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Network Quality Assessment in Heterogeneous Wireless Settings: An Optimization Approach

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Abstract: The identification of an effective network which can efficiently meet the service requirements of the target, while maintaining ultimate performance at an increased level is significant and challenging in a fully interconnected wireless medium. The wrong selection can contribute to unwanted situations like frustrated users, slow service, traffic congestion issues, missed and/or interrupted calls, and wastefulness of precious network components. Conventional schemes estimate the handoff need and cause the network screening process by a single metric. The strategies are not effective enough because traffic characteristics, user expectations, network terminology and other essential device metrics are not taken into account. This article describes an intelligent computing technique based on Multiple-Criteria Decision-Making (MCDM) approach developed based on integrated Fuzzy AHP-TOPSIS which ensures flexible usability and maximizes the experience of end-users in miscellaneous wireless settings. In different components the handover need is assessed and the desired network is chosen. Further, fuzzy sets provide effective solutions to address decision making problems where experts counter uncertainty to make a decision. The proposed research endeavor will support designers and developers to identify, select and prioritize best attributes for ensuring flexible usability in miscellaneous wireless settings. The results of this research endeavor depict that this proposed computational procedure would be the most conversant mechanism for determining the usability and experience of end-users.

Keywords: Wireless sensor networks; fuzzy logic; AHP-TOPSIS; miscellaneous network; intelligent computing techniques

1 Introduction

Wireless networks technology have made tremendous progress in recent years. Although, any specific type of current system equipped with wireless network like Wi-Fi, Bluetooth, UMTS, Worldwide Interoperability for Microwave Access (WiMAX) cannot offer any level of handling, for example broad coverage as well as high bandwidth. The unified diverse network of sustainable development calls for a combination of different form of network, such as bandwidth, time-limit communication distance, speed assistance, energy usage, protection, end-user cost, etc., [1–5].

Digital networking now provides diverse, flexible distribution and Quality of service wireless communications [6–9]. Among the key aspects for utilizing wireless communication technologies 4th generation (4G) systems are heterogeneous cellular networks. The miscellaneous network is a blend of diverse connectivity technologies to ensure the participant's integrated accessibility and excellent service, like high wireless communication distribution and wireless local area network (WLAN) bandwidth [10–15].

Wireless networks of the next generation require different wireless technology. Because of the limitation of network infrastructure, coverage issues and increasing needs of the customer, one channel may not always be capable and requires QoS to support the user during the session [16–21]. Consequently, switching between various wireless channels continues to be easy resolutions in modern miscellaneous networks settings due to the integration of several network connectivity systems [22–26]. With our growing dependence on technology, it has become extremely important to protect all aspects of digital information and data [27–29]. Privacy and Security is now one of the most critical issues for organizations to remember as the modern internet infrastructures have become larger [30–32]. Increased demand for wireless communication in the implementation of intelligent infrastructure, a huge rise in internet usage, growth in implementation of the internet of things (IoT), growing trends such as work from home as well as virtual learning leading to the COVID-19 pandemic, and growing demand for low-power wi-fi are the main reasons influencing the wireless communication industry growth.

The overall number of Internet consumers worldwide is expected to rise at a CAGR of 6% from 3.9 billion in 2018 to 5.3 billion by 2023. In terms of population, this accounts for 51% of the world's population in 2018 and 66% of worldwide population growth by 2023 [33,34]. The following Fig. 1 shows the Internet user growth worldwide.

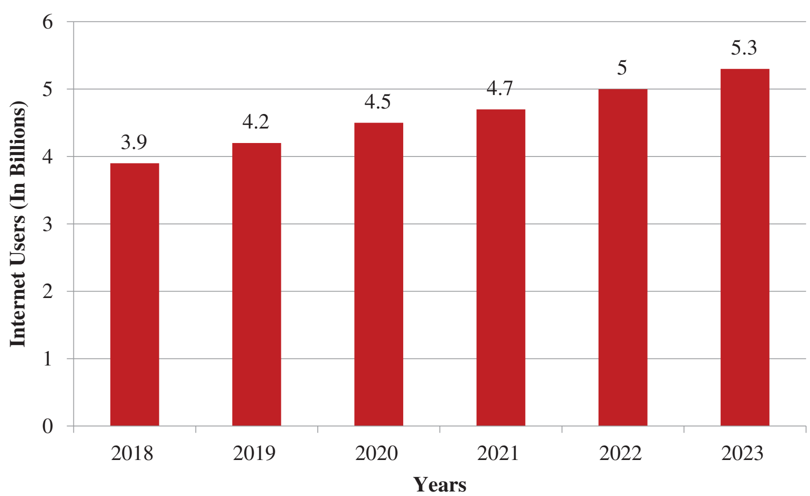

Figure 1: Global internet user growth (source: cisco annual internet report, 2018–2023)

In this article, we concentrate on the identification in expert based of the always appropriate linked network, preserving QoS for communication systems in a constrained environment. This is how we follow a Fuzzy approach to improve horizontal transfer decisions; it allows for a sensible and informed decision on the transfer, based on the network criteria. In order to justify the proposed objectives, deployment and analysis are presented.

The rest of the paper is organized accordingly. Section 2 summarizes associated work on network selection in miscellaneous wireless settings. Section 3 the presents the materials and methods used to achieve the objective of this study. Further, Section 3 also deals with and the implementation of integrated fuzzy AHP-TOPSIS approach and presents the statistical findings with sensitivity and comparative analysis. Finally the paper concludes in Section 4.

