible for hospitals and healthcare providers to improve their connectivity to improve patient care and operations[47][38].
6. ***Education sectors:*** Wi-Fi 7 has the potential to improve educational outcomes by providing more extraordinary e-learning experiences to students. When academic institutions implement technologies that are more interactive and immersive, both students and teachers may benefit from the use of these technologies [48].
7. ***Smart cities and the IoT***: The qualities of Wi-Fi 7 may hasten the development of smart cities, which will eventually lead to improvements in urban infrastructure and services. Improvements in areas such as traffic management, energy efficiency, public safety, and environmental monitoring are included. These improvements will result in economic advantages for both municipalities and their residents [49-51].
8. ***Customer advantages***: The provision of faster and more reliable internet connectivity would improve the user experience for streaming, gaming, and a wide variety of other online activities. As a result, customers' spending on digital content and services might increase [52-54].

7. ADVANTAGES AND DISADVANTAGES

Wi-Fi 7 is a cutting-edge wireless communication technology that provides increased network capacity, more bandwidth, and improved transmission speeds. Additional benefits include increased bandwidth. Through the use of expanded channel bandwidths and sophisticated modulation methods such as 4096-QAM, it is possible to achieve data transmission rates of up to 46 gigabits per second (Gbps) [55]. This makes it possible to broadcast high-definition content without interruption, support applications for virtual reality and augmented reality, and facilitate massive data transfers with little delay. Applications such as online gaming and real-time video conferencing need very low latency and outstanding stability, both of which are provided by the standard. The capability known as target wake time (TWT) reduces latency while simultaneously improving energy economy. Owing to its ability to manage communication intervals and eliminate idle listening, it is beneficial for Internet of Things devices [56].
In addition, Wi-Fi 7 provides enhanced functioning in crowded contexts such as stadiums and metropolitan areas because of its multilink operation and broader channels[21], which allows for more effective management and a reduction in interference. Because it has additional protection based on WPA3[46], the device emphasises security. The enhanced encryption and authentication capabilities provided by these features serve to protect against prevalent modern cyber danger threats[27], [57][58]. Older devices can connect to new networks via Wi-Fi 7, which ensures backwards compatibility with earlier versions of Wi-Fi. This eliminates the need to immediately replace all of the equipment that is already in use.
Enhanced energy efficiency, which may be achieved via the use of technologies such as the travelling wave tube (TWT) and advanced power management algorithms[59], results in a substantial reduction in the amount of power that is consumed. Consequently, this leads to an increase in the battery life of IoT devices as well as a decrease in the total amount of energy that is used. Additionally, Wi-Fi 7 makes use of the enhanced spectrum utilisation of the 6 GHz band in addition to the conventional channels operating at 2.4 GHz and 5 GHz[24][28]. This results in a wider variety of accessible frequencies and reduces the amount of congestion on channels that are often used.
Nevertheless, the implementation of Wi-Fi 7 poses several challenges, such as deploying and integrating new infrastructure and hardware upgrades, which may be challenging and expensive processes due to its inherent complexity. The elevated expenses linked to the sophisticated functionalities of Wi-Fi 7 can hinder small enterprises and consumers, potentially impeding wider acceptance until the costs of equipment and implementation decline gradually[60]. The global deployment of Wi-Fi 7 is more complex because of the limited availability of devices and legal obstacles, which are related mainly to the 6 GHz spectrum[28]. Table 1. Shows the advantages and disadvantages of WiFi7.

TABLE I. ADVANTAGES AND DISADVANTAGES OF WIFI 7.

Advantages	Disadvantage
• Higher data rates and wider bandwidth • Improved network capacity and efficiency • Reduced delay and increased accuracy • Enhanced support for congested locations • Advanced security functions • Compatibility with older processes • Enhanced energy efficacy • Optimal use of available spectrum	• The complexities of deploying and integrating. • Increased expenses • Need for more availability of devices. • Challenges related to regulations and compliance. • Possibility of more significant interference • Issues related to the protection and safety of a system or environment. • Incompatibility Problems with Older Devices • The relationship between the rate of learning and the level of complexity in management.

