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ANALYTICAL HIERARCHY PROCESS (AHP) APPROACH FOR SELECTING STATIONERY SUPPLIERS IN SELECTED UNIVERSITIES IN BENIN CITY

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ABSTRACT

Supplier Selection is a multi-criteria decision making (MCDM) Problem. It requires the evaluation of both qualitative and quantitative factors. Selecting the best supplier among several alternatives is an enormous task for decision makers (DMs) and procurement managers (PMs). Since no single supplier can excel in all the attributes required by DMs. this paper adopted both the quantitative and qualitative factors in the selection process. Also, this paper applied the AHP approach in the selection of stationery suppliers using real life data from selected universities in Benin City.

Key Words: Analytical Hierarchy process, stationary, multi-criteria decision making

INTRODUCTION

Many methods and techniques have been proposed in literature in solving MCDM problems, some of which are the Analytical Hierarchy process (AHP). (Saaty 1990, 2008, Hudymacova et al 2010, Chakrabory et aI, 2011). Techniques for Order Preference by Similarity to Ideal Solution (TOPSIS) (Wu and Liu, 2011), Artificial Neural Network (ANN) (Kumar and Roy, 2010), Superiority and Inferiority Ranking (SIR) (Mostafa et al, 2011). Some of the integrated or hybrid method identified in literature are: Integrated IFS and SIR (Chai and Liu, 2010), SIR

and MCO (Mostafa et al, 2011), Fuzzy Analytical Hierarchy Process (FAHP) (Ho et al, 2010) just to mention a few. A critical problem in literature shows a common practice of adopting quantitative criteria such cost/price, delivery/lead time and production and neglecting qualitative criteria such as integrity and honesty, flexibility, reliability and so on (Ho et al 2010). The qualitative criteria are also very important just as the quantitative factors in considering suppliers for selection.

ANALYTICAL HIERARCHY PROCESS (AHP)

The analytical hierarchy process (AHP) was first developed by Saaty in 1980 (Hudyniacova et al, 2010, Sharoodi et al, 2012). 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, Rouyendegh & Erkan, 2012). 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 to indicate how many times an element dominates another with respect to the particular attribute or criterion (Saaty, 2008, Rouyendegh & Erkan 2012).

The decision makers (DM) can express their preference between pairs of elements 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 (Rouyuendegh & Erkan, 2012).

BASIC PROCEDURES IN AHP

The basic procedures of AHP to supplier selection problem is stated in the following steps below:

Step 1: State the problem and its objective

Step 2: Structure the hierarchy from the top (which contains the objectives of DMs) through intermediate level containing the criteria or sub criteria to the lowest level which contains the alternatives or suppliers.

Step 3: Develop a pair wise comparison matrix A.

The pairwise comparison matrix A with element a_{ij} denotes the relative importance or

preference of the i^{th} factor with respect to j^{th} factor. The pairwise comparison matrix is given as:

$$A = (a_{ij}) = \begin{pmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ {}^{1}a_{1n} & {}^{1}/a_{2n} & & 1 \end{pmatrix} \quad (1)$$

There are n(n-1)/2 judgments required to develop the set of matrices in step 3. Reciprocal are automatically given to each element in the pairwise comparison matrix in the rows below the first row, just before the diagonal (Saaty, 2008), n is the size of the matrix.

Assuming we are given n criteria or attributes, $A_1 \ldots A_n$ with preference weight $W_1, \ldots w_n$.

Then, let the entries or elements of matrix A be given as $a_{ij} = W_i/W_j$ implies

$$A = \begin{pmatrix} W_1/W_1 & W_1/W_2 & \cdots & W_1/W_n \\ W_2/W_1 & W_2/W_2 & \cdots & W_2/W_n \\ \vdots & \vdots & \ddots & \vdots \\ W_n/W_1 & W_n/W_2 \cdots & W_n/W_n & \end{pmatrix} \quad (2)$$

Step 4. Calculate for the rank of the priority vectors and normalize. This is done for the criteria and each of the alternative with respect to each of the criteria.

