Published by
NIGERIAN SOCIETY OF PHYSICAL SCIENCES
Available online @ https://asr.nsps.org.ng/index.php/asr

African Scientific Reports 2 (2023) 115

African Scientific Reports

Multicriteria Decision Making for the Choice of the Global System for Mobile Telecommunication

Umaru Hassan[a,b,*], Mohd Tahir Ismail[a], Auwal Saleh Liman[c], Olayemi Joshua Ibidoja[a]

[a]School of Mathematical Science, Universiti Sains Malaysia, 11800 Pinang, Malaysia
[b]Department of Statistics, Federal Polytechnic Damaturu, Yobe, Nigeria
[c]Department of Statistics, Adamawa State Polytechnic, Nauman, Adamawa state, Nigeria

Abstract

When multiple conflicting criteria are available and must be considered, Multi-Criteria Decision Making (MCDM), a subfield of operations research, aids the decision maker in addressing the problem. The use of MCDM, a valuable and effective technique that may be applied in situations of certainty or uncertainty, makes it easier to integrate quantitative and qualitative assessments into scientific procedures. However, many Nigerians are found to retain more than one Subscriber Identity Module (SIM) in response to which of the network providers is best suited to meet their needs. This will help to minimize the number of SIM cards each person will carry, consequently reducing the cost of maintaining them. The aim of this study is to recognize and prioritize the most important mobile service provider criteria in the telecom industry in Borno State, Nigeria. Seven attributes were selected from the literature and customers. Questionnaires were systematically distributed, utilizing convenience and deliberate sampling, to 1200 customers. MTN and AIRTEL are the two most preferred service providers over the other operators within the competitive environment. It is advised that to increase their customer base, service providers in the research region enhance network connectivity, low call rates, and voice clarity.

DOI:10.46481/asr.2023.2.2.115

Keywords: Subscriber identity module, Service providers, Multiple attribute, Analytic hierarchy process

Article History :
Received: 22 April 2023
Received in revised form: 08 June 2023
Accepted for publication: 12 June 2023
Published: 24 July 2023

Communicated by: Tolulope Latunde

1. Introduction

Multi-Criteria Decision Making (MCDM) is a branch of operations research that helps the decision maker address issues when several competing criteria are present and need to be considered. It allows experts to choose the most

*Corresponding author tel. no: +234 80652903299
Email address: umaruh@rocketmail.com; umaruh@student.usm.my (Umaru Hassan)

ideal choice from a finite number of feasible choices [1, 2]. The Global System for Mobile (GSM) is a wireless system that mobile devices link to by looking for nearby cells. It enables simultaneous transmission of messages, sound, video, pictures, and other content from one cell phone to another via the radio. The GSM framework makes use of a Subscriber Identity Module (SIM) card. These cards hold all personal and contact information, making data transmission and phone activation as easy as switching out the SIM card.

At the time of writing this, the nation had four licensed GSM service providers. Mobile Telephone Networks Limited (MTN), Airtel (formerly Econet Wireless Nigeria Limited, then rebranded as V-Mobile and Celtel, and later Zain), Globacom Nigeria Limited (Glo), and Etisalat are the names of these companies.

The Nigerian telecom sector, consists of six players, including MTN, Globacom, Zain, Visafone, Etisalat, and M-Tel, as well as private telecom operations (PTOs) that mostly operate fixed wireless. But among these six GSM providers, the study considers the clients of the three giants (MTN, Globacom, and Zain), who have overseen the key shifts in the telecom industry during the last seven years [3]**.** Telecommunication products fall under the category of intangible services that are not concrete products, but their utility can be determined based on what the consumers feel. Service is an intangible task that satisfies the needs of consumers and is used by businesses [4]. The telecom operators must understand at every point in time what is called the 'customer service standard'. This is a statement of goals and acceptable performance for the quality of service that a firm expects. Customers will not want operators to fall below this standard, otherwise, they will jettison their service for another one that meets it [2].

All the service providers are highly focused on consumer fulfilment in providing services for good service delivery [5, 6]. Working on the evaluation of consumer satisfaction in this sector is therefore difficult. Subscribers who have an increasing need for the use of mobile telecom attributes are faced with a great deal of complexity, not only in deciding which network provider to settle with now that the market has implemented mobile number portability (MNP), which accords subscribers the opportunity to retain their known number rather than combining multiple SIMs. However, a significant number of Nigerians are found to be retaining more than one SIM in response to which of the network providers is best suited to meet their needs For any service provider to survive in the current turbulent business environment, the needs and wants of the consumers/customers must be identified, anticipating changes in their demands and satisfying their profitability [7].

