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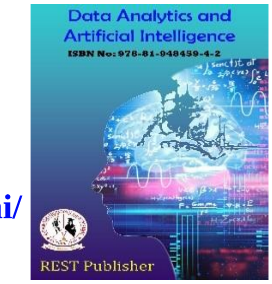

Enhancing Wireless Communication Networks with WASPAS Method: A Comprehensive Optimization Approach

Tejasvi Gorre

Staff Software Engineer, Home Depot Management Company LLC, TX, USA

**Corresponding Author Email: tejasvigr@gmail.com*

***Abstract**: Recent studies have highlighted the significance of communication technologies in the advancement of embedded systems and devices. The variety of communication technologies available for embedded systems, each with its own advantages and disadvantages, can impact decision-makers' choices. As the demand grows for dependable and high-performing wireless communication networks, the necessity for effective optimization techniques becomes increasingly crucial. This study's major goal is to address issues that wireless communication networks encounter, such as constrained bandwidth, signal interference, and shifting user needs. Through the use of the WASPAS approach and optimization of important network parameters, our objective is to improve network efficiency, coverage, and the overall user experience. Subsequently, the collected data is fed into the WASPAS method, where it undergoes the weighted aggregation process. The method calculates the weighted performance scores for each parameter, considering the importance assigned by network administrators and stakeholders. These scores enable the ranking of network parameters based on their contributions to the network's overall performance. In this study, a thorough plan for improving wireless communication networks was developed using the Weighted Aggregated Sum Product Assessment (WASPAS) method. A multi-criteria decision-making process called WASPAS evaluates and ranks numerous network characteristics by taking into account their relative importance and performance. **Evaluation parameters** taken as Bluetooth, Zigbee, Wifi, Classic Waveland and Z-wave. **Alternative parameters** taken as Transmission Speed (**C1**), Security (**C2**), Transmission Range (**C3**), Power Usage (**C4**), Development Cost (**C5**) and Development Complexity (**C6**). Based on the aggregation of responses from experts, the results show that the most preferred wireless communication alternative for embedded application is zigbee got high position, while the least preferred alternative is Bluetooth.*

***Keywords:** Wireless communication, WASPAS Method, Bluetooth, Transmission Range and Z-wave.*

1. INTRODUCTION

The integration of communication technologies, both wireless and wired, into the design of embedded systems has significantly propelled the realization of practical smart devices and the Internet of Things (IoT). While wired communication media tend to be more dependable in various use cases, wireless communication is gaining popularity due to its mobility, deployment convenience, and occasionally lowers costs [1]. Efficiently deploying mobile wireless communication nodes poses a significant real-world challenge, particularly as pre-deployed network infrastructures may face complete or partial destruction.[2] Network communication refers to the exchange of data and information between different devices, systems, or nodes over a network. It enables devices to communicate and share resources, such as files, messages, or services, with each other. Network communication can be categorized into various types, including: 1. Local Area Network (LAN): A LAN is a type of network that covers a specific area, like a house, office, or building. Without accessing the internet, devices connected to a LAN can communicate with one another.2. Wide Area Network (WAN): Over a larger geographic area, a WAN links several LANs together. The most well-known example of a wide area network is the internet.3. Internet: The internet is a massive worldwide network of interconnected devices and networks that enables global communication and data exchange.4. Wireless

Communication: Wireless networks transport data without the use of physical wires by using radio signals, microwaves, or infrared technology. Common examples are Wi-Fi, Bluetooth, and cellular networks. 5. Peer-to-Peer (P2P) Communication: In a P2P network, devices communicate with one another without the use of a central server. 6. Client-Server Communication: In a client-server approach, clients (often end-user devices) request resources or services from a central server, which then delivers the desired data.7. Protocols: Network communication relies on various communication protocols to ensure data is transmitted and received correctly. Examples include TCP/IP, HTTP, SMTP, FTP, and more. 8. Networking Devices: Routers, switches, hubs, and access points are some of the networking devices used to facilitate network communication.[3]Overall, network communication is a fundamental aspect of modern computing, enabling seamless data exchange, collaboration, and access to resources across the internet and local networks.