8. FUTURE TRENDS IN WIFI 7 TECHNOLOGY

Future research on Wi-Fi 7 will seek to augment its capabilities and address current challenges. Researchers are now investigating advanced modulation and coding approaches, such as improving 4096-QAM and including error-correcting mechanisms, to increase data throughput and spectrum efficiency. The integration of artificial intelligence and machine learning is being utilised to enhance network performance, bolster security measures, and optimise the user experience [61-64]. The examination of spectrum sharing with other technologies, such as optical communication[33], [65-70] and management approaches, aims to optimise the allocation of frequencies and reduce interference. Quantum communication technologies are being researched to develop highly secure communication routes.
Research is now prioritising the reduction of latency and improvement of dependability for real-time applications such as gaming and virtual/augmented reality[70][30]. The capabilities of operating on many bands and multiple links are being

improved to guarantee continuous connectivity and optimise the data transfer rate[71]. There is a focus on prioritising protocols and technologies that are efficient in their use of energy[72].
Security is of utmost importance, with extensive studies on encryption, authentication, and intrusion detection systems[27]. Another area of interest is the integration of the IoT and innovative city applications[73] [32]. A number of initiatives are now being carried out to investigate various methods that may reduce interference and improve coexistence to ensure that other wireless technologies can be used without friction.
The development of sophisticated network management and orchestration technologies is now underway as part of ongoing initiatives to improve the effectiveness of operations pertaining to the creation, monitoring, and maintenance of networks[74]. The primary focus is on integrating contemporary wireless technologies, such as 5G, to ensure that hybrid network solutions are implemented without interruptions. The achievement of worldwide harmonisation of Wi-Fi 7 standards is dependent upon the implementation of standardisation and regulatory compliance practices[68], [75].

9. CONCLUSION

Wi-Fi 7, a wireless communication system that adheres to the IEEE 802.11 standard, has made substantial strides in terms of operating efficiency, capacity, and speed. Multiuser MIMO and enhanced modulation techniques are among the technical innovations of this system, which improve spectrum efficiency and network performance. This research emphasises the changing nature of Wi-Fi standards and their influence on Wi-Fi 7. Wi-Fi 7 is implemented in numerous sectors, including industrial automation, healthcare delivery, and connected residences. It facilitates innovative problem solving, enhances productivity, and minimises latency by providing a rapid and dependable internet connection. However, it creates specific difficulties in terms of security. This requires the implementation of robust encryption methods and privacy protection. Expectations are high for the future of Wi-Fi 7 since it will continue to innovate and adapt to new circumstances. The possibilities of this system will be enhanced by the establishment of standards and protocols in the future. Developers and anyone in charge of making decisions may benefit significantly from the information included in this review article. It provides detailed information on the capabilities of Wi-Fi 7 as well as the possible applications of this particular technology. To facilitate the strategic inclusion of Wi-Fi 7 in the fast-growing digital environment of current society, it strives to ease the situation.

Funding
The author's paper explicitly states that the research was self-funded and no support was received from any institution or sponsor.

Conflicts Of Interest
None.

Acknowledgment
The author extends appreciation to the institution for their unwavering support and encouragement during the course of this research.

References

[1] C. Deng et al., “IEEE 802.11 be Wi-Fi 7: New challenges and opportunities,” IEEE Commun. Surv. \& Tutorials, vol. 22, no. 4, pp. 2136–2166, 2020.
[2] A. Garcia-Rodriguez, D. López-Pérez, L. Galati-Giordano, and G. Geraci, “IEEE 802.11 be: Wi-Fi 7 strikes back,” IEEE Commun. Mag., vol. 59, no. 4, pp. 102–108, 2021.
[3] K. K. . Vaigandla and R. K. . Siddoju , Trans., “A Comprehensive Review on OFDM, 5G and Various PAPR Minimization Techniques based on Machine Learning”, BJN, vol. 2025, pp. 43–58, Apr. 2025, doi: 10.58496/BJN/2025/004.
[4] S. Zhanga, L. Yub, and Y. Chengc, “An Introduction to Key Technologies of Wi-Fi 7,” Int. J. Front. Eng. Technol., vol. 6, no. 2, 2024.
[5] E. Khorov, I. Levitsky, and I. F. Akyildiz, “Current status and directions of IEEE 802.11 be, the future Wi-Fi 7,” IEEE access, vol. 8, pp. 88664–88688, 2020.
[6] Z. T. Al-qaysi, A. S. Albahri, M. A. Ahmed, and M. M. Salih, “Dynamic decision-making framework for benchmarking brain–computer interface applications: a fuzzy-weighted zero-inconsistency method for consistent weights and VIKOR for stable rank,” Neural Comput. Appl., pp. 1–24, 2024, doi: 10.1007/s00521-024-09605-1.
[7] P. Fowler, “5 GHz goes the distance for home networkng,” IEEE Microw. Mag., vol. 3, no. 3, pp. 49–55, 2002.
[8] S.-H. Cheng, S.-C. Chen, Y.-J. Chen, and C.-L. Liu, “Compact Asymmetric T-Feed Closed-Slot Antennas for 2.4/5/6 GHz WiFi-7 MIMO Laptops,” Electronics, vol. 13, no. 13, p. 2430, 2024.
[9] C. Room, “IEEE 802.11 ax”.