2 Related Works

Quang et al. [1] designed MCDM based method has to an effective target network out of the available alternative networks to providing the best service and also to provide enough best wireless network service at all times. This article intends to provide a means by which a desired network system of the available channels can be chosen optimally. This way the best wireless network can be chosen for deployment target network between many alternate networks to optimize service quality.

Gazis et al. [2] suggested a model of two rating systems, one of which is network-specific as well as the other user-specific. Systems used fuzzy logic to rate various networks focused on their parameters. The distinction between the two rating systems lies in the dynamism that they delivered. The user-specific rating criteria were versatile, whereas the network-specific system uses defined criteria. The network-specific process can assist to provide a framework to visualize the overall output index of the networks.

Kaleem et al. [3] anticipated a novel multi-criteria VHO technique that selects a targeted NAT centered on many variables, like user expectations, device factors, and network traffic-types along with variable quality of service (QoS) specifications. They used two parameters i.e., the VHO Necessity Estimation (VHONE) system as well as the target NAT preference component. All components used a set of weighted application and device parameters. In order to boost the superiority of the suggested method, the weighting method is premised based on the idea of fuzzy oriented linguistic terms.

Charilas et al. [7] tackled such problem by implementing Multi-Attribute Decision Making (MADM) approaches. Fuzzy AHP (Analytical Hierarchy Process) the MADM system is originally used to decide the weights of many service quality measures that serve as parameters influencing the decision-making process. In the form of subjective assessments, the fuzzy extension of this approach and hence the use of fizzy numbers was implemented to integrate the presence of fuzziness. Subsequently, ELECTRE, MADM priority scoring system, is used to rate alternatives.

Alkhawlani et al. [9] presented a comprehensive model to fix the issue of network selection (ANS) within heterogeneous wireless networks (HWN). Their suggested technique was designed to introduce and model a specific multicriteria software assistant (SA) which could be considered by the user, the controller and/or the QoS point of view. Mixed fuzzy logic and genetic algorithms (GAs) were used to provide the proposed technique with the necessary optimization, versatility and usability. Their consequences have demonstrated that the suggested methodology and SA have stronger and more stable output over unsystematic assortment.

Drissi et al. [10] suggested a strategy to effective network assortment focused on the Fuzzy Analytical Hierarchy System (FAHP) used to assess the comparative weights of the assessment parameters. They used Simple Additive Weighting (SAW) to prioritize the accessible channels. Deployment and visualisation tests with the NS3 Network Simulator are provided to evaluate the anticipated methodology. Experiential findings showed that FAHP, relative to traditional AHP, produced substantial improvements of up to 10% in terms of delay and 25% in terms of packet failure.

Mehbodniya et al. [11] introduced a new multi-attribute vertical hand-off approach for heterogeneous wireless channels that maintains flexible accessibility while optimizing end-user experience. They utilized two parameters to predict the need for hand-off and also to choose the projected channels. Such components use simultaneous Fuzzy Logic Controllers (FLCs) with a decreased instruction set in association through a network rating methodology built focused on Fuzzy VIKOR (FVIKOR). The simulation findings were given and also contrasted to the standard.

3 Materials, Methods and Results

3.1 Design of Hierarchical Structure

In this section, we aim to illustrate how and why the fuzzy AHP-TOPSIS approach should be used to overcome the issue of effective network selection in various wireless environments. The subsequent situation is taken into account: the client wants to share the data connection in a mobile for which four channels are accessible. All connections may support the client; although in order to optimize the Service (T1) [35], Quality (T2) [36] and Capability (T3) [37] criteria provided, the most effective network must be identified. The sub-criteria for the Service (T1) to be taken into account in the MCDM (Multiple-criteria decision-making) process are Delay (T11) [38,39], Jitter (T12) [40], Packet Loss Ratio (T13) [41,42] and Throughput (T14) [43,44]. Delay and Jitter are of higher importance relative to other Service criteria, whereas Throughput is of lower importance. The sub-criteria for Quality (T2) are Cost-effectiveness (T21) [45], Reliability (T22) [46,47] and Maintainability (T23) [48]. Moreover the sub-criteria for Capability (T3) are Security (T31) [49], Scalability (T32) [50], Data Support Rate (T33) [51] and Latency (T34) [49–51] yields an assortment of significance. Further, description of different types of wireless communication networks is given in Tab. 1.

Table 1: Different types of wireless communication networks

Network type	Description
WMAN	The wireless metropolitan area network (WMAN) is a type of wireless telecommunication channel that has an anticipated network coverage range—about the area of a city. WMAN is a greater distance than a wireless local area network (WLAN) although less than a wireless wide area network (WWAN).
WWAN	The WWAN (Wireless Wide Area Network) is a type of wireless network. WWAN varies from the local area network by the equipment used to relay the transmission and its size. It is offered locally, countrywide, or even worldwide.

(Continued)

Table 1: Continued

Network type	Description
UMTS	The 3rd generation wireless, packet-based text delivery, electronic voice, music, video and interactive at connection speeds of up to 2 Mbps. UMTS provides a single range of services to computing devices and android devices, regardless of where they are located in the globe.
LTE	LTE is a standard developed and implemented by the Third Generation Collaboration Project, an international standard, and is the nearest standard to the 4th generation of telecommunications (4G) technology. LTE was recognized and implemented by domestic and international societies as the baseline for developing communication technologies.
WiMAX	WiMAX network technology is a wireless broadband communication highly focused around the IEE 802.16 specification that provides high-speed data across a large area. WiMAX's letter stands for Worldwide Interoperability for Microwave Access (AXess) and is a point-to-point wireless communication network.
WLAN	WLANs normally consist of two foundational components: access points and other wireless installed applications, including laptop computers. These components depend on radio transmitters as well as receivers to share information with one another. Network nodes are physically connected to a network system as well as provide a method for connected networks to communicate to it.