Wireless communication networks are systems that allow data, information, and signals to be exchanged between devices or nodes without the use of physical connections. These networks transmit and receive data wirelessly using radio frequency (RF) waves, allowing devices to communicate over long distances. Wireless communication networks have become an essential component of modern society and technology, providing connectivity, mobility, and data sharing across a wide range of applications. [4] To monitor vital signs, wireless sensors are implanted in the body. The use of WBAN technology to monitor health metrics greatly minimizes the patient's hospital spending. Because this approach is used inside the human body, the work environment is extremely complex, with numerous problems such as battery replacement and heat generated by implanted sensors. [5] Network communication is a fundamental aspect of modern connectivity, enabling devices, systems, and individuals to exchange data, information, and resources seamlessly. It forms the backbone of our interconnected world, facilitating communication between computers, smartphones, IoT devices, and various other components within complex infrastructures. Network communication encompasses a range of technologies, protocols, and standards that allow devices to interact, share data, and collaborate effectively. This exchange of information can occur over wired or wireless mediums, each offering its own advantages and characteristics. In wired network communication, data is transmitted through physical cables, such as Ethernet cables or fiber optics. This method offers high data transfer rates, reliability, and security. For instance, local area network (LAN) connectivity within homes, workplaces, and data centres is made possible via the widely used technology known as Ethernet.[7] Contrarily, fibre optics allow for long-distance communication at incredibly fast speeds with no signal deterioration.using a wireless network, on the other hand, transmits data without the use of physical wires by using radio waves, microwaves, or infrared signals. This wireless approach facilitates mobility, allowing devices to connect and communicate on the move. Technologies like Wi-Fi provide wireless LAN connectivity, enabling devices to access the internet within a certain range. Cellular networks offer broader coverage, allowing mobile devices to maintain communication while traveling. Communication in networks is governed by various protocols and standards that ensure data integrity, security, and interoperability [8] The underlying architecture of the internet is TCP/IP, or Transmission Control Protocol/Internet Protocol, which controls the transmission and routing of data packets. The efficient sharing of information is facilitated by additional protocols like SMTP (Simple Mail Transfer Protocol), used for email communication, and HTTP (Hypertext Transfer Protocol), used for web browsing. In the context of the Internet of Things (IoT), where diverse devices, ranging from sensors to smart appliances, connect and share data, enabling automation and informed decision-making, network communication is of utmost importance. This interconnectedness facilitates the development of smart cities, intelligent transportation systems, and efficient energy management.[10] However, network communication is not without challenges. Security concerns, such as unauthorized access and data breaches, require robust encryption, authentication, and intrusion detection mechanisms. Network congestion can impact data flow, necessitating quality of service (QoS) measures to ensure consistent performance. The increasing complexity of networks demands effective management, monitoring, and troubleshooting to maintain smooth operations. Network communication is the lifeline of our digital age. It empowers global connectivity, drives innovations, and transforms industries. From the internet and social media to telecommunication networks and IoT ecosystems, network communication continues to shape the way we live, work, and interact with technology. Its ongoing evolution promises even more seamless and efficient communication in the future.[11] This study's main objective is to provide a framework that engineers and other stakeholders may use to choose the optimal wireless communication technologies based on a variety of criteria to produce an effective embedded device design. The technologies covered in this study include Bluetooth, Long-Term Evolution (LTE), Z-wave, Classic WaveLAN, Wi-Fi, and Zigbee. These technologies are chosen based on their importance and criteria for embedded device design, including Transmission Speed (TS), Security, Transmission Range (TR), Power Usage (PU), Development Cost (DC), and Development Complexity (DCOP).

2. MATERIALS AND METHOD

Alternative Parameters:

Bluetooth: Utilising the 2.4 GHz frequency band, this wireless communication technique enables devices to exchange data across short distances. Numerous electronic products, including laptops, wireless speakers, headphones, smart watches, and Internet of Things (IoT) gadgets, utilise it extensively.

Zigbee: This wireless communication protocol was designed for low-power, short-range wireless networking. It is commonly used in applications that demand low data rates, extended battery life, and secure communication, such as home automation, industrial automation, and healthcare, among other fields. Zigbee is based on the IEEE 802.15.4 standard and operates within the 2.4 GHz frequency spectrum.

Wi-Fi: Wi-Fi, which stands for Wireless Fidelity, is a type of technology that permits wireless communication between devices connected to the internet and in local area networks (LANs). One of the most widely utilized wireless communication technologies; it offers high-speed internet connectivity for a variety of gadgets, including laptops, smartphones, smart home gadgets, and Internet of Things (IoT) gadgets.

Classic WaveLAN: It refers to a family of early wireless communication technologies developed by NCR Corporation (later acquired by AT&T) in the late 1980s and early 1990s. These technologies were among the first to enable wireless local area network (LAN) connectivity, laying the foundation for modern Wi-Fi networks. WaveLAN technologies were primarily used for connecting computers and devices within a limited geographic area, typically within an office, campus, or industrial setting. They provided an alternative to wired Ethernet connections, allowing devices to communicate with each other and share resources without the need for physical cables.