[10] W. Robert, M. Bounabi, and A. . Badr , Trans., "Leveraging AI in Mixed Hierarchical Topologies to Improve WSN: A Survey", BJN, vol. 2025, pp. 59–69, May 2025, doi: 10.58496/BJN/2025/005.

[11] A. S. George, "The Microsecond Revolution: How Wi-Fi 7 Will Enable Real-Time Connectivity and Transform Key Industries," Partners Univers. Int. Res. J., vol. 2, no. 4, pp. 116–127, 2023.

[12] G. Naik and J.-M. J. Park, "Coexistence of Wi-Fi 6E and 5G NR-U: Can we do better in the 6 GHz bands?," in IEEE INFOCOM 2021-IEEE Conference on Computer Communications, 2021, pp. 1–10.

[13] A. Jeknić and E. Kočan, "Multi-Link Operation for Performance Improvement in Wi-Fi 7 Networks," in 2024 28th International Conference on Information Technology (IT), 2024, pp. 1–4.

[14] E. Oughton, G. Geraci, M. Polese, and V. Shah, "Prospective evaluation of next generation wireless broadband technologies: 6G versus Wi-Fi 7/8," Available SSRN 4528119, 2023.

[15] T. Adame, M. Carrascosa-Zamacois, and B. Bellalta, "Time-sensitive networking in IEEE 802.11 be: On the way to low-latency WiFi 7," Sensors, vol. 21, no. 15, p. 4954, 2021.

[16] "2310 @ arxiv.org."

[17] V. Gokhale, M. Eid, K. Kroep, R. V. Prasad, and V. S. Rao, "Toward enabling high-five over WiFi: A tactile internet paradigm," IEEE Commun. Mag., vol. 59, no. 12, pp. 90–96, 2021.

[18] V. Gokhale, M. Eid, K. Kroep, R. V. Prasad, and V. Rao, "Towards Enabling High-Five Over WiFi," arXiv Prepr. arXiv2111.01634, 2021.

[19] S. Chauhan, A. Sharma, S. Pandey, K. N. Rao, and P. Kumar, "IEEE 802.11 be: A review on Wi-Fi 7 use cases," in 2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions)(ICRITO), 2021, pp. 1–7.

[20] C. Chen, X. Chen, D. Das, D. Akhmetov, and C. Cordeiro, "Overview and performance evaluation of Wi-Fi 7," IEEE Commun. Stand. Mag., vol. 6, no. 2, pp. 12–18, 2022.

[21] J. Zhang, Q. Tan, Y. Gao, X. Sun, and W. Zhan, "WiFi 7 with Different Multi-Link Channel Access Schemes: Modeling, Fairness and Optimization," IEEE Trans. Commun., 2024.

[22] L. Alzubaidi et al., "MEFF – A model ensemble feature fusion approach for tackling adversarial attacks in medical imaging," Intell. Syst. with Appl., vol. 22, p. 200355, 2024, doi: 10.1016/j.iswa.2024.200355.

[23] T. Rahman, M. L. Othman, S. B. M. Noor, W. F. B. W. Ahmad, and M. F. Sulaima, "Methods and attributes for customer-centric dynamic electricity tariff design: A review," Renew. Sustain. Energy Rev., vol. 192, p. 114228, 2024.

[24] Y. Xi and E. M. Yeh, "Distributed algorithms for spectrum allocation, power control, routing, and congestion control in wireless networks," in Proceedings of the 8th ACM international symposium on Mobile ad hoc networking and computing, 2007, pp. 180–189.

[25] T. Kondo, H. Fujita, M. Yoshida, and T. Saito, "Technology for wifi/Bluetooth And wimax coexistence," Fujitsu Sci. Technol. J, vol. 46, no. 1, pp. 72–78, 2010.

[26] K. Kosek-Szott et al., "Coexistence issues in future WiFi networks," IEEE Netw., vol. 31, no. 4, pp. 86–95, 2017.