Although relative value cannot be precisely defined, we anticipate the utilization of fuzzy logic to be a beneficial option in our methodology. Ambiguity in correlations may be interpreted by fuzzy numbers, such that a range of potential results is obtained rather than just another single value. Correlating fuzzy numbers can be obtained from expert questionnaire survey or network measurements [13–17] in which the worst and best ratings may be the bottom and top limits of fuzzy numbers, accordingly. The following Fig. 2 shows the hierarchy for effective network selection.

3.2 Fuzzy AHP-TOPSIS

The FAHP-TOPSIS strategy is a systematic mixture of the Fuzzy AHP method and the Fuzzy TOPSIS process. In the first point, Fuzzy AHP is being utilized to calculate the relative value of the parameters as contrasted to one another. These weighted parameters are used to allocate a rating to each individual for each assessment criterion. This step is characterized by the Fuzzy TOPSIS, in which the distance score of and individual to the ideal is determined on the basis of the given ratings, for respectively the positive ideal and for the negative ideal. The strongest alternatives must be as close to the positive standard as practicable and as far away as possible from the negative ideal. The succinct measures of the FAHP-TOPSIS are as shown in Fig. 3.

Fuzzy AHP Initially introduced by Thomas L. Saaty, AHP is among the powerful MCDM solutions to address complex, unorganized challenges by constructing a conceptual hierarchy [14].

The key principle of AHP is to establish a preference for the weighting for every alternative decision. Priorities may be defined using a natural linguistic or numeric data value to determine the statistical significance of each parameter. In order to evaluate the order, the first two parameters are contrasted with the help of a nine-point scale ranking for importance [15]. To add fuzziness, pairwise values are then used in a matrix with the help of Triangular Fuzzy Number (TFN) [16,34].

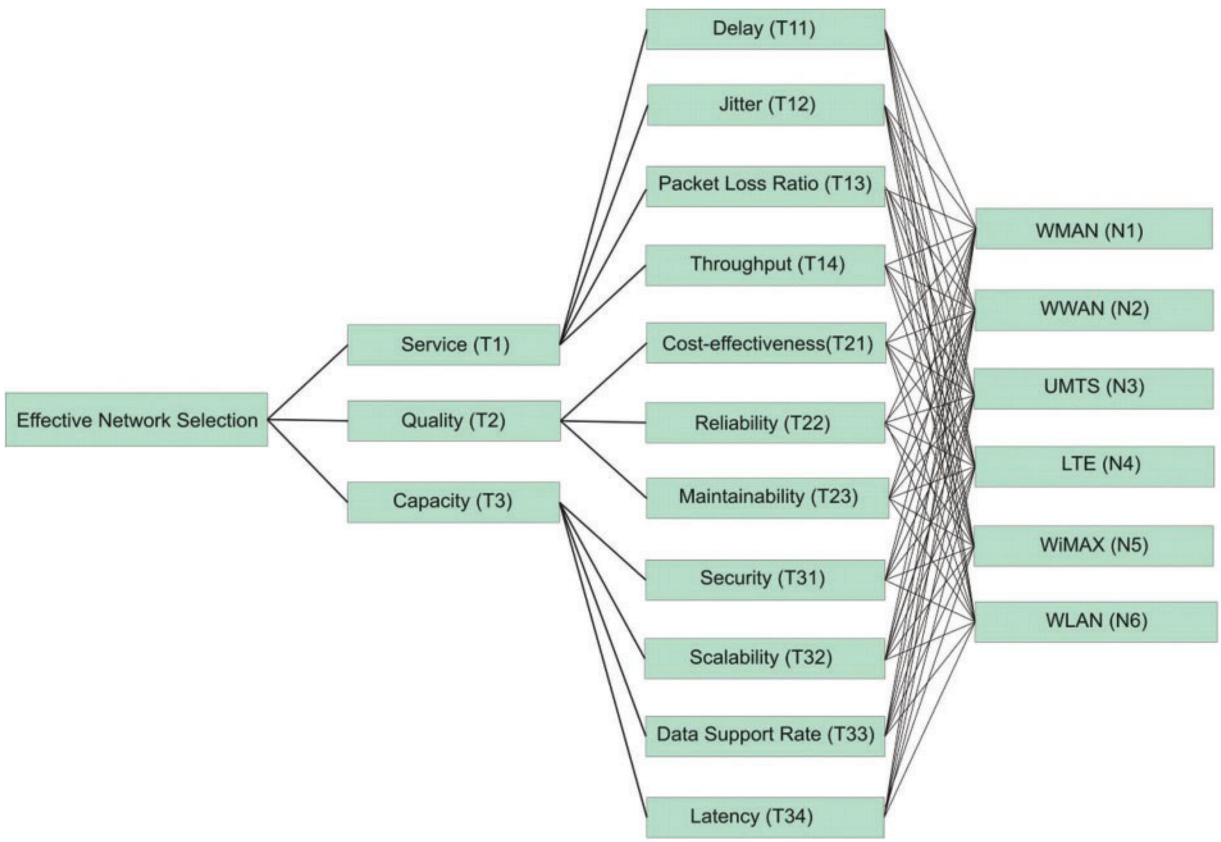

Figure 2: Hierarchy for effective network selection

Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (FTOPSIS) is the MCDM method developed by Hwang and Yoon [17], in which the resolution is the ones having the Euclidean distance closest to the strongest assumption, the Positive Ideal Solution (PIS) as well as the farthest with the weakest assumption, the Negative Ideal Solution (NIS) [18–24]. Fuzzy TOPSIS requires details on the overall relevance of every other weighting criterion. In integrated Fuzzy AHP-TOPSIS, the weights have always been determined in the Fuzzy AHP step [25–29].

