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Parents Preference for Students' Choice of Urban Schools in Benin City, Nigeria: Integrated AHP Intuitionistic Fuzzy Topsis

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Abstract

The paper examines the attributes considered by parents for school choice enrolment for their children and wards. Four classes of school alternatives with twelve attributes were considered in this work. A survey was randomly carried out in the three Local government areas in Benin City. The Analytical Hierarchy Process (AHP) was adopted in evaluating the attributes, while intuitionistic fuzzy TOPSIS (Technique for Order Preference by Similarity to the Ideal Solution) was applied in the ranking of the alternatives. In adopting the method two metric functions were used with both producing same result indicating consistency and correctness of results. The Missionary schools (A4) is the most preferred of the 4 alternative schools, closely followed by private schools for middle class (A2) as second best preferred and the premier private schools for the elite (A3) is third best preferred. While, the Public (government) schools (A1) is bracing the rear as least preferred of all the 4 alternatives. It is concluded that adopting scientific approach to humanistic system is appropriate and produces accuracy in results.

Key word: School choice, intuitionistic fuzzy TOPSIS and attributes.

Introduction

In today's competitive environment, the quest for knowledge for useful living and contribution to national development has risen not only in Nigeria, but globally. As a result, parents have taken the education of their children and wards seriously. Even when governments (local, state and federal) appear not to be serious with the educational development of the citizenry by not providing the necessary infrastructural equipment for teaching and learning, parent of students in Nigeria's urban schools are undaunted. Parents go all lengths to find a school of their choice for their children. The indifferent attitudes of successive governments have made majority of urban parents especially those that have the means to prefer the private schools to public (government) schools in Benin City. This leaves the children of the poor with the choice of public schools as their only affordable option especially at the primary and secondary levels. This paper identifies 12 attributes for parents' preference choice of urban schools for their children and wards in Benin City as follows:

- Cost/school fees (B1)
- Quality of Teaching and Learning (B2)
- Effective supervision of teachers (B3)
- Accessibility and Location (B4)
- Qualification of teachers (B5)
- Experience (B6)
- Proximity (B7)
- Quality of product (B8)
- School environment (B9)
- Professionalism (B10)
- Materials for teaching and learning (B11)
- Management/administration (B12).

An important issue in the school choice problem is the fact that it is almost impossible to find a school that excels in all the possible attributes (criteria) identified by the parents or decision makers. The scores for all schools on these attributes are not the same. Nevertheless, one must select a specific school from the available ones. This is the school choice selection problem (Omorogbe and Aibieyi, 2014).

The school choice selection problem is a multi-criteria decision making (MCDM) problem. Many methods and techniques have been proposed in literature in solving MCDM problems (Omosigho and Omorogbe, 2015, Ho et. al, 2010). In this paper we adopted the integrated Analytical Hierarchy process (AHP) and intuitionistic fuzzy TOPSIS method to address parents' preference for students' choice of urban schools in Benin City due to its amenability and applicability to humanistic systems and relevance to all practical human decision process and operations such as education, management, medicine. psychology, law, engineering, social and pure sciences. The AHP (Saaty, 1990, 2008) was used for evaluating the attributes while TOPSIS (Wu and Liu 2011 and Ashrafzadel et al 2012) was used in the ordering or ranking of the alternatives in intuitionistic fuzzy environment using more than one metric functions as proposed in Omosigho and Omorogbe (2015). This method of using more than one metric functions (Omosigho and Omorogbe, 2015) is to bring about accuracy and effective ranking of alternatives. By so doing, eliminating error in the ordering process. In this paper we considered four classes of school alternatives in Benin City, namely:

- Public (government) schools. (A1)
- Private schools for middle class (A2)
- Premier private schools for elite (A3)
- Missionary schools (A4)

The rest part of this paper is arranged as follow: section 2 presents integrated AHP intuitionistic fuzzy TOPSIS. methodology adopted in the study is in section 3. Section 4 is application of integrated intuitionistic fuzzy TOPSIS to supplier selection in the school system. our conclusion is in section 5.

Analytical Hierarchy Process

The analytical hierarchy process (AHP) was first developed by Saaty in 1980. Hudymacova et al, 2010). AHP is a widely used multi-criteria decision making method which is based on the decomposition of a complex decision problem into several smaller and easier to handle sub-problems (Saaty, 1990, 2008). Since its introduction, the AHP has become one of the most widely used multi-criteria decision making (MCDM) methods in different areas of human endeavour, such as political, military, economic, industries, social, education, administration and management sciences.