Step 5. Carryout a consistency test of the comparison matrix is given by the consistency ratio (CR) to assess the consistency of the comparison matrix, this is given as

$$CR = \frac{CI}{RI} \quad (3)$$

Where the consistency index (CI) is

$$CI = \frac{\lambda \text{ max} - n}{n-1} \quad (4)$$

i.e λ Max = (cell value 1 x obtained weight 1) + (Cell value 2 x obtained weight 2) + … + Cell value (n – 1) x obtained weight (n – 1) + (cell value n x obtained weight n) (5)

(Chakraborty et al, 2011)

CI is the consistency intensity which shows the entire consistency judgment for each comparison matrix and the hierarchy structure (Saaty, 1990, Erbasi & Parlakkaya; 2012).

And λ_{max} is the highest eigen value of the judgment matrix. The random indicators developed for the matrices of size n, where $1 \leq n \leq 15$ is given below in table 2

Table 1. Random index (indicators)

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Random indicator	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Source: (see Erbasi and Parlakkaya, 2012)

The C.R. is accepted if

CR $\leq$ 0.10, OTHERWISE the judgment matrix is inconsistent (Erbasi & Parlakkaya, 2012, Chakraborty et al, 2011)

6. If λmax; CI and CR are satisfactory, then the decision is taken based on the normalized values.

OTHERWISE the process is repeated until these values lies in the desired range (Saravanan, et al, 2012).

METHOD AND PROBLEM FORMULATION

Most of the work in literature on supplier selection shows that many of the researches have been centred on quantitative supplier's criteria like cost/price, lead time/delivery and production - but neglecting the qualitative criteria such as integrity and honesty, flexibility, reliability and so on. (see Ho et al 2010). The criteria for supplier selection are inexhaustible (Ho et al, 2010), and many literatures have not incorporating many of these criteria into their work. Therefore, this paper adopted twelve (12) criteria with eight (8) homogeneous stationery suppliers identified as regular suppliers to the four universities selected in this study.

Data were obtained from eight (8) procurement managers / decision makers in a survey from four (4) universities in Benin City using the questionnaires method. The universities are University of Benin, Tayo Akpata University, Benson Idahosa University and Wellspring University. The aggregated scores (data) from the eight (8) procurement managers / decision makers were used for implementing the AHP method in this paper.

The twelve (12) criteria considered in this paper are: Cost (C_1), Quality (C_2), Service (delivery & lead time) (C_3), Production and supply (C_4), Finance (C_5), Technological capacity (C_6), Performance History & Experience (C_7), Flexibility (C_8), Reliability (C_9), Honesty and integrity (C_{10}), Long term relationship (C_{11}), 12. Location (C_{12})

The table 2 below presents a brief explanation of the 12 criteria considered in this study

Table 2: Criteria and Explanation

S/N	CRITERIA	EXPLANATION
1.	Cost *(C_1)*	Procurement cost per unit item.
2.	Quality *(C_2)*	This is concern with the durability, timbre and the standard of the procured item
3.	Service *(C_3)*	Service in this context is looking at leadtime and delivery rate, ability to meet delivery due date, emergence / prompt response
4.	Production & supply *(C_4)*	The ability to produce or supply the quantity of item order.
5.	Finance *(C_5)*	This includes financial record disclosure, finances condition, profitability of supplier

6	Technological capacity *(C_6)*	The ability of having the technical know-how to deliver to specification and time. These include both manpower, and capital assets (facilities) at disposal
7	Performance history and Experience (C_7)	Record of past supply activity.
8	Flexibility (C_8)	The ability to respond to unexpected demand, changes in product volume, flexibility contract terms and conditions, short delivery notice, changes in product delivery
9	Reliability (C_9)	Reliability and consistence in quality, service and time, product length of warranty.
10	Honesty integrity (C_{10})	Insurance and litigation history, reference of suppliers, reputation to integrity, openness to evaluation and product warranty
11	Long term Relationship (C_{11})	Commitment to business relationship, market information sharing and advice and faith in customer
12	Location *(C_{12})*	Location site of supplier and proximity to customer.

Let $c_1, c_2, \ldots, c_n$ $(1 \leq n \leq 12)$ be the 12 criteria or factors for the Problem and $s_1, s_2, \ldots,$

s_n $(1 \leq n \leq 8)$ be the 8 suppliers to the problem. The problem face in this research is to determine the best among these 8 stationaries suppliers, based on the 12 criteria stated above.

We present the hierarchical structure of the problem in figure 1below.