3.3 Numerical Analysis

This section addresses numerous statistical results from the implementation of the integrated fuzzy AHP-TOPSIS model. Network experts typically perform behavioral assessments to examine the performance of different networks on the basis of identified criteria. To that end, the problematic actions of broad collections of indicators of implementation must be defined and characterized. Experts and researchers in wireless communication networks have a challenging task to quantify numerically the impact of different wireless networks in telecommunication organization. We have used a well-developed and validated decision maker technique, Integrated fuzzy AHP-TOPSIS, in order to achieve the goal in our research paper. This procedure is acquainted for prioritizing the different wireless networks based on their service, quality and capability evaluation in modern telecommunication situation.

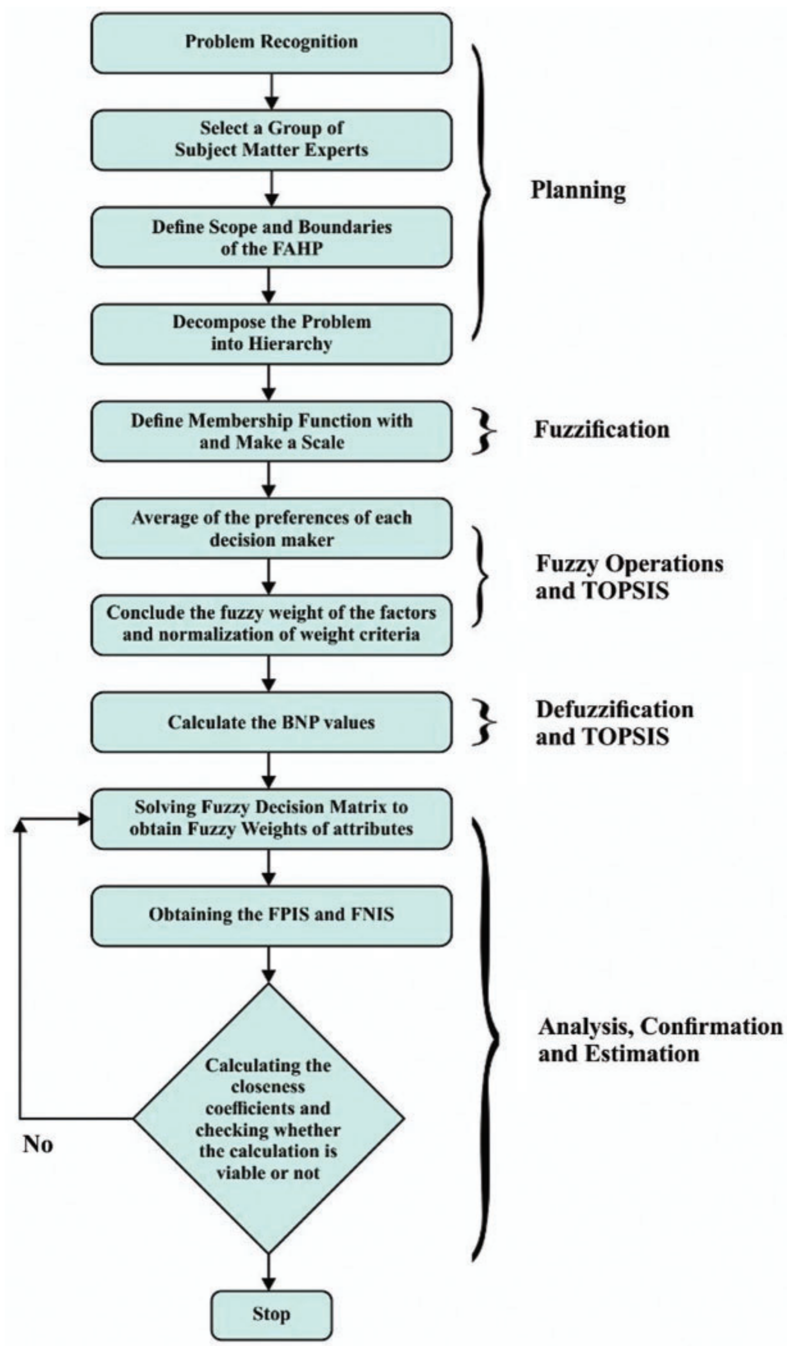

Figure 3: Flow chart of fuzzy AHP-TOPSIS method

For producing a more substantial result, we took recommendations from 75 network experts who come from different telecommunication firms and academic professional. The information subcontracted from these experts was composed for our observed investigations. The different factors for the performance evaluation at implementation phase i.e., Service, Quality and Capability are represented by T1, T2 and T3 respectively. Systematic approach of fuzzy-AHP TOPSIS is used according to functional structure shown in Fig. 3 to determine the effective network among different alternatives such as WMAN, WWAN, UMTS, LTE, WiMAX and WLAN represented by N1, N2, N3, N4, N5 and N6 respectively. The following Tabs. 2–14 demonstrates the statistical findings of the present study and graphical representation of satisfaction degree of different alternatives is shown in Fig. 4.