In AHP a problem is structured as a hierarchy. Once the hierarchy has been constructed the decision makers begin prioritization procedure to determine the relative importance of the elements in each level. Prioritization involves eliciting judgments in response to questions about the dominance of one element over another with respect to a property. The scale used for comparisons in AHP enable DMs (Decision Makers) to indicate how many times an element dominates another with respect to the particular attribute or criterion (Saaty, 1990, 2008).

The DMs or parents as the case in this study can express their preference between pairs of element verbally as equally important, moderately important, strongly important, very strongly important, extremely important. These descriptive preferences would then be translated into numerical values 1,3,5,7,9 respectively with 2.4,6 and 8 as intermediate or compromise values for comparison between two successive judgments. Reciprocals of these values are used for the corresponding transposed judgment. For details, see (Saaty, 2008, 1990, Chakraborty et al, 2011).

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

According to Wu and Liu (2011), the TOPSIS method was developed in 1981 by Huang and Yoon. The method is based on the assumption that the chosen alternative should have the longest distance from the negative ideal solution and shortest distance to the positive ideal solution. The Negative Ideal Solution (NIS) is the solution that maximizes the cost factor and minimizes the benefit factors. While the Positive Ideal Solution (PIS) is the solution that minimizes the cost factor and maximizes the benefit factors. An essential point of this method is that the ranking and weighting of the factors or attributes are known. If these are not known, TOPSIS method is not implementable. Some of the authors that applied the TOPSIS method are Wu and Liu (2011), Elanchezhian et al (2010), Ashrafzadel et al (2012), Kabir (2012).

The steps for TOPSIS for MCDM problems as used by (Boran et al, 2009, Wen et al, 2013) are stated below:

Step 1. Determine the most important criteria.
Step 2. Determine the weights of decision makers
Step 3. Construct the aggregated decision matrix.
Step 4. Determine the weights of criteria
Step 5. Determine the weighted decision matrix.
Step 6. Determine the positive ideal solution (PIS) and negative ideal solution (NIS).
Step 7. Construct the separation measures (distance from PIS and distance from NIS) for each alternative.
Step 8. Calculate the closeness coefficient for each supplier using the results obtained in step 7.

Step *9.* Rank the alternatives supplier using the closeness coefficients. For details see (Wu and Liu, 2011, Ashrafzadel et al, 2012, Kabir 2012, Boran et al, 2009, Wen et al, 2013).

Methodology

This paper addressed the school choice selection problem among parents of school age children in Benin City using integrated AHP-intuitionistic fuzzy TOPSIS. A random sample survey of 50 parents from each of the 3 local government areas in Benin City, namely Oredo, Egor and Ikpoba-Okha local government areas was carried out. The delphi questionnaires method was used in the survey, a total of 150 aforementioned questionnaires were given to respondents and 144 were returned. The data from the survey were analysed using Saaty (1990) AHP procedures. The results were used as weights of the 12 identified criteria used in this paper (Table 1.1) Another set of 150 questionnaires for rating the alternatives (schools) were also given to the same respondents the data obtained were transformed into intuitionistic fuzzy numbers using tables (1), (2) and (3) in Boran et al (2009). Such that $\mu_A(u_i) + v_A(u_i) + \tau_A(u_i) = 1$ where $\mu_A(u_{i,})$, $v_A(u_{i,})$ and $\tau_A(u_{i,})$ are membership, non-membership and hesitation functions or degrees. This gives the final decision matrix in Table 1.3. The Euclidean and Hamming distances (Yang and Chiclana, 2009) were adopted in the calculation of the closeness coefficient for each alternative schools were obtained using eq. (1) and (2) for Euclidean and Hamming respectively. The closeness coefficient is used for the ranking of alternatives. Omosigho and Omorogbe (2015) proposed the use of more than one distance functions for empirical MCDM problem for effective evaluation and selection of alternatives. This paper adopted Omosigho and Omorogbe (2015) in the evaluation and ranking of the of parents' preference of school choice for their children/wards respectively. The closeness coefficients of the Hamming and Euclidean metric functions are computed using equations (1) and (2).

$$\frac{E^-}{E^- + E^+}, \qquad (1)$$

$$\frac{H^-}{H^- + H^+}, \qquad (2)$$

Where H^- and H^+ are separation measures or distances from the negative ideal solution (NIS) and positive ideal solution (PIS) respectively. The PIS is the solution that gives the best rating of the attributes and the NIS is the solution that gives the worst rating of the attributes (Tzeng and Huang, 2011, and Omosigho and Omorogbe, 2015).