To solve for the eigenvector (priority vectors) of the pairwise comparison matrix, we followed the procedure below:

1. Square the pairwise comparison matrix A
2. Calculate the row sums and normalized. By normalizing we mean

$$\frac{Rn}{RT}$$

Were Rn is the row sums of matrix size n and RT is the now total

3. Then stop. If the difference between successive iterations is insignificant.

Given the pairwise comparison Matrix of the criteria in Table 3

Table 3 Evaluation of Criteria using AHP Methods

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	NPW
C_1	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
C_2	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
C_3	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
C_4	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
C_5	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

C_6	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
C_7	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
C_8	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
C_9	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
C_{10}	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
C_{11}	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
C_{12}	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

We developed a computer program in MATLAB to solve (1) using the Eigen vector algorithm (Saaty,1990). The result of normalized priority weights (NPW) for the criteria is given in Table 3.

from the above C_2 (which is quality) with NPW of 0.1785 has the best rating using the classical AHP method. This is followed by C_3 (Services delivery load time with NPW score off 0.1250 closely followed by C_g (reliability) and so on. The attribute C_{12} (location) is the least rated criteria for supplier selection based on the result in Table 3.

The suppliers S_1, S_2…. $S_{8\ are}$ evaluated with respect to each criterion from C_1, C_2 … C_{12}. The results are given by the NPW column with highest values as the best alternatives with respect to the particular criteria.

Table 4: Evaluation of Suppliers with respect to Cost (C_1) Using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	2/1	1/3	1/4	1/4	1/3	7/1	9/1	0.1898
S_2	1/2	1/1	3/1	1/4	2/1	5/1	1/8	3/1	0.0764
S_3	3/1	1/3	1/1	1/4	2/1	1/2	1/2	2/1	0.1289
S_4	3/2	4/1	4/1	1/1	5/1	3/1	2/1	9/1	0.2304
S_5	4/1	1/2	1/2	1/5	1/1	5/1	2/1	7/1	0.1448
S_6	1/5	5/1	1/3	1/3	1/2	1/1	3/1	5/1	0.1028
S_7	1/7	8/1	2/1	1/2	1/3	1/3	1/1	3/1	0.1076
S_8	1/9	1/3	1/2	1/9	1/2	1/5	1/3	1/1	0.0194

Table 5: Evaluation of suppliers with respect to Quality(C2) Using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW

S_1	1/1	1/3	2/1	4/1	5/1	1/3	2/1	1/4	0.1672
S_2	3/1	1/1	2/1	3/1	4/1	5/1	2/1	1/3	0.2155
S_3	1/5	1/2	1/1	1/2	1/3	1/2	2/1	1/4	0.0506
S_4	1/4	1/3	2/1	1/1	2/1	3/1	4/1	1/2	0.1106
S_5	1/5	1/4	3/1	1/2	1/1	5/1	3/1	2/1	0.1275
S_6	1/3	1/5	2/1	1/3	1/5	1/1	3/1	1/3	0.0538
S_7	1/2	1/2	1/2	1/4	1/3	1/3	1/1	2/1	0.0683
S_8	4/1	3/1	4/1	2/1	1/2	3/1	1/2	1/1	0.2065

Table 6 Evaluation of suppliers with respect to Service (delivery and lead time) C_3 using AHP method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	2/1	3/1	1/2	1/3	4/1	5/1	1/2	0.1834
S_2	1/2	1/1	1/2	3/1	2/1	1/2	3/1	1/3	0.1128
S_3	1/3	2/1	1/1	4/1	2/1	3/1	2/1	1/2	0.1582
S_4	2/1	1/2	1/4	1/1	1/7	1/5	1/2	1/3	0.0590
S_5	3/1	1/2	1/2	7/1	1/1	2/1	3/1	2/1	0.1861
S_6	1/4	2/1	1/3	5/1	1/2	1/1	2/1	1/3	0.0963
S_7	1/5	1/3	1/2	2/1	1/3	1/2	1/1	2/1	0.0669
S_8	2/1	3/1	1/2	1/3	1/2	3/1	1/2	1/1	0.1373