One thousand two hundred questionnaires were distributed and administered. The components included were attributes of purchasers of mobile operator services that were considered most vital by customers in selecting their service brand. Seven attributes were included A pilot test poll was developed and administered. The analytical hierarchy process (AHP) is a theory of measurement for handling quantitative and intangible criteria that has found significant applications in decision theory, dispute resolution, and brain model development. It is founded on the idea that when making decisions, people's experience and knowledge are at least as important as the data they utilize.

The findings suggest that MTN and AIRTEL are the two most favored service providers over the other operators within the competitive environment. A significant number of respondents have more interest in factors such as calling cost, voice clarity, and network connection when it comes to choosing a mobile service provider.

In order to address the issue of selecting the best mobile service provider in the telecom sector in Borno State, Nigeria, this study provides information on the application of multi-criteria decision making (MCDM). According to the study, MCDM is a useful method that may incorporate quantitative and qualitative evaluations into scientific methods, assisting decision-makers when several competing criteria must be considered.

The major contributions of this study are:

1. To address the specific context of choosing a mobile service provider in Nigeria.

2. To utilize MCDM techniques.

3. To provide insights into the preferences and priorities of customers in Borno State, Nigeria.

The MCDM approaches are designed to help a decision-maker choose the most desirable variant from a huge pool of choices while considering a variety of variables that affect whether a certain decision variant is acceptable. The criterion can also rate the worth of the options when all are viable and selecting the best one is a matter of personal preference. Since different factors are frequently weighted differently for different decision-makers, subjectivity in this context refers to the relative importance attributed to distinct criteria.

By streamlining, rationalizing, and speeding up the decision-making process, MCDM techniques can help increase the quality of decisions [8]. The authors stated that, modern decision science and decision theory both recognize MCDM, which encompasses a wide range of choice criteria and multiple decision alternatives, as a crucial element. The ability of these sets to handle, modify, and transform verbally provided knowledge into mathematical modelling and come up with practical solutions to difficult real-world problems is their greatest strength. In addition, fuzzy sets and their expansions are effective mathematical models for resolving problems in the real world that cannot be resolved using standard mathematical techniques [9].

In general, multi-criteria decision-making challenges consist of five fundamental elements: expert preferences, the study's objective, the problem's options, the criteria at hand, and the study's findings [10]. Two or three categories can be used to group MCDM techniques.

2. Multi-Criteria Decision Making (MCDM) Techniques

2.1. Multiple Attribute Decision Making (MADM)

MADM models are intended to identify the most satisfactory alternatives or to rate alternatives based on how well they are relevant to the goal. Problems involving choosing from a limited number of accessible options are solved using this strategy. It outlines the steps that will be taken to process the attribute data to make the choice, requiring both intra- and between-attribute comparisons. Alternatives, attributes, the relative relevance of each attribute or alternative, and measures of performance on an alternative regarding an attribute are the four fundamental components of MADM techniques [11]. Simple additive weighting technique, weighted product method, analytical hierarchy process method, revised AHP method, multiplicative AHP method, TOPSIS method, modified TOPSIS method, and VIKOR method are the various types of multi-attribute choice methods (compromise ranking method). Multiple-objective decision-making (MODM) models are appropriate for assessing continuous options for which clients can predefine restrictions in the form of decision variable vectors (Ribeiro) [12].

2.2. Weight Determination

According to various decision-making processes, it is possible to identify the type of criterion weight. Decision-makers assign subjective weights depending on their skill, knowledge, and other characteristics. The assessment matrix, which is created using actual data about the estimation criteria of the alternatives, is calculated in a few steps to arrive at objective weights [13]. Different weighting techniques have been developed different fields in the literature to address various MCDM issues, including goal programming, the Analytic Hierarchy Process (AHP), VIKOR, and TOPSIS [14, 15].

2.3. The Analytic Hierarchy Process (AHP)

According to Saaty [16], the Analytic Hierarchy Process (AHP) technique was invented. The complex problem system is reduced to a simple modular system via the AHP approach. In the analysis, the eigenvalue is obtained as the starting point for assessing the consistency of the multiple comparisons carried out on the numerical scale and is used to indicate the priority ratio between the items in a hierarchy, and the eigenvector is used to do so. The eigenvector's representation of the priority order will serve as the foundation for choice or decision-making if the consistency requirements are satisfied [8]. The analytical hierarchy process (AHP), suggested in 1977, is currently one of the most widely used approaches in most MCDM procedures. Furthermore, AHP is complicated since the number of pairwise comparisons grows as quickly as the number of criteria. The VIKOR and TOPSIS procedures are other frequently employed techniques. Pairwise comparisons between attributes are made while considering each criterion separately to handle the challenge of ranking alternatives from best to worst. The decision maker may nevertheless take the chance of favoring one choice over the other despite the outranking connection [17].