Table 2: Fuzzy pair-wise comparison matrix at level 1

	T1	T2	T3
T1	1.00000, 1.00000, 1.00000	0.68908, 0.88600, 1.10002	0.22550, 0.27620, 0.35740
T2	–	1.00000, 1.00000, 1.00000	0.30501, 0.38920, 0.56009
T3	–	–	1.00000, 1.00000, 1.00000

Table 3: Fuzzy aggregated pair-wise comparison matrix at level 2 for service

	T11	T12	T13	T14
T11	1.00000, 1.00000, 1.00000	1.00000, 1.37041, 1.71018	0.56010, 0.83600, 1.07801	0.30040, 0.37606, 0.47203
T12	–	1.00000, 1.00000, 1.00000	0.30300, 0.42008, 0.60052	0.19106, 0.23003, 0.30001
T13	–	–	1.00000, 1.00000, 1.00000	0.51308, 0.79509, 1.20302
T14	–	–	–	1.00000, 1.00000, 1.00000

Table 4: Fuzzy aggregated pair-wise comparison matrix at level 2 for quality

	T21	T22	T23
T21	1.00000, 1.00000, 1.00000	0.69500, 0.95002, 1.34507	1.14860, 1.43850, 1.69620
T22	–	1.00000, 1.00000, 1.00000	1.19280, 1.58260, 2.14970
T23	–	–	1.00000, 1.00000, 1.00000

Table 5: Fuzzy aggregated pair-wise comparison matrix at level 2 for capacity

	T31	T32	T33	T34
T31	1.00000, 1.00000, 1.00000	1.07810, 1.59900, 2.11300	0.82006, 1.11108, 1.61500	0.56700, 0.71302, 0.87309
T32	–	1.00000, 1.00000, 1.00000	0.32300, 0.44800, 0.60501	0.25804, 0.31702, 0.41608
T33	–	–	1.00000, 1.00000, 1.00000	0.66601, 1.05640, 1.54207
T34	–	–	–	1.00000, 1.00000, 1.00000

Table 6: Defuzzified pair-wise comparison matrix

	T1	T2	T3	Weights
T1	1.00000	0.89050	0.28390	0.18320
T2	1.1230	1.00000	0.41110	0.22390
T3	3.52240	2.43250	1.00000	0.59290
CR = 0.006200				

Table 7: Aggregated pair-wise comparison matrix at level 2 for service

	T11	T12	T13	T14	Weights
T11	1.00000	1.36510	0.82780	0.38240	0.18110
T12	0.73250	1.00000	0.43750	0.23810	0.11670
T13	1.20800	2.28570	1.00000	0.82720	0.27570
T14	2.61510	4.19990	1.20890	1.00000	0.42650
CR = 0.015100					

Table 8: Aggregated pair-wise comparison matrix at level 2 for quality

	T21	T22	T23	Weights
T21	1.00000	0.98530	1.35780	0.36110
T22	1.01490	1.00000	1.62690	0.38730
T23	0.73650	0.61470	1.00000	0.25160
C.R. = 0.002600				

Table 9: Aggregated pair-wise comparison matrix at level 2 for capacity

	T31	T32	T33	T34	Weights
T31	1.00000	1.59730	1.16480	0.71680	0.25430
T32	0.62610	1.00000	0.4561	0.32740	0.13020
T33	0.85850	0.14545	1.00000	1.08040	0.28290
T34	1.39510	3.05440	0.92560	1.00000	0.33260
CR = 0.018700					

Table 10: Overall weights and ranking of methods

The first level	The weight of the first level	The second level	The local weight of the second level	The (Global) final weight of the second level
T1	0.18320	T11	0.18110	0.03317752
		T12	0.11670	0.02137944
		T13	0.27570	0.05050824
		T14	0.42650	0.07813480
T2	0.22390	T21	0.36110	0.08085029
		T22	0.38730	0.08671647
		T23	0.25160	0.05633324
T3	0.59290	T31	0.25430	0.14917364
		T32	0.13020	0.07719558
		T33	0.28290	0.16773141
		T34	0.33260	0.19719854