Table 7: Evaluation of Suppliers with respect to Production and Supply Capacity (C_4) using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	4/1	3/1	2/1	1/2	2/1	1/3	2/1	0.1415
S_2	1/4	1/1	1/2	1/3	1/2	1/3	2/1	1/3	0.0533
S_3	1/3	1/2	1/1	3/1	2/1	1/4	5/1	1/2	0.1654
S_4	1/2	3/1	1/3	1/1	1/6	1/5	1/5	1/3	0.1177
S_5	2/1	2/1	1/2	6/1	1/1	2/1	3/1	1/2	0.1911

S_6	1/2	3/1	4/1	1/2	1/2	1/1	2/1	1/2	0.1213
S_7	3/1	1/2	1/5	5/1	1/3	1/2	1/1	2/1	0.1434
S_8	1/2	3/1	1/3	1/8	1/2	2/1	1/2	1/1	0.0663

Table 8: Evaluation of Suppliers with respect to Finance (C_5) using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	3/1	2/1	4/1	5/1	1/3	1/2	3/1	0.2114
S_2	1/3	1/1	3/1	2/1	1/3	5/1	4/1	2/1	0.1702
S_3	1/2	1/3	1/1	5/1	7/3	1/2	5/2	3/4	0.1285
S_4	1/4	1/2	1/5	1/1	3/1	2/1	1/2	2/1	0.0919
S_5	1/5	3/1	3/7	1/3	1/1	2/1	3/1	2/1	0.1281
S_6	3/1	1/5	2/1	1/2	1/2	1/1	4/3	1/2	0.1151
S_7	2/1	1/4	2/5	2/1	1/3	3/4	1/1	2/1	0.0936
S_8	1/3	1/2	3/4	1/2	1/2	2/1	1/2	1/1	0.0613

Table 9: Evaluation of Suppliers with respect to Technological Capacity (C_6) using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	5/1	4/1	2/1	3/1	1/3	1/4	1/5	0.1320
S_2	1/5	1/1	2/1	3/1	1/3	1/4	1/2	1/3	0.0717
S_3	1/4	1/2	1/1	2/1	3/1	1/4	1/2	1/2	0.0741
S_4	1/2	1/3	1/2	1/1	3/1	2/1	1/2	2/1	0.1131
S_5	1/3	3/1	1/3	1/3	1/1	1/3	2/1	1/4	0.0770
S_6	3/1	4/1	4/1	1/2	1/2	1/1	1/2	1/3	0.1375
S_7	4/1	2/1	2/1	2/1	1/2	2/1	1/1	2/1	0.1869
S_8	5/1	3/1	2/1	1/2	4/1	3/1	1/2	1/1	0.2078

Table 10: Evaluation of Suppliers with respect to Performance History and Experience (C_7) using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	2/1	3/1	1/2	4/1	3/1	1/3	5/1	0.1974
S_2	1/2	1/1	2/1	4/1	1/2	3/1	3/4	5/2	0.1465
S_3	1/3	1/2	1/1	2/1	3/1	1/4	1/2	1/2	0.0805
S_4	1/4	2/1	3/7	1/1	5/2	1/4	2/3	3/2	0.0961
S_5	1/4	2/1	3/7	2/5	1/1	1/2	2/1	3/1	0.1105
S_6	1/5	4/3	3/1	3/2	1/2	1/1	1/3	1/2	0.1070
S_7	3/1	4/3	3/1	3/2	1/2	3/1	1/1	2/3	0.1742
S_8	1/5	2/5	2/1	2/3	1/3	2/1	3/2	1/1	0.0878

Table 11: Evaluation of Suppliers with respect to Flexibility (C_8) using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	1/2	1/4	1/6	1/7	2/1	1/2	1/4	0.0463
S_2	2/1	1/1	3/1	2/1	1/3	1/2	1/4	2/1	0.1184
S_3	1/4	1/3	1/1	1/4	1/3	1/2	2/1	3/1	0.0853
S_4	6/1	1/2	4/1	1/1	4/1	3/1	2/1	1/4	0.2134

S_5	7/1	3/1	3/1	1/4	1/1	2/1	3/1	2/1	0.1811
S_6	1/2	2/1	2/1	1/3	1/2	1/1	2/1	3/1	0.1181
S_7	2/1	4/1	1/2	1/2	1/3	1/2	1/1	1/2	0.0908
S_8	4/1	1/2	1/3	4/1	1/2	1/3	2/1	1/1	0.1466