In multi-criteria evaluation, weights are allocated to criteria based on both qualitative and quantitative data to ensure that the weight is considered for more effective and precise decision-making. To overcome this limitation, [18] suggested a numerical scale of 1- 9 that classified "1" as equivalent worth and "9" as excessive importance to translate qualitative information into quantitative. Three categories can also be used to classify weights: weighting techniques that are subjective, objective, integrated, or a combination of these [7].

Table 1. GSM operator's attributes point allocation techniques

Attributes	**Weight Criteria**
Calling Cost	35
Network Coverages	10
Internet Connectivity	15
Free Call Time & SMS	15
Money transfer	25

Expert judgement serves as the foundation for subjective weight assessment, and to obtain these opinions, analysts typically ask the decision-makers a series of questions. However, determining the subjective criteria weights might take a while, particularly when there is disagreement among the decision-makers regarding the issue at hand. The subjectivity of multiple criteria decision analysis was explained [19]. He thought that as judgement is the foundation of human judgement, it must be subjective. The analytical hierarchy analysis is an illustration of a subjective weighting strategy (AHP). To decide objectively, one just has to have the decision support viewpoint. When selecting the best alternative in cases of multiple-criteria decision-making, decision-makers ought to adhere to the rationality principle, which calls for evaluating a constrained number of independent or interdependent factors [13].

2.3.1. The Point Assigning Techniques

One of the simplest methods for figuring out criteria weights is to give each criterion a specific number of points and weigh them according to their importance. The decision-maker in this situation must allocate 100 points among the pertinent factors. The sum of the weights for each condition must be 100. This method is easy to standardize. The weights produced by the point allocation strategy are not very accurate, and the procedure becomes increasingly difficult as the number of criteria increases to six or more. Table 1 shows the five essential GSM operator qualities as an illustration.

2.3.2. Direct Rating

This sort of technique has the decision-maker order the criteria entirely in terms of priority. Unlike fixed-point scoring techniques, the rating does not limit the decision maker's options. One criterion's relevance can be changed without affecting the importance of another [20].

2.3.3. Pair-wise Comparisons

These are used to compare different populations to see if there are any significant differences between them. It may alternatively be described as a process where the decision-maker assesses all the criteria in relation to each other and calculates the relative weights of each pair. To make it easier to compare one criterion's preference value to another, an ordinal scale (1–9) is used. The Analytical Hierarchy Process (AHP) method is one of the most often used pairwise comparison methodologies. You can choose how many comparisons to make using Equation (1).

$$cp = \frac{n\,(n-1)}{2}, \tag{1}$$

where n is the number of criteria and cp is the number of comparisons. The following are the three basic processes that make up the pairwise comparison approach for determining the criteria weights. To create a matrix, the criteria listed in Step II of the AHP model's steps must first be compared. The matrix is filled using the intensity values (1, 3, 5, 7, 9), which, in turn, stand for equal significance, moderate relevance of one over the other, high importance, very strong relevance, and extreme relevance, respectively. The ordinal scale of 2, 4, 6, and 8 may be translated as follows when a compromise is necessary: equally to slightly preferred - 2, highly to strongly preferred - 4, strongly to very strongly preferred - 6, and very strongly to extremely strongly desired. When attempting to determine the best weighting scheme from the results, the literature demonstrates that subjective weighting methods are simpler and more straightforward in terms of computation than objective weighting techniques, which use mathematical functions to choose the weights without input from the decision-maker [7].

2.4. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

Another well-known MCDM technique that assesses the performance of alternatives based on their distance from the ideal solution is TOPSIS, which was first created by [21]. The favored option must be closest to both the positive ideal solution and the negative ideal solution and be farthest from both. Six major stages for applying TOPSIS were suggested by [21]. A decision matrix is created and normalized first. The construction of a weighted normalized decision matrix follows. The optimal solutions, both positive and negative, are then identified. The separation measures for every alternative are then computed in step four. The relative proximity to the optimal solution is calculated in step five. The alternatives are then evaluated from best to worst based on how closely they resemble the ideal option [11]. This gives a helpful understanding of TOPSIS techniques and applications. The outline of its advancements was presented in Ref. [22].

This method states that the optimal alternative is that which is farthest from the negative ideal solution and closest to the positive ideal solution. The most desirable choice should have the greatest distance from the negative ideal solution as well as the smallest distance from the positive ideal solution, according to the TOPSIS approach's main tenet [22]. To gauge how close the alternatives are to the ideal answer, the Euclidean distance approach was devised. As a result, a sequence of assessments of these relative distances can be used to determine the preferred order of the options. To create non-dimensional criteria, the TOPSIS method initially converts the multiple criteria dimensions. According to the principle of insufficient reason, every criterion should have equal weight in decision-making. when the designer cannot think of a good reason to favor one over another. However, Sivarajah *et al.* [23] suggested several changes to TOPSIS.