Table 11: Subjective cognition results of evaluators in linguistic terms

Properties/ Alternatives	N1	N2	N3	N4	N5	N6
T11	2.450, 4.450, 6.450	2.910, 4.640, 6.550	1.450, 3.000, 4.910	2.450, 4.270, 6.270	2.450, 4.450, 6.450	2.910, 4.640, 6.550
T12	2.820, 4.820, 6.820	3.180, 5.180, 7.100	1.450, 3.070, 4.910	2.090, 3.730, 5.730	2.820, 4.820, 6.820	3.180, 5.180, 7.100
T13	4.270, 6.270, 8.140	2.820, 4.820, 6.820	3.180, 5.180, 7.100	3.000, 4.820, 6.820	4.270, 6.270, 8.140	2.820, 4.820, 6.820
T14	5.360, 7.360, 9.120	3.730, 5.730, 7.550	2.450, 4.450, 6.450	3.910, 5.910, 7.820	5.360, 7.360, 9.120	3.730, 5.730, 7.550
T21	4.640, 6.640, 8.550	3.000, 5.000, 7.140	2.180, 4.090, 6.140	2.550, 4.450, 6.450	4.640, 6.640, 8.550	3.000, 5.000, 7.140
T22	3.120, 5.000, 7.140	2.450, 4.450, 6.450	0.910, 2.450, 4.450	3.910, 5.910, 7.910	3.120, 5.000, 7.140	2.450, 4.450, 6.450
T23	5.360, 7.360, 9.090	4.280, 6.370, 8.370	2.450, 4.450, 6.450	3.180, 5.180, 7.090	5.360, 7.360, 9.090	4.280, 6.370, 8.370
T31	4.280, 6.370, 8.370	4.270, 6.270, 8.140	2.820, 4.820, 6.820	2.090, 3.730, 5.730	4.280, 6.370, 8.370	4.270, 6.270, 8.140
T32	3.180, 5.180, 7.100	1.450, 3.070, 4.910	0.820, 2.270, 4.270	3.000, 4.820, 6.820	3.180, 5.180, 7.100	1.450, 3.070, 4.910
T33	2.450, 4.450, 6.450	0.910, 2.450, 4.450	2.450, 4.270, 6.270	3.910, 5.910, 7.820	2.450, 4.450, 6.450	0.910, 2.450, 4.450
T34	2.180, 4.090, 6.140	2.820, 4.640, 6.640	1.910, 3.730, 5.730	2.550, 4.450, 6.450	2.180, 4.090, 6.140	2.820, 4.640, 6.640

Table 12: The normalized fuzzy-decision matrix

Properties/ Alternatives	N1	N2	N3	N4	N5	N6
T11	0.320, 0.580, 0.850	0.470, 0.740, 1.000	0.270, 0.560, 0.860	0.250, 0.550, 0.860	0.490, 0.740, 1.000	0.300, 0.530, 0.790
T12	0.340, 0.610, 0.870	0.380, 0.640, 0.890	0.420, 0.690, 1.000	0.390, 0.700, 1.000	0.400, 0.650, 0.890	0.260, 0.470, 0.720
T13	0.370, 0.630, 0.900	0.420, 0.690, 0.950	0.210, 0.460, 0.730	0.120, 0.350, 0.660	0.370, 0.600, 0.860	0.370, 0.600, 0.860
T14	0.490, 0.750, 1.000	0.320, 0.590, 0.860	0.130, 0.360, 0.670	0.370, 0.660, 0.970	0.490, 0.740, 0.980	0.490, 0.740, 0.980
T21	0.500, 0.720, 0.930	0.390, 0.660, 0.940	0.290, 0.540, 0.820	0.420, 0.690, 1.000	0.290, 0.570, 0.880	0.320, 0.560, 0.810
T22	0.340, 0.540, 0.780	0.320, 0.580, 0.850	0.470, 0.740, 1.000	0.270, 0.560, 0.860	0.250, 0.550, 0.860	0.490, 0.740, 1.000
T23	0.580, 0.800, 0.990	0.340, 0.610, 0.870	0.380, 0.640, 0.890	0.420, 0.690, 1.000	0.390, 0.700, 1.000	0.400, 0.650, 0.890
T31	0.460, 0.680, 0.890	0.370, 0.630, 0.900	0.420, 0.690, 0.950	0.210, 0.460, 0.730	0.120, 0.350, 0.660	0.370, 0.600, 0.860
T32	0.580, 0.800, 1.000	0.490, 0.750, 1.000	0.320, 0.590, 0.860	0.130, 0.360, 0.670	0.370, 0.660, 0.970	0.490, 0.740, 0.980
T33	0.500, 0.720, 0.930	0.320, 0.580, 0.850	0.470, 0.740, 1.000	0.270, 0.560, 0.860	0.250, 0.550, 0.860	0.490, 0.740, 1.000
T34	0.460, 0.680, 0.890	0.340, 0.610, 0.870	0.380, 0.640, 0.890	0.420, 0.690, 1.000	0.390, 0.700, 1.000	0.400, 0.650, 0.890

Table 13: The weighted normalized fuzzy-decision matrix

Properties/ Alternatives	N1	N2	N3	N4	N5	N6
T11	0.054, 0.116, 0.278	0.041, 0.095, 0.242	0.059, 0.121, 0.296	0.041, 0.100, 0.260	0.045, 0.098, 0.239	0.041, 0.089, 0.149
T12	0.041, 0.095, 0.198	0.061, 0.121, 0.233	0.054, 0.116, 0.278	0.041, 0.095, 0.242	0.059, 0.121, 0.296	0.041, 0.100, 0.260
T13	0.102, 0.137, 0.299	0.114, 0.144, 0.306	0.041, 0.095, 0.198	0.061, 0.121, 0.233	0.034, 0.091, 0.200	0.032, 0.089, 0.200
T14	0.029, 0.067, 0.158	0.036, 0.072, 0.162	0.102, 0.137, 0.299	0.114, 0.144, 0.306	0.125, 0.155, 0.344	0.116, 0.157, 0.344
T21	0.070, 0.126, 0.275	0.054, 0.116, 0.278	0.029, 0.067, 0.158	0.036, 0.072, 0.162	0.019, 0.052, 0.135	0.016, 0.050, 0.137
T22	0.054, 0.116, 0.278	0.041, 0.095, 0.242	0.059, 0.121, 0.296	0.041, 0.100, 0.260	0.045, 0.098, 0.239	0.063, 0.120, 0.233
T23	0.041, 0.095, 0.198	0.061, 0.121, 0.233	0.034, 0.091, 0.200	0.032, 0.089, 0.200	0.063, 0.120, 0.233	0.112, 0.146, 0.306
T31	0.102, 0.137, 0.299	0.114, 0.144, 0.306	0.125, 0.155, 0.344	0.116, 0.157, 0.344	0.112, 0.146, 0.306	0.024, 0.055, 0.133
T32	0.029, 0.067, 0.158	0.036, 0.072, 0.162	0.054, 0.116, 0.278	0.041, 0.095, 0.242	0.059, 0.121, 0.296	0.041, 0.100, 0.260
T33	0.077, 0.131, 0.230	0.065, 0.123, 0.228	0.041, 0.095, 0.198	0.061, 0.121, 0.233	0.034, 0.091, 0.200	0.032, 0.089, 0.200
T34	0.042, 0.080, 0.169	0.029, 0.067, 0.158	0.102, 0.137, 0.299	0.114, 0.144, 0.306	0.125, 0.155, 0.344	0.116, 0.157, 0.344