Table 12: Evaluation of Suppliers with respect to Reliability (C_9) using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	2/1	3/1	4/1	1/4	3/1	1/2	1/3	0.1500
S_2	1/2	1/1	3/1	4/1	2/3	5/1	1/3	2/1	0.1637
S_3	1/3	1/3	1/1	1/3	4/1	7/1	2/1	3/1	0.2020
S_4	1/4	1/4	1/3	1/1	1/2	1/3	2/1	1/2	0.0484
S_5	4/1	3/2	1/4	2/1	1/1	2/1	3/1	4/1	0.1706
	1/3	1/5	1/7	3/1	1/2	1/1	2/1	3/1	0.0774
S_7	2/1	3/1	1/2	1/2	1/3	1/2	1/1	1/2	0.1108
S_8	3/1	1/2	1/3	2/1	1/4	1/3	1/2	1/1	0.0770

Table 13: Evaluation of Suppliers with respect to Honesty and Integrity (C_{10}) using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	2/1	2/3	1/4	2/3	1/3	4/1	3/4	0.1071
S_2	3/2	1/1	4/1	5/1	3/1	2/1	1/2	3/5	0.2029
S_3	3/2	1/4	1/1	2/1	3/1	4/5	6/1	2/1	0.1612
S_4	1/4	1/5	1/2	1/1	2/1	3/1	1/2	3/1	0.1460

S_5	3/2	1/3	1/3	1/2	1/1	1/2	1/3	1/4	0.0481
S_6	3/1	1/2	5/4	1/3	2/1	1/1	2/1	3/1	0.1327
S_7	1/4	2/1	1/6	2/1	3/1	1/2	1/1	1/2	0.0989
S_8	4/3	5/3	1/2	1/3	4/1	1/3	1/2	1/1	0.1031

Table 14: Evaluation of Suppliers with respect to Long Term Relationship (C_{11}) using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	2/1	9/1	5/1	1/3	1/4	3/5	2/1	0.1127
S_2	1/2	1/1	7/1	3/1	4/1	1/3	1/2	3/1	0.1483
S_3	1/9	1/7	1/1	3/1	4/1	1/2	1/3	1/2	0.0663
S_4	1/5	1/3	1/3	1/1	1/3	1/4	6/1	2/3	0.0981
S_5	3/1	1/4	1/4	3/1	1/1	1/2	1/4	1/8	0.0805
S_6	4/1	3/1	2/1	4/1	2/1	1/1	2/5	3/5	0.1664
S_7	5/3	2/1	1/3	1/6	4/1	5/2	1/1	3/1	0.1648
S_8	1/2	1/3	2/1	3/2	8/1	5/3	1/3	1/1	0.1129

Table 15: Evaluation of Suppliers with respect to Location (C_{12}) using AHP Method

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	NPW
S_1	1/1	4/1	3/1	1/4	2/5	3/4	1/2	3/1	0.1180
S_2	1/4	1/1	1/2	3/1	2/1	4/3	1/4	1/2	0.1053
S_3	1/3	2/1	1/1	1/2	1/3	1/4	1/5	3/1	0.0719
S_4	4/1	1/3	2/1	1/1	2/1	3/1	4/1	2/1	0.2263
S_5	5/2	1/2	3/1	1/2	1/1	1/3	1/4	1/2	0.0848
S_6	4/3	3/4	4/1	1/3	1/3	1/1	1/2	1/3	0.1036
S_7	2/1	4/1	5/1	1/4	4/1	2/1	1/1	3/1	0.1959
S_8	1/3	2/1	1/3	1/2	2/1	3/1	1/3	1/1	0.0942

Table16: Decision Matrix AHP Method

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
S_1	0.1898	0.1672	0.1834	0.1415	0.2114	0.1320	0.1974	0.0463	0.1500	0.1071	0.1627	0.1180
S_2	0.0764	0.2155	0.1128	0.0533	0.1702	0.0717	0.1465	0.1184	0.1637	0.2029	0.1483	0.1053
S_3	0.1289	0.0506	0.1582	0.1654	0.1285	0.0741	0.0805	0.0853	0.2020	0.1612	0.0663	0.0719
S_4	0.2304	0.1106	0.0590	0.1177	0.0919	0.1131	0.0961	0.2134	0.0484	0.1460	0.0981	0.2263
S_5	0.1448	0.1275	0.1861	0.1911	0.1281	0.0770	0.1105	0.1811	0.1706	0.0481	0,0805	0.0848
S_6	0.1028	0.0538	0.0963	0.1213	0.1151	0.1375	0.107O	0.1181	0.0774	0.1327	0.1664	0.1036
S_7	0.1076	0.0683	0.0669	0.1434	0.0936	0.1869	0.1742	0.0908	0.1108	0.0989	0.1648	0.1959
S_8	0.0194	0.2065	0.1373	0.0663	0.0613	0.2078	0.0878	0.1466	0.0770	0.1031	0.1129	0.0942