Z-Wave: It is a wireless communication technology that was developed for home automation and control. It is designed primarily for establishing a dependable and low-power wireless network for smart devices within a home or building. Z-Wave is commonly used in smart lighting, thermostats, door locks, sensors, and other applications, allowing these devices to interact with one another and with a central controller.

Evaluation Parameters:

Transmission speed: The speed at which data is transferred from one point to another across a communication channel or network is referred to as transmission speed, also known as data transfer rate or bandwidth. Bits per second (bps) or its higher levels, such as kilobits, megabits, gigabits, and so forth, are commonly used to quantify this statistic.Different communication technologies and networks offer diverse transmission speeds depending on their design, specifications, and the quality of the medium employed.

Security: In the context of communication technologies, security refers to the safeguards put in place to protect data, systems, and information against unauthorised access, data breaches, cyberattacks, and other potential dangers. Security is critical for ensuring the confidentiality, integrity, and availability of information, as well as maintaining user and stakeholder trust.

Transmission Range: Transmission range, in the context of communication technologies, refers to the maximum distance over which a signal can travel between a sender and a receiver while maintaining an acceptable level of signal strength and data integrity. The range of a communication system is influenced by factors such as the transmission power, frequency, antenna design, environmental conditions, obstacles, and interference. Different communication technologies have varying transmission ranges due to their design and intended use.

Power usage: It also known as power consumption, refers to the amount of electrical energy consumed by a device or system over a certain period of time. In communication technologies, power usage is a critical factor as it affects device performance, battery life, operating costs, and environmental considerations. Different technologies and devices have varying power requirements based on their design, usage patterns, and efficiency.

Development Cost: Development cost in the context of communication technologies refers to the expenses incurred during the design, creation, testing, and deployment of new technologies, systems, or products. These costs encompass various aspects of development, including research, design, engineering, prototyping, testing, software development, and more. Development costs can vary greatly based on the technology's complexity, the extent of the project, the team's competence, and other considerations.

Development complexity: In the realm of communication technologies refers to the intricacy, sophistication, and level of difficulty involved in creating new technologies, systems, or products. Complexity can arise from various factors, including technical challenges, integration of different components, interoperability requirements, regulatory considerations, and more.

WASPAS METHOD:

WASPAS, or Weighted Aggregated Sum Product Assessment, is a decision-making technique that evaluates and ranks alternatives by taking multiple criteria into account. This method is utilized in various fields, including engineering, economics, and management, to facilitate informed decision-making in complex systems or situations with numerous possibilities. The WASPAS approach operates through the following steps:

1. Criteria Identification: First, the relevant criteria that are essential for evaluating the alternatives are identified. These criteria should be measurable and relevant to the decision context.
2. Normalization: Once the criteria are determined, they might have different units or scales. To ensure fair comparison, the criteria are usually normalized to bring them onto a common scale (e.g., 0 to 1).
3. Weight Assignment: In this step, weights are assigned to each criterion to indicate its relative importance. These weights are often assigned by decision-makers or experts based on their understanding of the problem and the significance of each criterion.
4. Aggregation: The weighted sum strategy is used to aggregate the criteria values for each choice after normalisation and weighting. This method involves multiplying each criterion's normalised value by its corresponding weight and summing the results.
5. Ranking: The alternatives are arranged in a specific order according to their combined scores. The option with the highest combined score is regarded as the most favored or optimal selection for the particular decision scenario. The WASPAS method is useful when there are multiple criteria that may have varying degrees of importance in the decision-making process. By incorporating both the weights and performance of each criterion, the method helps decision-makers identify the best alternative in a systematic and structured manner. However, it is essential that the weights are assigned carefully, as they directly influence the final ranking of the alternatives. Furthermore, the technique operates under the assumption of criterion independence, a condition that might not consistently apply in real-life situations. Hence, it becomes vital to approach the utilization of the WASPAS method with careful consideration and the insights of experts.

Step 1 The decision matrix X which shows the performances of different alternatives with respect to various criteria is formed.

$$D = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & x\cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

Weight vector may be expressed as

$$w_j = [w_1 \quad \cdots \quad w_n], \quad (2)$$

where ,$\sum_{j=1}^{n}(w_1 \ \cdots \ w_n) = 1$

Step 2: The decision matrix is normalized. Beneficial and non-beneficial criteria are normalized

$$n_{ij} = \begin{cases} \frac{x_{ij}}{max.x_{ij}} \mid j \in B \\ \frac{min.x_{ij}}{x_{ij}} \mid j \in C \end{cases} \quad (3)$$

Here, nij represents the normalized value of the i-th alternative for the j-th section, where max.x_ij and min.x_ij correspond to the highest and lowest values of x_ij in the j-th column, specifically for benefit (B) and cost criteria (C) respectively.