[27] K. Ramezanpour, J. Jagannath, and A. Jagannath, "Security and privacy vulnerabilities of 5G/6G and WiFi 6: Survey and research directions from a coexistence perspective," Comput. Networks, vol. 221, p. 109515, 2023.

[28] O. Baiyekusi, H. Mahmoud, D. Mi, J. Arshad, A. Adeyemi-Ejeye, and H. Lee, "An ML-based Spectrum Sharing Technique for Time-Sensitive Applications in Industrial Scenarios."

[29] A. Chinmay and H. K. Pati, "VoWiFi Cell Capacity Evaluation using WiFi 7 considering VBR Traffic," IETE J. Res., pp. 1–11, 2024.

[30] T. M. Fernández-Caramés and P. Fraga-Lamas, "Forging the Industrial Metaverse-Where Industry 5.0, Augmented and Mixed Reality, IIoT, Opportunistic Edge Computing and Digital Twins Meet," arXiv Prepr. arXiv2403.11312, 2024.

[31] S. S. Murad, S. Yussof, R. Badeel, and R. A. Ahmed, "Impact of COVID-19 Pandemic Measures and Restrictions on Cellular Network Traffic in Malaysia," Int. J. Adv. Comput. Sci. Appl., vol. 13, no. 6, pp. 630–645, 2022, doi: 10.14569/IJACSA.2022.0130676.

[32] S. M. Geddam, A. B. Gowda, and A. Hussain, "IoT Enabled Smart Homes in Tropical Regions as a Means of Sustainable Development," in IOP Conference Series: Earth and Environmental Science, 2024, vol. 1306, no. 1, p. 12035.

[33] S. S. Murad, R. Badeel, and R. A. Ahmed, "Is LiFi Technology Ready for Manufacturing and Adoption? An End-user questionnaire-based study," Appl. Data Sci. Anal., vol. 2024, pp. 95–107, 2024.

[34] Y. A. Qadri, H. Jung, and D. Niyato, "Towards the Internet of Medical Things for Real-Time Health Monitoring over Wi-Fi," IEEE Netw., 2024.

[35] S. S. Murad, R. Badeel, R. A. Ahmed, and S. Yussof, "Using Drones and Robots for Social Distancing: Literature Review, Challenges and Issues," in 2024 Panhellenic Conference on Electronics \& Telecommunications (PACET), 2024, pp. 1–6.

[36] A. M. Albayati and F. Zarai , Trans., "Protecting Communication Situations Using IPSec and IKE Essentials and Applications", BJN, vol. 2024, pp. 198–203, Oct. 2024, doi: 10.58496/BJN/2024/020.

[37] M. A. Fadhel et al., "Comprehensive systematic review of information fusion methods in smart cities and urban environments," Inf. Fusion, vol. 107, p. 102317, 2024, doi: 10.1016/j.inffus.2024.102317.

[38] A. S. Albahri et al., "Explainable Artificial Intelligence Multimodal of Autism Triage Levels Using Fuzzy Approach-Based Multi-criteria Decision-Making and LIME," Int. J. Fuzzy Syst., pp. 1–30, Nov. 2023, doi: 10.1007/s40815-023-01597-9.

[39] A. H. Alamoodi, O. S. Albahri, A. S. Albahri, and I. Mohamad Sharaf, "Sustainability transitions and their relationship to digital technology," in Decision Support Systems for Sustainable Computing, M. B. T.-D. S. S. for S. C. Deveci, Ed. Academic Press, 2024, pp. 235–264. doi: 10.1016/B978-0-443-23597-9.00012-3.

[40] A. M. Carmona et al., "Instrumentation and data collection methodology to enhance productivity in construction sites using embedded systems and IoT technologies," in Advances in Informatics and Computing in Civil and Construction Engineering: Proceedings of the 35th CIB W78 2018 Conference: IT in Design, Construction, and Management, 2019, pp. 637–644.

[41] M. A. H. Almher, A. Sivadass, L. Thiruchelvam, B. B. Abdal, J. B. Jais, and M. M. Aliyu, "FACTORS AFFECTING KNOWLEDGE SHARING OF ENGINEERS IN OIL AND GAS COMPANIES," J. Ind. Eng. Manag., vol. 6, no. 1, pp. 70–78, 2021.

[42] A. S. George, A. S. H. George, and T. Baskar, "Wi-fi 7: the next frontier in wireless connectivity," Partners Univers. Int. Innov. J., vol. 1, no. 4, pp. 133–145, 2023.