Table 14: Closeness coefficients to the aspired level among the different alternatives

Alternatives		d^{+i}	d^{-i}	Gap degree of CC^{+i}	Satisfaction degree of CC^{-i}
Alternative 1	N1	1.249451	1.333754	0.5167545	0.4848825
Alternative 2	N2	0.699454	0.840778	0.5474574	0.4545528
Alternative 3	N3	0.787126	1.484754	0.6544575	0.3468867
Alternative 4	N4	2.165457	1.484784	0.4077747	0.5937746
Alternative 5	N5	2.005745	1.536445	0.4347794	0.5667548
Alternative 6	N6	0.448774	0.397784	0.4657798	0.5354467

We discussed the issue of network selection in wireless telecommunication context which characterizes operational efficiency over a miscellaneous wireless access setting. The implementation of Fuzzy AHP with Fuzzy TOPSIS, i.e., two powerful MCDM approach, for the assessment of different wireless network alternatives were defined in this context. Although the relative value of each parameter over another could be clearly specified, fuzzy numbers have been introduced in order to incorporate the complexity of subjective judgments into the description of the issues. The anticipated technique was eventually checked by means of a numerical model, which showed how the most effective solution, in this case the most effective wireless channel, was chosen. The satisfaction degree (CC-i) of different alternatives is estimated as 0.4848825, 0.4545528, 0.3468867, 0.5937746, 0.5667548 and 0.5354467 for N1, N2, N3, N4, N5 and N6 respectively. As per the findings shown in Fig. 4 the fourth alternative (N4) is highly effective and proficient network channel among miscellaneous wireless settings in a telecommunication organization.

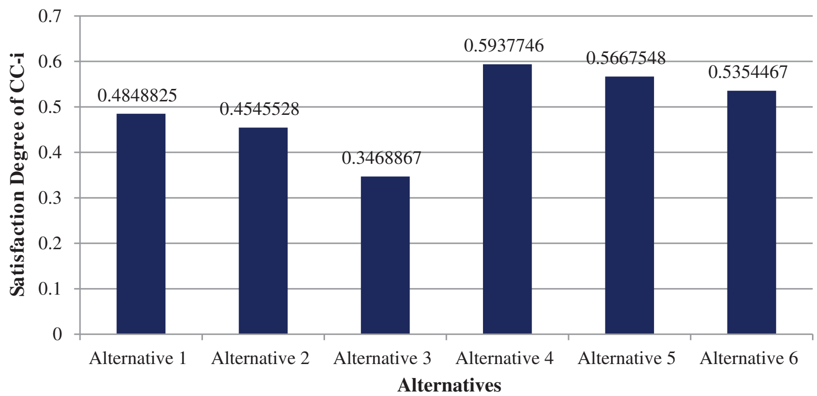

Figure 4: Graphical representation of satisfaction degree of different alternatives

3.4 Sensitivity Analysis

In this section we present the findings of sensitive analysis performed with the help of different experiments. Sensitive analysis is a significant approach used to analyses how the numbers of independent factors would affect a specific dependent factor under a certain set of expectations. Its application will be determined by one or many input parameters within the specified parameters. Any action or system can benefit from sensitivity analysis. Ultimately, the decision maker has a good notion of how sensitive his optimal solution is to variations in the input values of one or more variables. Tab. 15 and Fig. 5 shows the sensitivity analysis of the final results.

Table 15: Sensitivity analysis of the final results

Scenario	Weights/Alternatives		A1	A2	A3	A4	A5	A6
Exp-0	Original weights	Satisfaction degree (CC-i)	0.4848825	0.4545528	0.3468867	0.5937746	0.5667548	0.5354467
Exp-1	T11		0.4848451	0.4555414	0.3477854	0.5955865	0.5677854	0.5355625
Exp-2	T12		0.4841141	0.4665244	0.3466351	0.5546547	0.5665695	0.5345454
Exp-3	T21		0.4844417	0.4454154	0.3455624	0.5965241	0.5668547	0.5385858
Exp-4	T22		0.4854127	0.4663521	0.3455515	0.6025446	0.5665214	0.5458965
Exp-5	T23		0.4885474	0.4652541	0.3433254	0.5945545	0.5665236	0.5568598
Exp-6	T31		0.4847447	0.4555857	0.3485474	0.5938585	0.5652365	0.5354457
Exp-7	T32		0.4865325	0.4635241	0.3466358	0.5944547	0.5655258	0.5359658
Exp-8	T41		0.4874474	0.4545528	0.3488978	0.5945858	0.5652653	0.5358897
Exp-9	T42		0.4846321	0.4545528	0.3485476	0.5944747	0.5655647	0.5351122
Exp-10	T51		0.4845441	0.4454564	0.3466352	0.5965258	0.5667548	0.5354635
Exp-11	T52		0.4844471	0.4663632	0.3464457	0.5985474	0.5667252	0.5358547