Step 3 Weighted normalized decision matrix by WSM method is calculated as follows:

$$w_{ij} = w_i n_{ij} \quad (4)$$

Step 4. Weighted normalized Decision Matrix

$$W_{n_{ij}} = (n_{ij})^{w_j} \quad (5)$$

Step 5: Preference score for the given alternative, based on WSM, is calculated as follows:

$$S_i^{WSM} = \sum_{j=1}^{n} w_j n_{ij} \quad (6)$$

Step 6: Preference score for the given alternative, based on WSM, is calculated as follows:

$$S_i^{WPM} = \prod_{j=1}^{n} (n_{ij})^{w_j} \quad (7)$$

Step 7: Preference score for WASPAS method is calculated using equation (6) and (7),

$$S_i^{WASPAS} = \lambda\, S_i^{WSM} + (1 - \lambda\,) S_i^{WPM}$$

$$S_i^{WASPAS} = \lambda \sum_{j=1}^{n} w_j n_{ij} + (1 - \lambda\,) \prod_{j=1}^{n} (n_{ij})^{w_j}$$

Where λ is between 0 and 1.

The alternatives are then sorted according to the S_iWASPAS values. The highest S_iWASPAS value is found in the best alternative. The WASPAS technique is converted to WPM if the value of is 0 and to WSM if is 1.

3. RESULT AND DISCUSSION

Table 1. Wireless communication network

Wireless communication network						
criterion	Transmission Speed ($C1$)	Security ($C2$)	Transmission Range ($C3$)	Power Usage ($C4$)	Development Cost ($C5$)	Development Complexity ($C6$)
Bluetooth	4.8	5.28	3.31	1.76	1.46	0.61
Zigbee	6.24	7.04	7.36	1.02	0.95	0.49
Wi-Fi	5.44	6.51	6.26	1.47	1.17	0.5
Classic WaveLAN	5.92	6.16	6.62	1.33	1	0.57
Z-wave	7.04	7.57	7.36	1.26	1.06	0.56

Table 1 serves as a performance comparison of five distinct wireless communication networks across six criteria. The first criterion being discussed is Transmission Speed. Bluetooth has the lowest transmission speed, followed by Zigbee, Classic WaveLAN, Wifi, and Z-wave. Security: Zigbee, Classic WaveLAN, and Z-wave are all more secure than Bluetooth and Wifi. Transmission Range: Bluetooth has the shortest transmission range, followed by Zigbee, Classic WaveLAN, and Wifi. Z-wave has the longest transmission range. Power Usage: Bluetooth uses the most power, followed by Classic WaveLAN, Zigbee, Wifi, and Z-wave. Development Cost: Bluetooth has the lowest development cost, followed by Zigbee, Classic WaveLAN, Wifi, and Z-wave. Development Complexity: Bluetooth has the lowest development complexity, followed by Zigbee, Classic WaveLAN, Wifi, and Z-wave. In general, Bluetooth is an excellent option for applications where performance and cost must be balanced. For applications that need security and minimal power consumption, Zigbee is an excellent option. Applications that call for high-speed data transmission should consider using WiFi.. For applications that demand high security, classic WaveLAN is a solid option. Z-wave is a wise choice for applications that are ready to pay a premium for security and low power consumption. Depending on the individual needs of a given application, the optimum wireless communication network will be determined.