2.5. VlseKriterijuska Optimizacija I Komoromisno Resenje (VIKOR)

The ranking and choice problems were the original targets of the initial proposal of the VIKOR technique. The goal of the VIKOR technique is to choose the best alternative, or a compromise option, among realistic alternatives by comparing how closely they come to the ideal solution while considering competing criteria. The option that is closest to the perfect answer is compromise. A thorough explanation of the approach applied to the VIKOR procedures was given [24]. The VIKOR has been compared to various methodologies in other investigations. Such comparisons were made between VIKOR and TOPSIS, TOPSIS, ELECTRE, and PROMETHEE [24]. With this approach, you rank and choose from a range of options to find the compromise answer that comes the closest to the ideal one. (VIKOR), which translates to "multi-criteria optimization and compromise solution," is a decision-making process that is presented for material selection [25].

3. Methodology

3.1. Analytical Hierarchy Process (AHP) Model

According to Saati [16], the analytical hierarchy process (AHP) offers a methodical way to blend logic, experience or knowledge, emotion, and a sense of optimization into a decision-making approach. This method simplifies a multi-criteria complex problem into a hierarchy structure. Using this method, a complex issue can be broken down into manageable chunks and then organized into a hierarchy to give the issue a more organized, systematic appearance [26].

The AHP approach is divided into four major steps [18]. The model is first organized into a hierarchy; then, using pairwise comparisons, the criteria, sub-criteria, and alternatives are compared in terms of their relative importance; next, the pairwise comparison results are summarized in an evaluation matrix; and finally, the normalized evaluation matrix is used to synthesize the order of preferences for the alternatives [26].

1. Build a hierarchical structure. Classify the factors involved in the problem and construct a hierarchical structure of the interconnections between the factors. A typical hierarchical structure is shown in Figure 1.

2. Calculate the weight of each single-level model.

3. Calculate the combined weight of each level element.

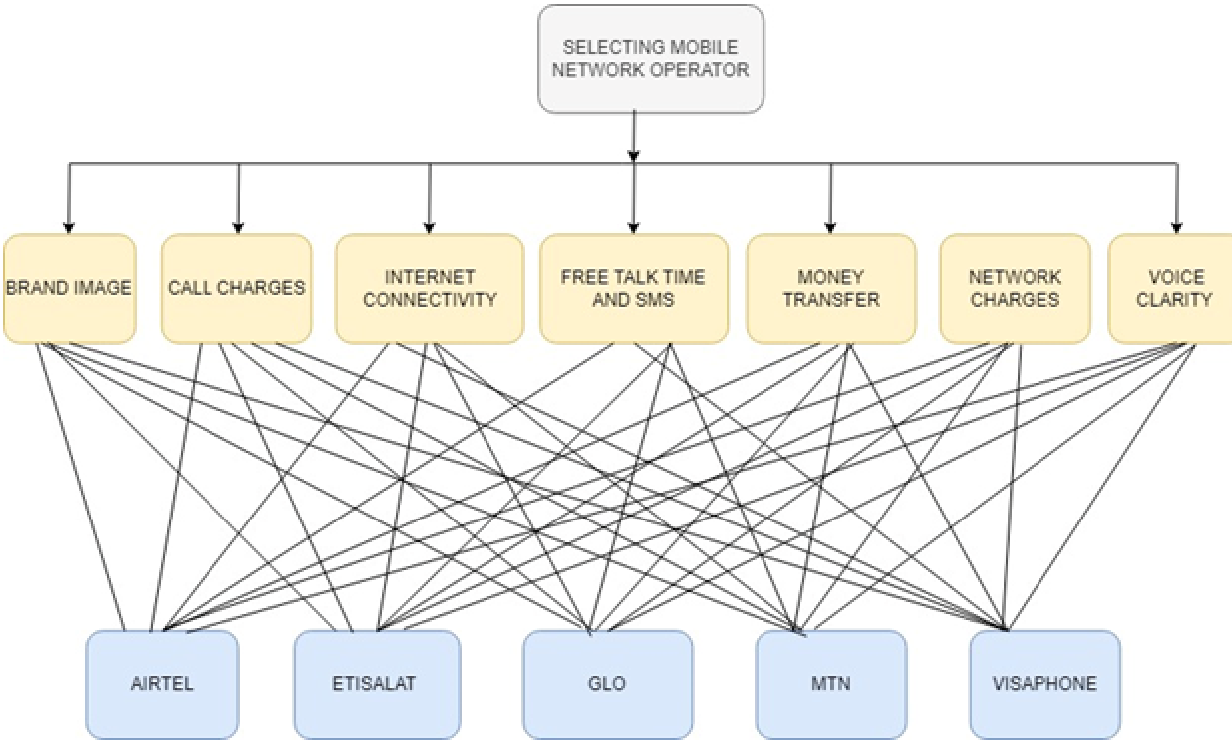

Figure 1. The AHP model for this study

4. Evaluate the overall ranking of the hierarchy and calculate the consistency of the results. There are two main AHP consistency tests, the first one is the consistency index (CI) test, and the second is the consistency ratio (CR) test.