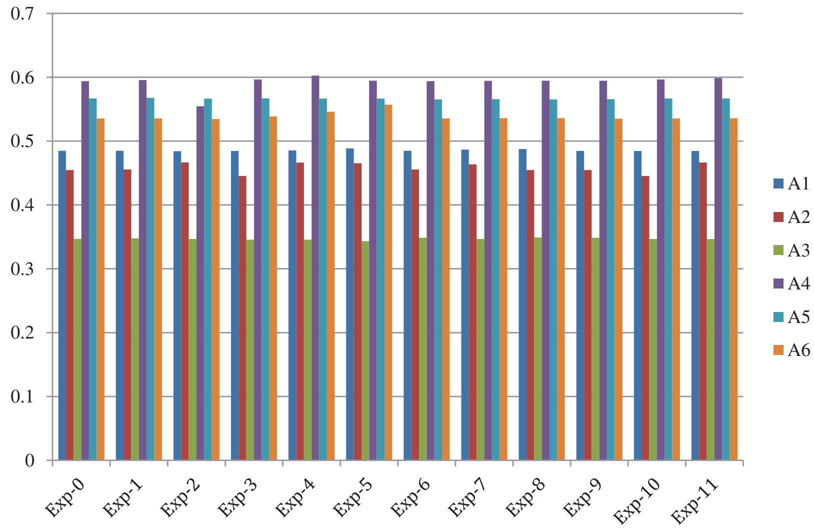

Figure 5: Graphical representation of sensitivity analysis

3.5 Comparative Analysis

Comparing the results of many alternative approaches and displaying the accuracy of the results is a regular process in multi criterion decision making. Models are frequently tested using cross-validation approaches and directly compared. Although straightforward, this strategy can be deceptive because it is difficult to determine if the difference in average performance ratings is true or the product of a statistical anomaly. Here we compare findings from Fuzzy-AHP-TOPSIS Method with findings of four other MCDM approach such as Fuzzy-ANP-TOPSIS Method, Fuzzy Weighted Average Method, Classical-AHP-TOPSIS Method, Classical-AHP-TOPSIS Method. The following Tab. 16 and Fig. 6 shows the comparison of the outcomes from different MCDM methodology.

Table 16: Comparison of the outcomes from different MCDM methodology

Methods/Alternatives	A1	A2	A3	A4	A5	A6
Fuzzy-AHP-TOPSIS method	0.4848825	0.4545528	0.3468867	0.5937746	0.5667548	0.5354467
Fuzzy-ANP-TOPSIS method	0.4854874	0.4652541	0.3433254	0.5945545	0.5665236	0.5356585
Fuzzy weighted average method	0.4865389	0.4555857	0.3485474	0.5938585	0.5652365	0.5359965
Classical-AHP-TOPSIS method	0.4885474	0.4635241	0.3466358	0.5944547	0.5655258	0.5361254
Classical-AHP-TOPSIS method	0.4869657	0.4545528	0.3488978	0.5945858	0.5652653	0.5353264

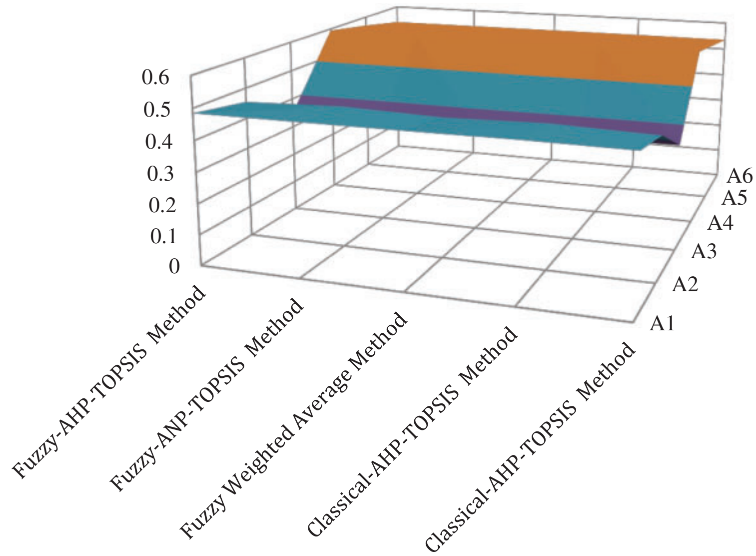

Figure 6: Graphical representation of different outcomes

4 Conclusion

We have demonstrated through the findings that in particular, the goals for effective network selection for the telecommunications organization are very consistent from one observer to another. This represents the presence of a group of standards which are considered to be crucial for the organization in choosing its network for assured functions. FAHP-TOPSIS has successfully captured this by consistently determining the effective access network which currently holds the better service, quality and capability. Although there are, areas in which the preferences provided the value of the determining factor have seemed to vary from the standard operation, causing in a failure of the FAHP-TOPSIS. Consequently, it should be assumed that the FAHP-TOPSIS is generally effective when implemented in the effective access network selection process. Although the drawback is that the experts whose viewpoint is being used as feedback must have an outstanding understanding or principles similar to those of the implementation of the smart for the evaluation process. Additionally, FAHP-TOPSIS may help as a significant method to provide feedback to an evaluation process that is supposed to conform with some kind of group of standards, because it is more impartial when associated to participants.

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