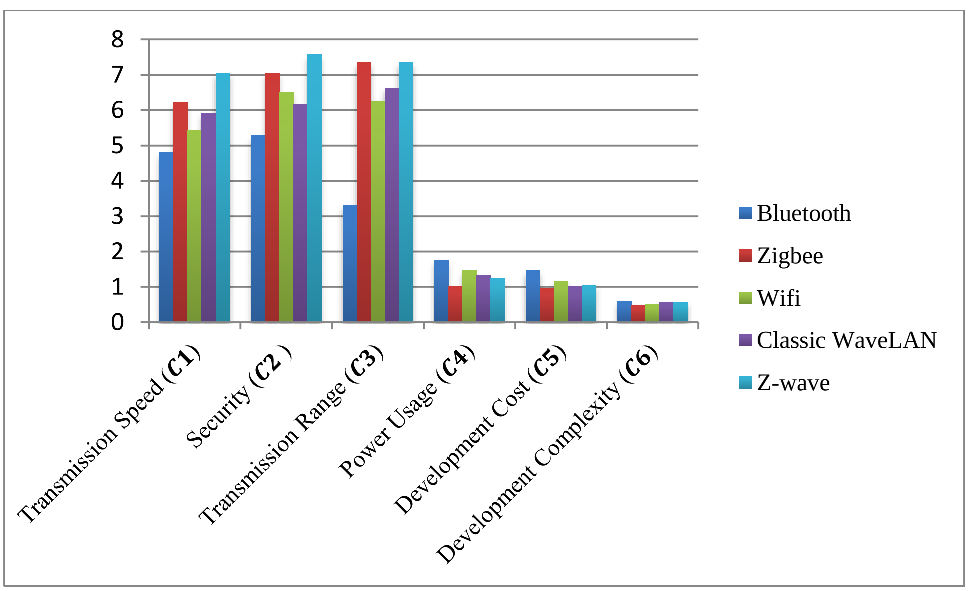

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Table 2. Performance value

Performance value						
Bluetooth	0.681818	0.75	0.47017	0.579545	0.69863	1.672131
Zigbee	0.886364	1	1.045455	1	1.073684	2.081633
Wifi	0.772727	0.924716	0.889205	0.693878	0.871795	2.04
Classic WaveLAN	0.840909	0.875	0.940341	0.766917	1.02	1.789474
Z-wave	1	1.075284	1.045455	0.809524	0.962264	1.821429

This table 2 represents the performance value of Bluetooth has the lowest performance value, followed by Zigbee, Classic WaveLAN, and Wifi. Z-wave has the highest performance value. The performance value is determined by computing the average of the values within each column of the table. These columns map to several metrics used to evaluate a wireless communication network's effectiveness. The network performs better the higher the performance value. In terms of performance, Z-wave is generally the best wireless communication network. The cost is also the highest, though. For applications that need to strike a compromise between performance and price, Zigbee is a solid option. For applications that demand high-speed data transmission, WiFi is an excellent option. For applications that demand high security, classic WaveLAN is a solid option. Applications that need a balance between performance and usability should choose Bluetooth.

Table 3. Weight

	Weight					
Bluetooth	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Zigbee	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Wifi	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Classic WaveLAN	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667
Z-wave	0.166667	0.166667	0.166667	0.166667	0.166667	0.166667

In this table 3, all of the criteria are equally important, so each network has a weight of 0.166667. This means that all of the criteria will contribute equally to the overall performance value of the network.

Table 4. Weighted Normalized Decision Matrix (WSM)

Weighted Normalized Decision Matrix(WSM)						
Bluetooth	0.113636	0.125	0.078362	0.096591	0.116438	0.278689
Zigbee	0.147727	0.166667	0.174242	0.166667	0.178947	0.346939
Wifi	0.128788	0.154119	0.148201	0.115646	0.145299	0.34
Classic WaveLAN	0.140152	0.145833	0.156723	0.12782	0.17	0.298246
Z-wave	0.166667	0.179214	0.174242	0.134921	0.160377	0.303571

This table 4 represents the Weighted Normalized Decision Matrix (WSM) for different communication protocols, namely Bluetooth, Zigbee, Wifi, Classic WaveLAN, and Z-wave. The matrix contains the weighted scores for each metric (Metric 1 to Metric 6) for the corresponding communication protocol. The values in the table represent the weighted and normalized performance scores for each metric for the respective communication protocol.