$$CI = \frac{(\lambda_{\max} - n)}{n - 1}, \tag{2}$$

where the consistency is improved, and the CI value decreases as the value of λ_{max} gets near to n.

$$CR = \frac{CI}{RI}, \tag{3}$$

where RI is a consistency and random index that randomly generates a reciprocal matrix and is affected by the order. When the order n is larger, the value increases [18]. It says that when the value of the consistency ratio (CR) is equal to or less than 0.1, the consistency of this matrix is acceptable. The AHP model for this study is shown in Figure 1.

3.2. Comparative Judgment Phase

In the comparative judgment phase, a comparison matrix at each level is constructed based on the user's preference based on the numerical rating of the pair - wise comparison. In this phase, the AHP questionnaire was assigned in accordance with the analytic hierarchy structure. All criteria and alternatives were compared pair - wise extracting a numerical scale from 1 (equally important) to a (very important) rating to obtain their relative importance to the problem. If there are n decision criteria or decision alternatives, then there will be $0.5n(n-1)$ pair wise comparison

Table 2. Random indices

N	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Table 3. AHP 1-9 scale

Intensity of importance	**Definition**
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Compromises between the above

in square matrices. A pair - wise comparison matrix X, for n decision criteria is in the form:

$$X = \begin{bmatrix} 1 & X_{12} & X_{13}\ldots & X_{1n} \\ 1/X_{12} & 1 & X_{23}\ldots & X_{2n} \\ 1/X_{13} & 1/X_{23} & 1\ldots & X_{3n} \\ 1 & 1 & 1\ldots & 1 \\ 1 & 1 & 1\ldots & 1 \\ 1/X_{1n} & 1/X_{2n} & 1/X_{3n}\ldots & 1 \end{bmatrix}. \quad (4)$$

A pair wise comparison matrix for decision alternatives with respect to each of the criteria uses the same form as the matrix above as shown in Equation (4).

The right principal eigenvectors are estimated corresponding to the maximal eigenvalue λ_{max} of the pair wise comparison. The resulting composite weights produce a relative ranking of the alternatives with top rank indicate an optimal alternative. With λ_{max} being the maximal eigenvalue and the standard RI value are those calculated by [16] as shown below in Table 2.

In this study, seven criteria were selected from the literature and customers. Questionnaires were systematically distributed, utilizing convenience and deliberate sampling to 1200 customers of these mobile service providers who self-completed questionnaires. From the questionnaires distributed, only 1107 were duly completed and considered valid for the analysis. This represents 92%, which is considered extremely good in view of time, cost, and certainty. Even though the sampling methods adopted are convenient and deliberate sampling, which contains some limitations in terms of generality as compared to other probability sampling methods, the analytical hierarchy process and VIKOS were applied. Components included were attributes of purchasers of mobile operator services that were considered most vital by customers in selecting their service brand. A pilot test poll was developed and administered.

For data collection and empirical analysis, a questionnaire has been developed using the AHP 1- 9 scale. For simplicity and reliability, data collection is being made on face-to-face interview with the respondents. The following AHP as shown in Table 3 is used in the study.

3.3. Model Development

Three stages are used in the data hierarchy in the AHP paradigm. The study objectives are presented in the first step, ranking criteria are presented in the second stage, and an alternative to empirical analysis is presented in the third stage. Five network operators are being evaluated using seven criteria. Below is a summary of the AHP model's steps, as shown in Table 4.

where $X = (x_{ij})$, $x_{ij} > 0$ and

Step IV. Using the matrices as a starting point, the normalization technique calculated the weights of the criterion and the local weights of the alternatives.

The following equations determine the criterion and local weight of the alternatives:

Table 4. AHP Steps

AHP model's steps		
Step I	Goal	Choice mobile network operator
Step II	Criteria	Brand image, Call Charges, money transfer, Internet Connectivity, Free talk time/SMS, Voice Clarity.
Step III	Alternatives	Airtel, Etisalat, Glo, MTN, Vodafone.