[43] A. Yacoub and D. N. Aloi, "Innovative Loaded Low-Profile Tri-Band MIMO Antenna System for Wi-Fi 7 Technology," Prog. Electromagn. Res. M, vol. 122, 2023.

[44] E. J. Oughton, W. Lehr, K. Katsaros, I. Selinis, D. Bubley, and J. Kusuma, "Revisiting wireless internet connectivity: 5G vs Wi-Fi 6," Telecomm. Policy, vol. 45, no. 5, p. 102127, 2021.

[45] M. Taha Aljburi et al., "Exploring decision-making techniques for evaluation and benchmarking of energy system integration frameworks for achieving a sustainable energy future," Energy Strateg. Rev., vol. 51, p. 101251, 2024, doi: https://doi.org/10.1016/j.esr.2023.101251.

[46] A. S. Albahri et al., "A systematic review of trustworthy and explainable artificial intelligence in healthcare: Assessment of quality, bias risk, and data fusion," Inf. Fusion, vol. 96, pp. 156–191, Aug. 2023, doi: 10.1016/j.inffus.2023.03.008.

[47] Y. A. Qadri, Zulqarnain, A. Nauman, A. Musaddiq, E. Garcia-Villegas, and S. W. Kim, "Preparing wi-fi 7 for healthcare internet-of-things," Sensors, vol. 22, no. 16, p. 6209, 2022.

[48] R. Kyere Asomah, D. Darko Agyei, G. Assamah, and K. Darko Amponsah, "Examining teachers' perceptions of the impact of government of Ghana's wi-fi technology program on teaching practices: an empirical study from the senior high schools in the cape coast metropolis," Cogent Educ., vol. 11, no. 1, p. 2296455, 2024.

[49] R. Mageswaran, J. P, N. J, T. Rengaraj, M. Neeladri, and R. Rama , Trans., "Optimizing Energy Efficiency in 6G Communication Networks Based on Data Transmission Rate Allocation", BJN, vol. 2024, pp. 182–190, Sep. 2024, doi: 10.58496/BJN/2024/018.

[50] O. S. Albahri et al., "Multi-perspective evaluation of integrated active cooling systems using fuzzy decision making model," Energy Policy, vol. 182, p. 113775, 2023, doi: 10.1016/j.enpol.2023.113775.

[51] Y. R. Muhsen, N. A. Husin, M. B. Zolkepli, N. Manshor, A. A. J. Al-Hchaimi, and A. S. Albahri, "Routing Techniques in Network-On-Chip Based Multiprocessor-System-on-Chip for IOT: A Systematic Review," Iraqi J. Comput. Sci. Math., vol. 5, no. 1, pp. 181–204, 2024, doi: 10.52866/ijcsm.2024.05.01.014.

[52] C. Sassanelli and D. A. de J. Pacheco, "The impact of the internet of things on the perceived quality and customer involvement of smart product-service systems," Technol. Forecast. Soc. Change, vol. 198, p. 122939, 2024.

[53] O. S. Albahri et al., "Evaluation of organizational culture in companies for fostering a digital innovation using q-rung picture fuzzy based decision-making model," Adv. Eng. Informatics, vol. 58, p. 102191, 2023, doi: 10.1016/j.aei.2023.102191.

[54] M. Talal, A. H. Alamoodi, O. S. Albahri, A. S. Albahri, and D. Pamucar, "Evaluation of remote sensing techniques-based water quality monitoring for sustainable hydrological applications: an integrated FWZIC-VIKOR modelling approach," Environ. Dev. Sustain., pp. 1–45, 2023, doi: 10.1007/s10668-023-03432-5.

[55] J. Tan et al., "4096-QAM signal transmission by an IM/DD system at THz band using delta-sigma modulation," IEEE Photonics Technol. Lett., 2024.

[56] A. Belogaev, X. Shen, C. Pan, X. Jiang, C. Blondia, and J. Famaey, "Dedicated Restricted Target Wake Time for Real-Time Applications in Wi-Fi 7," arXiv Prepr. arXiv2402.15900, 2024.

[57] E. Firdus et al., "WiFi from past to today, consequences that can cause and measures of prevention from them, WiFi security protocols," in E3S Web of Conferences, 2024, vol. 474, p. 2004.

[58] Y. L. Khaleel, M. A. Habeeb, A. S. Albahri, T. Al-Quraishi, O. S. Albahri, and A. H. Alamoodi, "Network and cybersecurity applications of defense in adversarial attacks: A state-of-the-art using machine learning and deep learning methods," J. Intell. Syst., vol. 33, no. 1, 2024, doi: 10.1515/jisys-2024-0153.