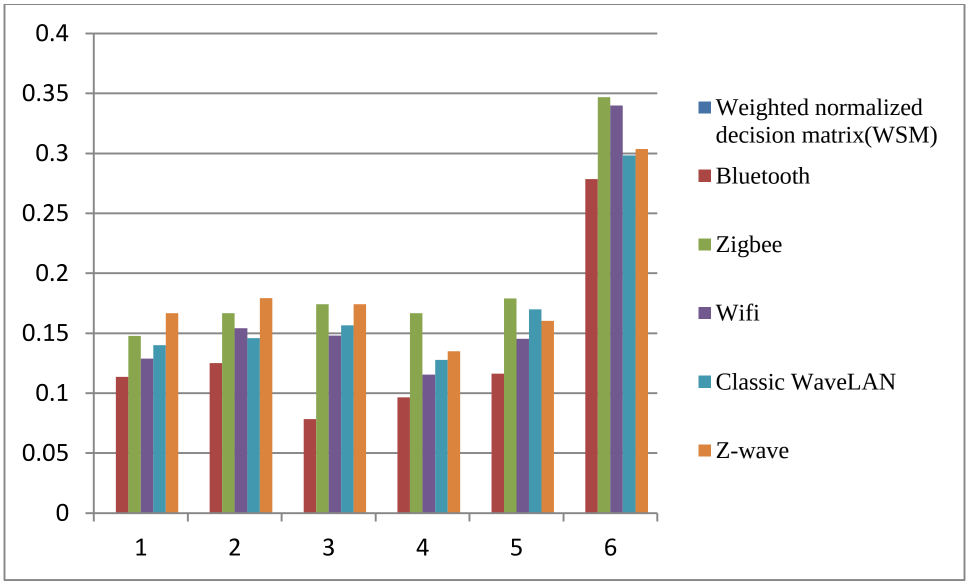

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Table 5. Weighted normalized decision matrix (WPM)

Weighted normalized decision matrix(WPM)						
Bluetooth	0.938163	0.953184	0.881812	0.913092	0.941979	1.089461
Zigbee	0.980096	1	1.007436	1	1.01192	1.129971
Wifi	0.957939	0.98704	0.980619	0.940908	0.977393	1.126173
Classic WaveLAN	0.971534	0.977991	0.9898	0.956734	1.003306	1.101846
Z-wave	1	1.012171	1.007436	0.965395	0.993609	1.105101

In this table 5, each row corresponds to a specific technology (Bluetooth, Zigbee, Wifi, Classic WaveLAN, and Z-wave), and each column represents a criterion used for evaluation as transmission speed, security, transmission range, power usage, development cost, and development complexity. The values in the matrix represent the performance scores of each technology concerning the respective criteria. Higher scores generally indicate better performance in that specific criterion. For example, in the Bluetooth the values are in transmission speed is 0.938163, Zigbee is 0.980096, Wifi is 0.957939, Classic WaveLAN is 0.971534 and Z-wave is 1.

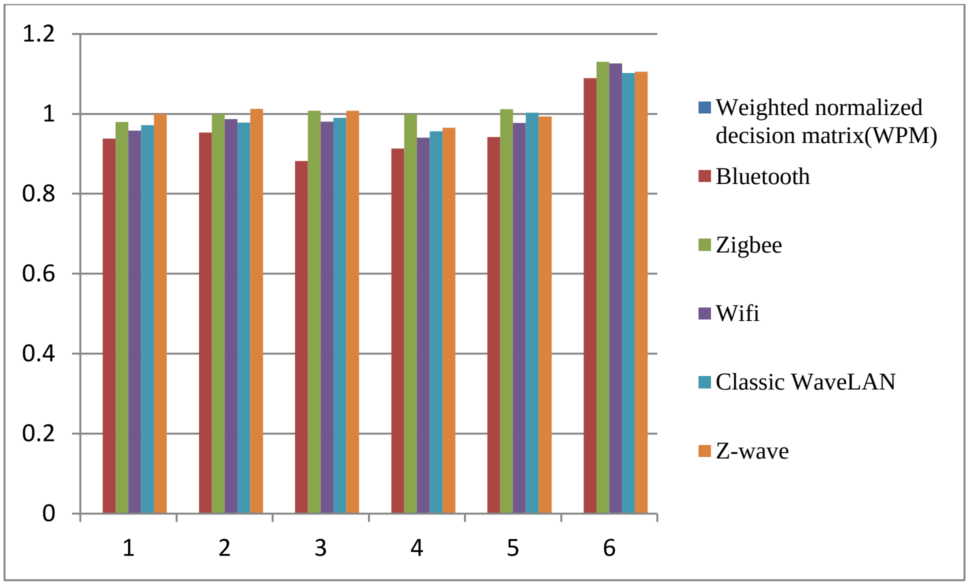

FIGURE 3. Weighted normalized decision matrix (WPM)

Each row in Figure 3 refers to a certain technology (Bluetooth, Zigbee, Wifi, Classic WaveLAN, and Z-wave), and each column represents an evaluation criterion such as transmission speed, security, transmission range, power utilisation, development cost, and development complexity. The values in the matrix represent the performance scores of each technology concerning the respective criteria. Higher scores generally indicate better performance in that specific criterion. For example, in the Bluetooth the values are in transmission speed is 0.938163, Zigbee is 0.980096, Wifi is 0.957939, Classic WaveLAN is 0.971534 and Z-wave is 1.