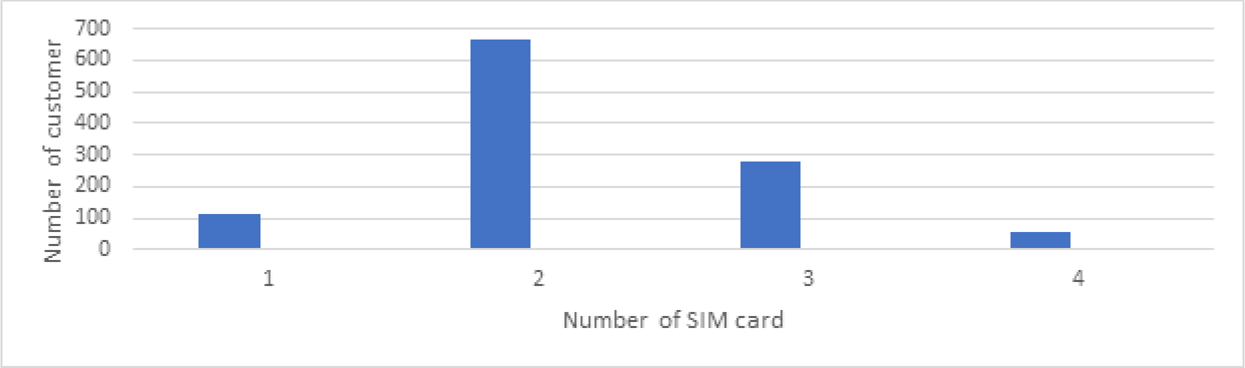

Figure 2. Distribution of Customers to Service Provider

Average sum of the normalized weights of each row is given in Equation (5).

$$\varpi_i = \frac{x_{ij}}{n}, i = 1, 2, ..., n. \quad (5)$$

Step V: Synthesizing the local weights to produce the global weights of the alternatives.

$$B \times V = \begin{bmatrix} b_{11} & b_{12} & ... & b_{1n} \\ b_{21} & b_{22} & ... & b_{2n} \\ ... & ... & ... & ... \\ ... & ... & ... & ... \\ b_{n1} & b_{n2} & ... & b_{nn} \end{bmatrix} \times \begin{bmatrix} v_1 \\ v_2 \\ ... \\ ... \\ v_n \end{bmatrix}. \quad (6)$$

The local weights of the options are represented by Matrix B, where each column denotes the local weight for each criterion. The local weight of the criteria is transposed as represented by the V matrix. Multiplying the matrices B and Vyields the global weight. The Statistical Package for Social Science (SPSS) software is used to assess data consistency after the data analysis, which was done using a Microsoft Excel spreadsheet.

4. Results and Discussion

Using the AHP technique, the first stage of a pair-wise comparison is done based on the customer's priorities.Pair-wise comparisons of the criteria with respect to the goal and pair-wise comparisons of the alternatives with respect to the criteria were conducted, and the summary of the results is presented in the tables. Figure 2 displays a chart of the number of customers and GSM operators to which they are subscribed in the study area. it's clear that customers are not satisfied with a single GSM.

Based on the importance of one alternative over the others, scores are being computed and weights are being determined, which gives the bases for ranking as indicated in Table 5. Similar pair-wise matrices have been made for the other service operators. Call charges are in the best interests of Airtel customers, followed by free calls and SMSs over other choices.

Table 5. Normalized pairwise matrix table of attributes (Airtel)

Attributes	Call Charges	Internet Connectivity	Network Coverage	Money Transfer	Free calls/SMS	Voice Clarity	Brand image	Weight	Rank
Call Charges	0.321	1.133	0.495	0.182	0.225	0.402	0.327	0.461	1
Internet Connectivity	0.107	0.162	0.330	0.255	0.160	0.067	0.182	0.193	4
Network Coverage	0.046	0.081	0.165	0.109	0.160	0.402	0.327	0.208	3
Money Transfer	0.064	0.023	0.055	0.036	0.005	0.027	0.327	0.079	6
Free calls/SMS	0.046	0.032	0.033	0.218	0.032	1.207	0.255	0.296	2
Voice Clarity	0.107	0.324	0.055	0.182	0.004	0.134	0.182	0.147	5
Brand image	0.036	0.032	0.033	0.004	0.005	0.027	0.036	0.023	7

!t

Table 6. Consistency Index Table

w/sum	Weight/(w/sum)
3.690845	8.011572
1.517735	7.880985
1.557449	7.505357
0.554707	7.023444
2.160632	7.292977
1.112459	7.584224
0.193884	8.480543
λ_{max}	7.682729

$lambda_{max}$ = 7.683, *CR = 0.086 < 0.1*

Table 7. Showing the GSM operators with their respective weights and ranking preference

GSM	Airtel	Etisatat	Glo	MTN	Visafone	weight	Rank
Airtel	0.292	0.432	0.425	0.256	0.333	0.348	2
Etisatat	0.058	0.086	0.189	0.102	0.111	0.109	3
Glo	0.032	0.022	0.047	0.073	0.185	0.072	4
MTN	0.584	0.432	0.330	0.512	0.333	0.438	1
Visafone	0.032	0.029	0.009	0.057	0.037	0.033	5

Table 6 shows the summary of the consistency index. Since the consistency ratio is less the 0.1 means we are taking the best weights of less than 10%.