This is because the PIS minimizes the cost attribute and maximizes the benefit attributes, while the NIS maximizes the cost criteria and minimizes the benefit criteria. In this paper, B1 is the only cost criterion while the other attributes B2, B3, ..., B12 are benefit attributes or criteria.

The results obtained from rating of the criteria using AHP are given in Table 1.1.:

Results

Table 1.1: evaluation of criteria using AHP method

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	NPW
B1	1/1	1/3	1/2	1/2	3/1	2/3	4/1	2/1	1/2	1/2	1/3	5/1	0.0753
B2	3/1	1/1	3/2	4/3	6/1	2/1	2/1	3/1	2/1	2/1	7/1	9/1	0.1785
B3	2/1	2/3	1/1	2/1	3/1	2/1	2/1	2/1	1/3	2/1	4/1	5/1	0.1250
B4	1/2	3/4	1/2	1/1	2/1	2/1	3/1	2/1	1/3	2/1	3/1	4/1	0.0963
B5	1/3	1/6	1/3	1/2	1/1	1/2	2/1	1/3	1/2	1/2	2/1	3/1	0.0491
B6	3/2	1/2	1/2	1/2	2/1	1/1	2/1	2/3	3/1	2/1	3/1	4/1	0.0975
B7	1/4	1/2	1/2	1/3	1/2	1/2	1/1	1/3	1/2	1/2	1/3	3/1	0.0431
B8	1/2	1/3	2/1	1/2	3/1	3/2	3/1	1/1	2/1	2/1	4/1	5/1	0.1123
B9	2/1	1/2	3/1	3/1	2/1	1/3	2/1	1/2	1/1	3/1	3/1	5/1	0.1215
B10	2/1	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/3	1/1	2/1	2/1	0.0523
B11	3/1	1/7	1/4	1/3	1/2	1/3	3/1	1/4	1/3	1/2	1/1	2/1	0.0489
B12	1/5	1/9	1/5	1/4	1/3	1/4	1/3	1/5	1/5	1/2	1/2	1/1	0.0183

Here in table 1.1 the data obtained of the rating of the 12 attributes from the respondents were evaluated using the AHP techniques and the resultant normalized priority weights (NPW) are provided.

Table 1.2 shows the ratings of the criteria using AHP method. The result shows that the attributes of quality of teaching and learning (B2), effective supervision of teachers (B3), school learning environment (B9) and quality of products (B8) are top four attributes that influence parents' choice of urban school for their children. The ordering of the 12 attributes identified in this paper for school choice selection using the AHP method as given in Table 1.1 are: B2>>B3>>B9>>B8>>B6>>B4>>B1>>B10>>B5>>B11>>B7>>B12, meaning B2 is rated higher or preferred to B3 and so on.

Table 1.2: Attributes, NPW and Ratings using AHP method

Attributes	NPW	Ratings
B1	0.0753	7
B2	0.1785	1
B3	0.1250	2
B4	0.0963	6
B5	0.0491	9
B6	0.0975	5
B7	0.0431	11
B8	0.1123	4
B9	0.1215	3
B10	0.0523	8
B11	0.0489	10
B12	0.0183	12

In Table 1.3 below, we have a decision matrix for the 4 alternative schools A1, A2 A3 and A4 together with the 12 attributes B1, B2, ..., B12 considered in this paper. The PIS and NIS are also given. Intuitionistic fuzzy TOPSIS was applied to the problem based in the data from the survey transformed into intuitionistic numbers (Boran et al, 2009) using and the result is shown in Table 1.4.

Table 1.3: Decision Matrix for 4 alternative Schools with 12 Attributes

	B1	B2	B3	B4
A1	< 0.8550 0.0599 0.0851>	< 0.3202 0.0497 0.6301>	<0.2000 0.3605 0.4395>	< 0.4317 0.5323 0.0360>
A2	< 0.3743 0.4750 0.1507>	< 0.0484 0.4363 0.5153>	< 0.4444 0.0859 0.4697>	< 0.5723 0.0111 0.4166>
A3	< 0.5656 0.1501 0.2843>	< 0.2857 0.3773 0.3370>	< 0.1049 0.4459 0.4492>	< 0.3557 0.3764 0.0829>
A4	<0.1047 0.1121 0.7832>	< 0.3878 0.1609 0.4513>	<0.3416 0.1071 0.5513>	<0.4930 0.4123 0.0947>