TABLE 6. Preference Score (WSM) and Preference Score (WPM)

	Preference Score(WSM)	Preference Score(WPM)
Bluetooth	0.8087159	0.73892165
Zigbee	1.1811892	1.12901477
Wifi	1.0320534	0.96027125
Classic WaveLAN	1.0387735	0.99468616
Z-wave	1.1189925	1.0809213

In this table 6 shows the Preference Score (WSM) and Preference Score (WPM). It seems there are two sets of preference scores available: one calculated using the Weighted Sum Model (WSM) and the other using the Weighted Normalized Decision Matrix (WPM). These preference scores depict the overall performance of each technology, considering the evaluation criteria and their respective weights. Based on the preference scores, we can observe that: Zigbee has the highest preference score in both models, indicating that it performs the best overall among the listed technologies. Bluetooth has the lowest preference score in both models, suggesting it performs the weakest among the listed technologies. Wifi, Classic WaveLAN, and Z-wave have varying preference scores, showing their relative performance compared to the other technologies.

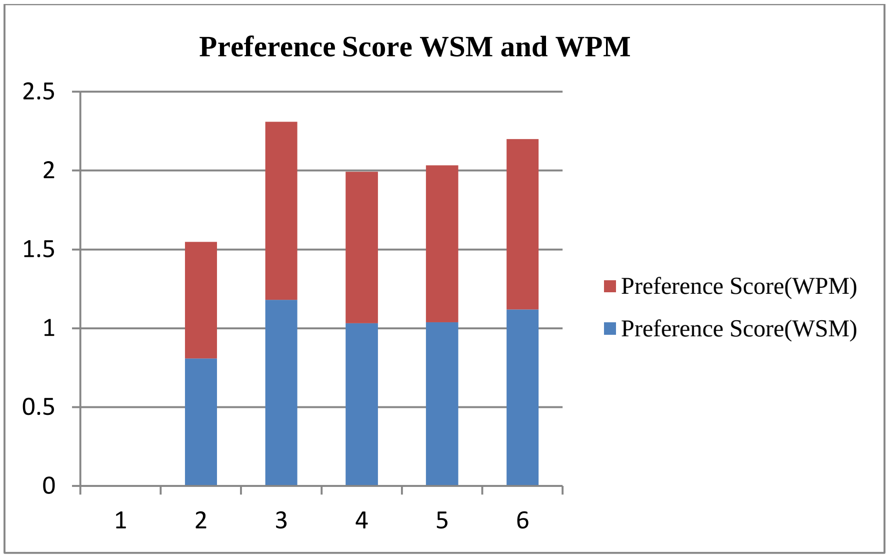

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Table 7.WASPAS Coefficient

Name of criterion	WASPAS Coefficient
Bluetooth	0.773819
Zigbee	1.155102
Wifi	0.996162
Classic WaveLAN	1.01673
Z-wave	1.099957

Table 7 displays the WASPAS model's weighted aggregated sum product assessment (WASPAS) criteria along with the accompanying coefficients. These coefficients represent the relative importance or weight assigned to each technology for the evaluation in the WASPAS model. The higher the coefficient, the more significant the criterion is in the assessment process. In the WASPAS Coefficient, the values are Bluetooth is 0.773819, Zigbee is 1.155102, Wifi is 0.996162, Classic WaveLAN is 1.01673 and Z-wave is 1.099957.