From Table 7, MTN is most preferred by customers over other service providers in the GSM industry, with a weight of 0.438. This means that customers can buy a SIM card for MTN alone to achieve service satisfaction instead of using more than one SIM card. Table 6 shows that respondents preferred the MTN network to other network operators by 43.8%. Followed by Airtel with 34.8%, closely followed by Etisalat with 10.9% then Glo, and Visafone with 7.2%and 3.3% respectively.

In Table 8, it shows the set of alternatives on the left-hand side after comparing within themselves, while at the top we have the set of service providers to determine the ranking based on the service provider's choice by the customers. Since the overall importance or weight of the alternatives in relation to the GSM operators was computed. Call charges are most preferred, followed by voice clarity, with weights of 0.348 and 0.203, respectively, as the attributes most likely to interest customers.

Table 8. Table of overall score

	GSM									
Attributes	Airtel	Etisatat	Glo	MTN	Visafone		Weight			Rank
Call Charges	0.461	0.527	0.149	0.245	0.217		0.348		0.343	1
Internet Connectivity	0.193	0.217	0.292	0.186	0.207		0.109		0.176	3
Network Coverage	0.208	0.223	0.178	0.185	0.158	×	0.072	=	0.171	4
Money Transfer	0.079	0.079	0.037	0.038	0.059		0.438		0.033	6
Free calls/SMS	0.296	0.309	0.069	0.067	0.068		0.033		0.104	5
Voice Clarity	0.147	0.159	0.260	0.263	0.266				0.203	2
Brand image	0.023	0.027	0.016	0.017	0.024				0.020	7

Priority matrix × weight overall score

5. Conclusions

The findings make it quite evident that the three variables ‘calling cost, voice clarity, and network connection’ are most important to customers in deciding their choice of service provider. It is also found that a significant number of respondents have less interest in other factors. MTN and AIRTEL are the two most favored service providers over the other operators within the competitive environment. It is advised that to increase their customer base, service providers in the research region enhance network connectivity, low call rates, and voice clarity. For further research, the AHP method may be applied to classify mobile phone options.

References

[1] J. A. Adebisi & O. M. Babatunde, “Green Information and Communication Technologies Implementation in Textile Industry Using Multicriteria Method”, Journal of the Nigerian Society of Physical Sciences **4** (2022) 165. https://doi.org/10.46481/jnsps.2022.518

[2] K. Ajilore & B. O. Rasheed, “GSM Operators’ Unsolicited Promotional SMS and the Attitude of Undergraduates in Select Universities in South-West Nigeria”, (2020).

[3] S. Adebisi & A. S. Abayomi, “GSM Marketing Service Providers Operations and Customers Satisfaction in Nigeria: An Empirical Investigation Articles View project Knowledge Management as Strategic Tool for Performance of Selected Global System for Mobile Telecommunication (GSM) Firms in Nigeria View project GSM Marketing Service Providers Operations and Customers Satisfaction in Nigeria: An Empirical Investigation”, (2017).

[4] A. Victor, S. Oyebola & V. Mojisola, “Service Quality Delivery and Assessment of Customers’ Satisfactions in Nigerian Health Care Industry”, (2018).

[5] A. S. Oladimeji & O. J. Ibidoja, “The Distribution of Service Time of Patients”, Journal of Reliability and Statistical Studies **13** (2020) 61. https://doi.org/10.13052/jrss0974-8024.1313.