	B5	B6	B7	B8
A1	< 0.0643 0.3707 0.5650>	< 0.2002 0.2422 0.5576>	< 0.3476 0.4821 0.1713>	< 0.5267 0.4667 0.0066>
A2	< 0.2026 0.2347 0.5627>	< 0.3423 0.2669 0.3908>	< 0.4406 0.1572 0.4022>	< 0.3324 0.3637 0.3039>
A3	< 0.3622 0.2592 0.3786>	< 0.3980 0.3094 0.2926>	< 0.4187 0.3807 0.2006>	<0.0379 0.3361 0.6260>
A4	< 0.4342 0.1907 0.3751>	< 0.4954 0.4345 0.0701>	< 0.1083 0.2661 0.6256>	< 0.5966 0.1834 0.2200>

	B9	B10	B11	B12
A1	< 0.3793 0.2692 0.3515>	< 0.1626 0.7540 0.0834>	< 0.5609 0.0905 0.3486>	< 0.3625 0.3586 0.2789>
A2	< 0.1902 0.1425 0.6673>	< 0.0322 0.4056 0.5622>	< 0.0553 0.5076 0.4371>	< 0.3258 0.1809 0.4933>
A3	< 0.4239 0.5165 0.0596>	< 0.3759 0.2157 0.4084>	< 0.4347 0.3537 0.2116>	< 0.0830 0.4865 0.4305>
A4	< 0.2363 0.1285 0.6352>	< 0.1292 0.3136 0.5572>	< 0.6290 0.0967 0.2743>	< 0.4205 0.2010 0.3785>

PIS	< 0.1047 0.4750 0.4203>	<0.3878 0.0497 0.5625>	<0.4444 0.0859 0.4697>	< 0.5723 0.0111 0.4166>
	< 0.4342 0.1907 0.3751>	< 0.4954 0.2422 0.2624>	< 0.4406 0.1572 0.4022>	< 0.5966 0.1834 0.2200>
	< 0.4239 0.1285 0.4476>	< 0.3759 0.2157 0.4084>	< 0.6290 0.0905 0.2805>	< 0.4205 0.1809 0.3986>
NIS	< 0.8553 0.0598 0.0849>	< 0.0484 0.4363 0.5153>	< 0.1049 0.4459 0.4492>	< 0.3557 0.5323 0.1120>
	< 0.0643 0.3707 0.5650>	< 0.2002 0.4345 0.3653>	< 0.1083 0.4821 0.4096>	<0.0379 0.4667 0.4954>
	< 0.1902 0.5165 0.2933>	< 0.0322 0.7540 0.2138>	< 0.0553 0.5076 0.4371>	<0.0830 0.4865 0.4305>

Table 1.4: Separation Measures, Closeness coefficients and Ranks of Suppliers Based on Hamming distance

Schools	4 Schools with 12 Attributes (Hamming distance)			
	H^+	H^-	CC	Ranks
A1	1.1485	0.8999	0.4393	4
A2	0.8601	1.0441	0.5483	2
A3	1.0674	0.8375	0.4397	3
A4	0.7024	1.3635	0.6600	1

Table 1.5: Separation Measures, Closeness coefficients and Ranks of Suppliers Based on Euclidean distance

Schools	4 Schools with 12 Attributes (Euclidean distance)			
	H^+	H^-	CC	Ranks
A1	3.8115	2.6458	0.4097	4
A2	2.5509	3.3379	0.5668	2
A3	3.5461	2.7231	0.4344	3
A4	1.9433	4.7605	0.7080	1

Table 1.4 shows that the Missionary schools (A4) is ths most preferred of the 4 alternative schools, closely followed by private schools for middle class (A2) as second best preferred and the premier private schools for the elite (A3) is third best preferred. While, the Public (government) schools (A1) is bracing the rear as least preferred of all the 4 alternative choices considered in this paper. The ranking of alternatives produced by the Hamming distance in Table 1.4 is the same with the ranking produced by the Euclidean distance in Table 1.5 which indicates consistency and correctness in the ordering of the alternatives. A computer program was written in MATLAB to obtain the results throughout this paper.

Conclusion

The result in Table 1.2 of this paper showed that the choices made by parents in Benin City is informed by certain attributes possessed by a given class of schools which may not well exhibited by other alternatives. The attributes of quality of teaching and learning (B2), effective supervision of teachers (B3), school learning environment (B9) and quality of products (B8) are top rated four attributes that influenced parents' choice of urban schools for their children in Benin City. The ranking of the alternative class of schools are: A4>A2>A3>A1, meaning the missionary schools (A4) is the most preferred followed by private schools for middle class (A2) and so on. The use of more than one metric functions in intuitionistic fuzzy TOPSIS for the evaluation and ordering of the alternatives provide accuracy in the method. And apply scientific techniques to handle humanistic system is most appropriate and expedient for accuracy in the evaluation and selection processes.

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