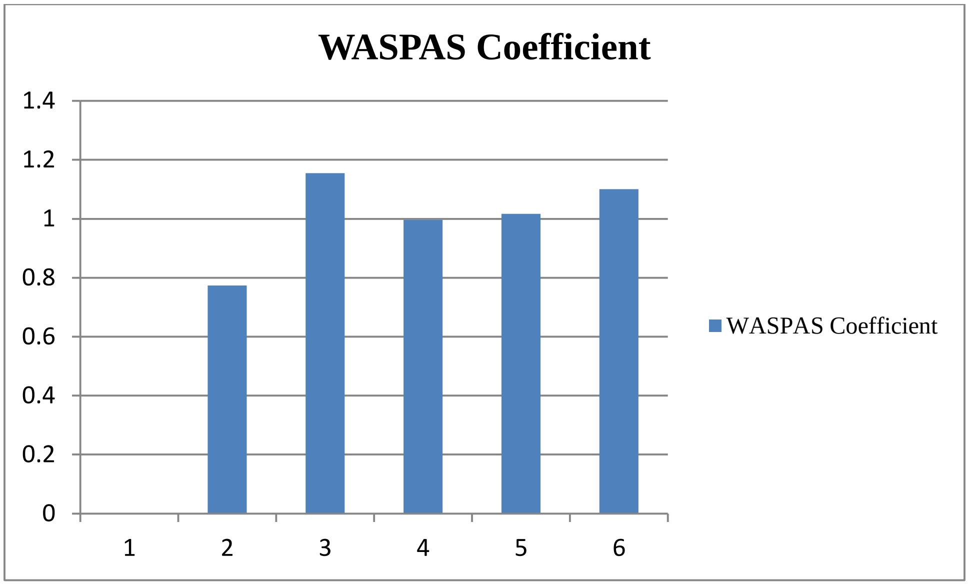

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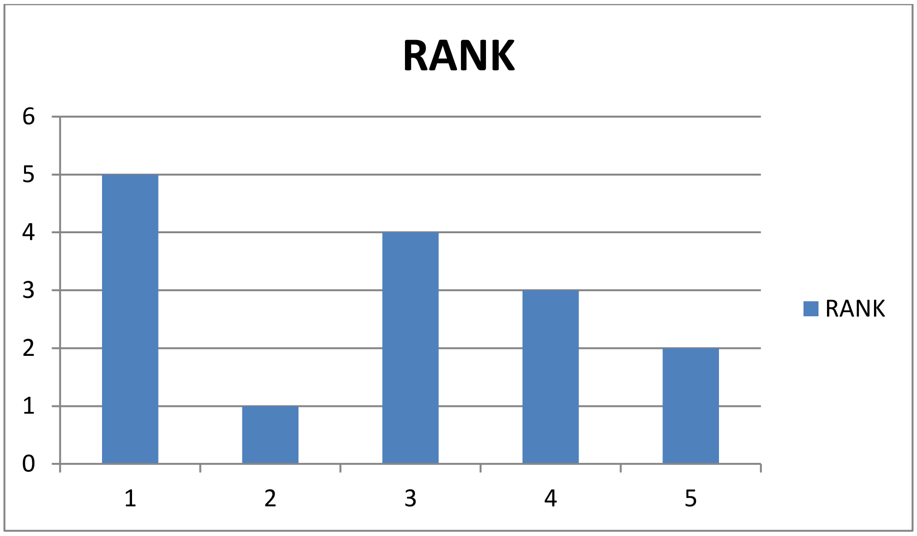
TABLE 8. Rank

Name of criterion	RANK
Bluetooth	5
Zigbee	1
Wifi	4
Classic WaveLAN	3
Z-wave	2

In this table 8 the ranks indicate the position of each technology in the order of preference or performance. In this case, Zigbee has the highest rank (1), meaning it is ranked first, followed by Z-wave (2), Classic WaveLAN (3), Wi-Fi (4), and Bluetooth (5). The ranking provides a clear ordering of the technologies based on their evaluated performance or other specified criteria.



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In this figure 6 the ranks indicate the position of each technology in the order of preference or performance. In this case, Zigbee has the highest rank (1), meaning it is ranked first, followed by Z-wave (2), Classic WaveLAN (3), Wifi (4), and Bluetooth (5). The ranking provides a clear ordering of the technologies based on their evaluated performance or other specified criteria.

4. CONCLUSION

This article evaluated numerous wireless communication technologies that are suitable for the development and implementation of embedded devices. Previous research ranked these technologies based on expert opinions and multi-criteria decision-making analysis. Different stakeholders involved in embedded device development have different goals, which are translated into criteria for selecting the best wireless communication technologies. From the literature, the researchers selected six wireless communication technologies (Bluetooth, Z-wave, Classic WaveLAN, Wi-Fi, and Zigbee). Transmission Speed (C1), Security (C2), Transmission Range (C3), Power Usage (C4), Development Cost (C5), and Development Complexity (C6) were used to rank these technologies. This study was carried out to examine the advantages and disadvantages of each wireless communication option for embedded device development. The goal was to make it easier to choose and rank the best wireless communication technology. To accomplish this, the opinions of the experts participated in the evaluation process were given equal weight. The study sought to find the best wireless communication technology for the development of embedded devices by taking into account numerous factors and expert opinions. According to professional opinion and review, Zigbee is the most favoured wireless technology solution for embedded systems, with the highest rank (1) and ranking first. Z-wave came in second place (2), followed by Classic WaveLAN in third place (3), Wi-Fi in fourth place (4), and Bluetooth in fifth place (5). This ranking provides a separate order of technologies based on their evaluated performance and specified criteria, assisting in the selection of the best wireless communication technology for embedded device development.

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