[59] N. M. Saleh, A. M. Saleh, , R. A. Hasan, J. Keighobadi, O. K. Ahmed, and Z. K. Hamad , Trans., "Analyzing and Comparing Global Sustainability Standards: LEED, BREEAM, and PBRS in Green Building arch article topic ", BJIoT, vol. 2024, pp. 70–78, Jul. 2024, doi: 10.58496/BJIoT/2024/009.

[60] K. W. Hon, "Networking/Internet infrastructure and technologies," in Technology and Security for Lawyers and Other Professionals, Edward Elgar Publishing, 2024, pp. 288–316.

[61] A. S. Albahri et al., "A systematic review of trustworthy artificial intelligence applications in natural disasters," Comput. Electr. Eng., vol. 118, p. 109409, 2024, doi: 10.1016/j.compeleceng.2024.109409.

[62] I. A. Zahid et al., "Unmasking large language models by means of OpenAI GPT-4 and Google AI: A deep instruction-based analysis," Intell. Syst. with Appl., vol. 23, p. 200431, 2024, doi: https://doi.org/10.1016/j.iswa.2024.200431.

[63] M. A. Fadhel et al., "Navigating the metaverse: unraveling the impact of artificial intelligence—a comprehensive review and gap analysis," Artif. Intell. Rev., vol. 57, no. 9, p. 264, 2024, doi: 10.1007/s10462-024-10881-5.

[64] Z. T. Al-Qaysi et al., "A comprehensive review of deep learning power in steady-state visual evoked potentials," Neural Comput. Appl., vol. 36, no. 27, pp. 16683–16706, 2024, doi: 10.1007/s00521-024-10143-z.

[65] S. S. Murad, S. Yussof, W. Hashim, and R. Badeel, “Three-Phase Handover Management and Access Point Transition Scheme for Dynamic Load Balancing in Hybrid LiFi / WiFi Networks,” 2022.
[66] R. Badeel, S. K. Subramaniam, Z. M. Hanapi, and A. Muhammed, “A Review on LiFi Network Research: Open Issues, Applications and Future Directions,” Appl. Sci., vol. 11, no. 23, p. 11118, 2021.
[67] S. S. Murad et al., “OPTIMIZED MIN-MIN TASK SCHEDULING ALGORITHM FOR SCIENTIFIC WORKFLOWS IN A CLOUD ENVIRONMENT,” J. Theor. Appl. Inf. Technol., vol. 100, no. 2, pp. 480–506, 2022.
[68] S. S. Murad, S. Yussof, R. Badeel, and W. Hashim, “A Novel Social Distancing Approach for Limiting the Number of Vehicles in Smart Buildings Using LiFi Hybrid-Network,” Int. J. Environ. Res. Public Health, vol. 20, no. 4, p. 3438, 2023.
[69] S. S. Murad et al., “Wireless Technologies for Social Distancing in the Time of COVID-19: Literature Review, Open Issues, and Limitations,” Sensors, vol. 22, no. 6, p. XXX, 2022, doi: 10.3390/s22062313.
[70] R. Badeel, S. K. Subramaniam, Z. M. Hanapi, and ..., “Metaverse architecture, components, challenges: a review,” Researchgate.Net, no. ICIoT, 2023.
[71] J. Wu, X. Fang, and G. Min, “Deep Reinforcement Learning based Multi-link Frame Aggregation Length Optimization in Next Generation Wi-Fi Networks,” IEEE Trans. Wirel. Commun., 2024.
[72] S. M. Mohammed, A. Al-Barrak, and N. T. Mahmood, “Enabling Technologies for Ultra-Low Latency and High-Reliability Communication in 6G Networks,” J. homepage http//iieta. org/journals/isi, vol. 29, no. 3, pp. 1195–1208, 2024.
[73] I. Conference and O. N. Information, “Department of Computer Science, Sathyabama University Chennai,India,” no. Icices, 2017.
[74] I. Despotopoulos, “Wireless local area network security and modern cryptographic protocols: WEP \& WPA1/2/3,” 2024.
[75] S. S. Murad, S. Yussof, and R. Badeel, “Wireless Technologies for Social Distancing in the Time of COVID-19: Literature Review, Open Issues, and Limitations,” Sensors, vol. 22, no. 6, 2022, doi: 10.3390/s22062313.