[6] U. M. Aliyu, K. B. G. Bello Gamagiwa, O. Ibidoja, & M. Garba, “Application of Queuing Theory in a University Clinic”, International Journal of Science for Global Sustainability **8** (2022) 9. https://doi.org/10.57233/ijsgs.v8i1.338

[7] G. O. Odu, “Weighting methods for multi-criteria decision making technique”, Journal of Applied Sciences and Environmental Management **23** (2019) 1449. https://doi.org/10.4314/jasem.v23i8.7

[8] I. Daniyan, K. Mpofu & B. Ramatsetse, “The use of Analytical Hierarchy Process (AHP) decision model for materials and assembly method selection during railcar development”, Cogent Eng **7** (2020) 1833433. https://doi.org/10.1080/23311916.2020.1833433

[9] M. Riaz, N. Çagman, N. Wali & A. Mushtaq, “Certain properties of soft multi-set topology with applications in multi-criteria decision making”, Decision Making: Applications in Management and Engineering **3** (2020) 70. https://doi.org/10.31181/dmame2003070r

[10] W. Ma, Y. Du, X. Liu & Y. Shen, “Literature review: Multi-criteria decision-making method application for sustainable deep-sea mining transport plans”, Ecological Indicators **140** (2022) 109049. https://doi.org/10.1016/j.ecolind.2022.109049

[11] P. P. Mohanty, S. S. Mahapatra, A. Mohanty & Sthitapragyan, “A novel multi-attribute decision making approach for selection of appropriate product conforming ergonomic considerations”, Operations Research Perspectives **5** (2018) 82. https://doi.org/10.1016/j.orp.2018.01.004

[12] M. Shao, Z. Han, J. Sun, C. Xiao, S. Zhang & Y. Zhao, “A review of multi-criteria decision making applications for renewable energy site selection”, Renewable Energy **157** (2020) 377. https://doi.org/10.1016/j.renene.2020.04.137

[13] C. H. Chen, “A novel multi-criteria decision-making model for building material supplier selection based on entropy-AHP weighted TOPSIS”, Entropy **22** (2020) 259. https://doi.org/10.3390/e22020259

[14] O. J. Ibidoja, F. P. Shan, J. Sulaiman & M. K. M. Ali, “Robust M-Estimators and Machine Learning Algorithms for Improving the Predictive Accuracy of Seaweed Contaminated Big Data”, J. Nig. Soc. Phys. Sci **5** (2022) 1137. https://doi.org/10.46481/jnsps.2022.1137

[15] E. Abel, L. Mikhailov & J. Keane, “Inconsistency reduction in decision making via multi-objective optimisation”, Eur J Oper Res. **267** (2018) 212. https://doi.org/10.1016/j.ejor.2017.11.044

[16] T. L. Saaty, “A Scaling Method for Priorities in Hierarchical Structures”, Journal of Mathematical Psychology **15** (1977) 234.

[17] A. Ishizaka, *Analytic Hierarchy Process and Its Extensions*, In: Doumpos, M., Figueira, J., Greco, S., Zopounidis, C. (eds) New Perspectives in Multiple Criteria Decision Making. Multiple Criteria Decision Making. Springer, Cham. (2019). https://doi.org/10.1007/978-3-030-11482-4_2

[18] R. W. Saaty, "The Analytic Hierarchy Process-What it is and how it is used", Mathematical Modelling **9** (1987) 161.

[19] A. Toloie-Eshlaghy, M. Homayonfar, M. Aghaziarati & P. Arbabiun, "A Subjective Weighting Method Based on Group Decision Making for Ranking and Measuring Criteria Values", Aust J Basic Appl Sci. **5** (2011) 2034.

[20] E. Abel, L. Mikhailov & J. Keane, "Inconsistency reduction in decision making via multi-objective optimisation", Eur J Oper Res. **267** (2018) 212. https://doi.org/10.1016/j.ejor.2017.11.044

[21] C.-L. Hwang & K. Yoon, *Multiple Attribute Decision Making*, in Lecture Notes in Economics and Mathematical Systems, Springer Berlin Heidelberg **186** (1981). https://doi.org/10.1007/978-3-642-48318-9

[22] X. Liu & L. Wang, "An extension approach of TOPSIS method with OWAD operator for multiple criteria decision-making", Granular Computing **5** (2020) 135. https://doi.org/10.1007/s41066-018-0131-4

[23] U. Sivarajah, M. M. Kamal, Z. Irani & V. Weerakkody, "Critical analysis of Big Data challenges and analytical methods", J Bus Res. **70** (2017) 263. https://doi.org/10.1016/j.jbusres.2016.08.001

[24] M. K. Sayadi, M. Heydari & K. Shahanaghi, "Extension of VIKOR method for decision making problem with interval numbers", Appl Math Model. **33** (2009) 2257. https:/doi.org/10.1016/j.apm.2008.06.002

[25] S. Chakraborty & P. Chatterjee, "Selection of materials using multi-criteria decision-making methods with minimum data", Decision Science Letters **2** (2013) 135. https://doi.org/10.5267/j.dsl.2013.03.005

[26] F. Sitorus, J. J. Cilliers & P. R. Brito-Parada, "Multi-criteria decision making for the choice problem in mining and mineral processing: Applications and trends", Expert Systems with Applications **121** (2019) 393. https://doi.org/10.1016/j.eswa.2018.12.001