In taking decision using the AHP method (Saaty, 1990, 2008), The Npw result (values) of the suppliers evaluate against each of the criteria (i.e. $C_1,\ldots,C_n$) are used in forming the decision matrix in Table 16. In this decision matrix the suppliers are evaluated based on the criteria results (NPW values) in Table 3 – 15. The result of the decision matrix (Table 16) is given Table 17.

Suppliers	**Npw values**	**Rank**
S_1	0.1727	1
S_2	0.1395	3
S_3	0.1074	6
S_4	0.1422	2
S_5	0.1291	4
S_6	0.0918	8
S_7	0.1116	5
S_8	0.1056	7

In using the AHP method the suppliers S_1, S_4 and S_2 are ranked as first, second and third respectively, while suppliers S_6, S_8 and S_3 are brazing the rear as the least preferred, second least preferred and third least preferred respectively.

Consistence test

We analysis the consistency test of the AHP method using (3)

$$CR = \frac{CI}{RI} = -0.6441 \leq 0.1$$

Which show that the method is consistency

Where $CI = -0.9533, RI = 1.48$ in Table1

DISCUSSION OF RESULTS AND CONCLUSION

It obvious from the results from this work that no single supplier can excel in all the attributes for selection. This is demonstrated in Tables 3-15 which is the crux of supplier selection problems. This

paper has been able to use the AHP method to address the problem. Again, this paper adopted both quantitative and qualitative criteria in the selection process which is a deviation from the common practice in literature where quantitative criteria are commonly adopted (Ho et al, 2010). Results from this paper for the evaluation of stationaries suppliers in selected universities in Benin City shows that suppliers S_1, S_4 and S_2 are top ranked alternatives as 1st, 2nd and third preferred respectively. While suppliers S_6, S_8 and S_3 are least preferred, 2nd least preferred and 3rd least preferred respectively. These least preferred suppliers should be eliminated among the suppliers. A consistency test was also done for the method and CR $\leq$ 0.10 was obtained indicating that the result is consistent.

REFERENCES

Chakraborty, T., Ghosh, T., & Dan, P. K., (2011). Application of analytic hierarchy process and heuristic algorithm in solving vendor selection problem. *Business Intelligence Journal,* 167-177.

Chai, J. & Liu. J. N. K (2010). A novel multi-criteria group decision making approach with intuitionistic Fuzzy SIR Method. *World Automation Congress.*

Erbasi, A. & Parlakkaya, R. (2012). The use of Analytic Hierarchy Process (AHP) in the balanced score card: An approach in a hotel firm. *Business and Management Review,* 2(2), 23-37.

Ho, W., Xu, X., & Dey, P. K. (2010). Multi-criteria decision-making approaches for supplier evaluation and selection: A literature review. *European Journal of Operational Research* 202 (1), 16-24.

Hudymacova, M., Bebcova, M., Pocsova, J., & Skovranek, T., (2010). Supplier selection based on multi-criteria AHP Method. *Acta Montanistica Slovaca Rocnik* 15(3), 249-255.

Kumar & Roy (2010). A Hybrid Method for vendor Selection using Neural Network. *International Journal of Computer Applications.*

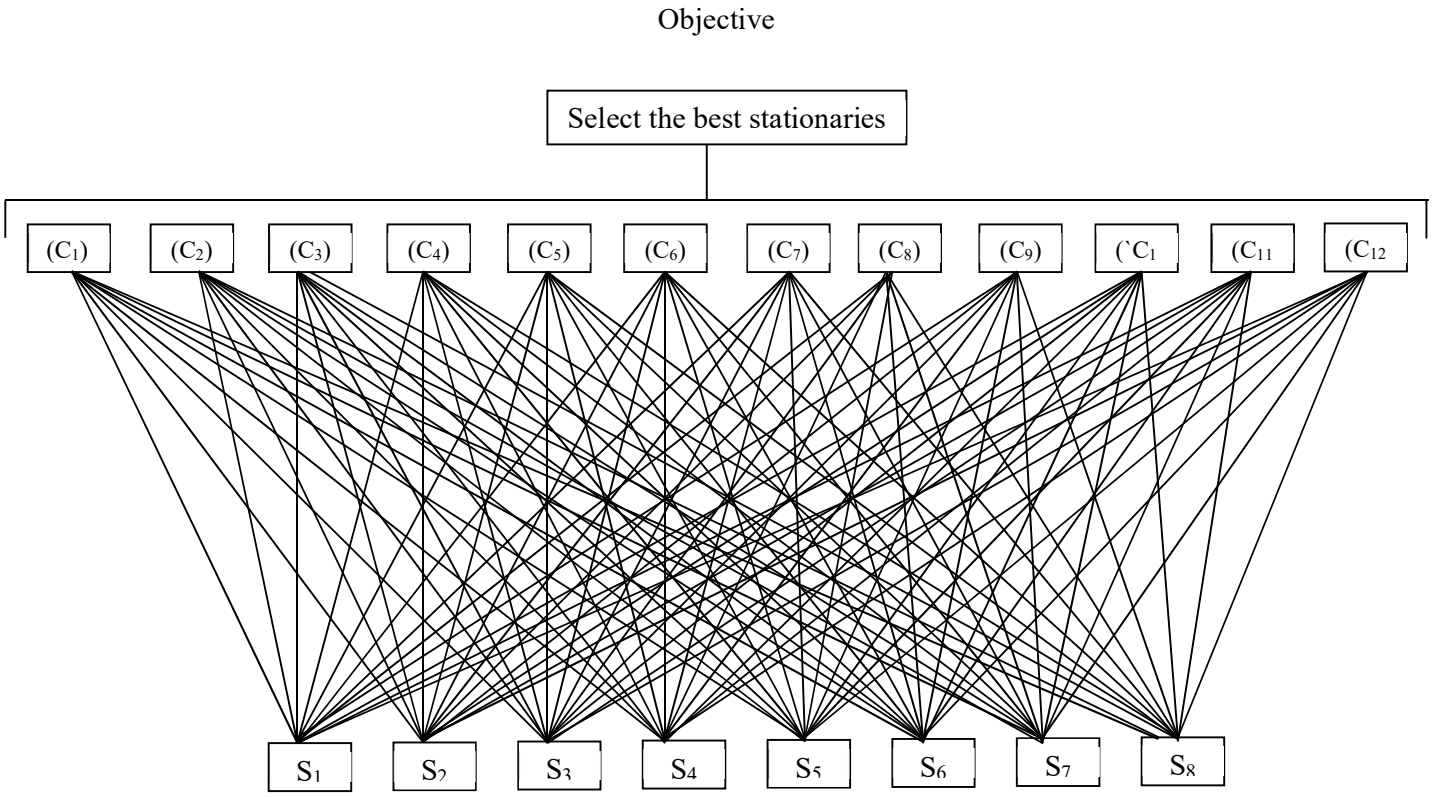
Mostafa, M., Mohsen, A., & Reza, K. M (2011). Developing a New MADM by integrating SIR and VIKOR method. *America Journal of Scientific Research*28, 71-86.

Rouyendegh, B. D. & Erkan, T. E (2012). Selecting the best supplier using Analytical Hierarchy Process (AHP), *African Journal of Business Management,* 6(4), 1455 – 1462.

Saaty, T. L. (2008). Decision making with the Analytical Hierarchy Process. *Int. Journal of Service sciences* 1 (1), 83-98.

Saaty, T. L. (1990). How to make a decision: The Analytical Hierarchy Process. *European Journal of Operational Research*, 48, 9–26

Wu, M., & Liu, Z., (2011). The supplier selection application based on two method: VIKOR Alyorithm with Entropy methods and Fuzzy TOPSIS with Vague Sets method *International Journal of Management Science and Engineering Management.* 6(2), 110-116.



Where C_n $1 \leq n \leq 12$ are the 12 criteria. $S_m, 1 \leq m \leq 8$ are the suppliers.
Figure 1: Hierarchical Structure of the Problem