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Contractor Selection for Enhancing the Quality of University Education in Nigeria using the Hamming Distance

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Abstract

The need for contractor selection in our university education system cannot be over emphasized. And applying scientific techniques for appropriateness and accuracy in the selection process is of utmost importance. This paper identifies four main attributes that should be considered uppermost in the selection of contractors in our university system and the application of intuitionistic fuzzy TOPSIS using hamming distance for handling human decision problems. A survey *was carried out in four randomly selected Nigerian universities using Delphi method. Data collected were transformed into inituitionistic fuzzy numbers. Then inituitionistic fuzzy TOPSIS algorithm was used in the evaluation and selection process due to its amenability to humanistic systems. A computer program was written in matlab which run in 0.004698 seconds to compute the numerical result. It is concluded that adopting scientific techniques to humanistic systems lead to accuracy and development in the system.*

Key words: contractor selection, university education system, intuitionistic fuzzy TOPSIS

Introduction

Education is the life wire of any meaningful development in every society. For Nigeria to realize its potential in the midst of abundant human and natural resources the issue of funding the education sector should be taking seriously. One of the problems of education in this part of the world is underfunding. This has led to series of strikes by the Academic Staff Union of Universities (ASUU) for over 30 year blaming the federal government of Nigeria of underfunding which resulted in the decline in quality of university education in the country. And government on the other hand hinged the problem on financial constraints. However various approaches had being employed by government to address the cankerworm of underfunding. Some of these approaches by government are: Education Trust Fund (ETF), Tertiary Education Trust (TET) Fund, grants, private support and budgeting are grossly inadequate to address the problem. The perennial problem of under budgeting for the education sector which is a far cry from the international requirement of 26% of the total budget does not help matters. As a result, the federal government of Nigeria signed agreement with ASUU in December, 2013 to release 200 billion Naira in 2013; 220 billion Naira in each of the 5 subsequent years, i.e., from 2014 to 2018. This is to address the decay in Nigerian university system as result of government neglect due to poor budget allocation to education over the years. By implcation, the federal government of Nigeria is to pump in a total of 1.3 trillion

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Naira to the universities in 6 years, i.e. from 2013 to 2018. This fund is for infrastructural development to enhance teaching, learning and research in Nigerian university system.

No matter how much fund is released into the university sector in Nigeria, if proper implementation is not carried out by way of effective contractor selection for project execution the purpose of the fund would be a mirage. To this end, this paper examines the various selection approaches in literature and proposed intuitionistic fuzzy TOPSIS (Technique for Order Preference by Similarity to the Ideal Solution) for the selection problem due its amenability and susceptibility to humanistic system. Generally TOPSIS is based on the concept of minimum distance from the positive ideal solution and maximum distance from the negative ideal solution. In this paper we consider the following attributes for contractor selection: 1.cost, 2.quality and consistency, 3.technical know-how and 4.experience. An important issue in the selection problem is the fact that it is almost impossible to find a contractor that excels in all the possible criteria identified by an organization or decision makers. The scores for all contractors on these attributes are not the same. Nevertheless, the organization must select a specific number of contractors from the available ones. This is the selection problem.

Mathematically, the contractor selection problem can be stated as follow:

Decision factors	Mathematical formulation
contractors or alternative set	$S = \{S_1, S_2, \cdots S_n\}$
(DM) set	$E = \{e_1, e_2, \cdots e_l\}$
Criteria or attributes	$C = \{c_1, c_2, \cdots c_m\}$
(D M) weights	$W = \{w_1, w_2, \cdots w_l\}$
Criterion weights	$\omega = (\omega_1, \omega_2 \cdots \omega_m)$

Using Chai and Liu (2010)

Mixing these variables together to select the best contractor is the selection problem.

Many approaches for the MCDM problems have been considered in literature. Ho et al (2010) provides a review of some of the methods suggested for solving the selection problem. The methods reviewed include: Data envelopment analysis (DEA), Mathematical programming, Analytic hierarchy process (AHP), Case-based reasoning (CBR), Fuzzy set theory, Simple multi-attribute rating technique (SMART), Genetic algorithm (GA). They also considered hybrid methods combining some of the foregoing methods and their variations. For example, under mathematical programming, the following variations were considered: Linear programming, Binary integer linear programming, mixed integer linear programming, mixed integer nonlinear programming, Goal programming, and Multi-objective programming. Soeini et al (2012) also reviewed some articles on the supplier selection problem. These authors however ignored intuitionistic fuzzy TOPSIS. Therefore, this paper uses intuitionistic fuzzy TOPSIS method 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 rest part of this paper is arranged as follows: section 2 presents the algorithm for intuitionistic fuzzy TOPSIS as used by Boran et al (2009). Section 3 is the methodology adopted in the study. Section 4 is application to IBS provider selection. Section 5 is our conclusion.

Fuzzy Set

The fuzzy set theory is used to solve the rigorous theory of approximation and vagueness based on generalization of standard set theory to fuzzy set or numbers (Carlsson and Fuller, 1996). Fuzzy set and fuzzy logic are powerful mathematical tools for addressing uncertain system in the absence of complete and precise information. However, fuzzy set theory is built around the concept of approximate reasoning. The classical set theory is built on the fundamental concept of set which is either a member or not a member. A sharp, crisp and unambiguous distinction exists between a member and non-member for any well-defined set of entities in this theory. There is a precise and clear boundary to indicate if any entity belongs to the set or not. But many real life problems cannot be describe or handle by classical set theory.

A fuzzy set is an extension of crisp set. Crisp set only allows full membership only. While fuzzy set allows both full membership and partial membership. In other words, an element may partially belong to a fuzzy set. The theory uses values ranges from 0-1 for showing membership of the objects in a fuzzy set. Complete non-membership is denoted as 0, and complete membership as 1. Values between 0 and 1 represent intermediate degree of membership.

Intuitionistic fuzzy set proposed by Atanassov (1986) is an extension of fuzzy set with the introduction of the hesitation degree $\tau_A(u_{i,})$ is stated as $\mu_A(u_i) + v_A(u_i) + \tau_A(u_i) = 1$, where $\mu_A(u_{i,})$, $v_A(u_{i,})$ is the membership and non membership function or degree $(i = 1,2, \dots n)$. If $\tau_A(u_{i,})$ is small knowledge about u is certain and decision is ease. However, if $\tau_A(u_{i,})$ is large, knowledge about u is uncertain and decision is difficult.

But: $\tau_A(u_i) = 1 - \mu_A(u_i) - v_A(u_i)$ (1)

$$0 \le \tau_A(u_i) \le 1$$

$$0 \le \mu_A(u_i) \le 1$$

$$0 \le v_A(u_i) \le 1$$

A decision matrix of intuitionistic fuzzy set is of the form

$$\begin{bmatrix} (\mu_{A1}(u_1),v_{A1}(u_1),\tau_{A1}(u_1)) & (\mu_{A1}(u_2),v_{A1}(u_2),\tau_{A1}(u_2)) & \cdots & (\mu_{A1}(u_n),v_{A1}(u_n),\tau_{A1}(u_n)) \\ (\mu_{A2}(u_1),v_{A2}(u_1),\tau_{A2}(u_1)) & (\mu_{A2}(u_2),v_{A2}(u_2),\tau_{A2}(u_2)) & \cdots & (\mu_{A2}(u_n),v_{A2}(u_n),\tau_{A2}(u_n)) \\ \vdots & \vdots & & \\ (\mu_{Am}(u_1),v_{Am}(u_1),\tau_{Am}(u_1)) & (\mu_{Am}(u_2),v_{Am}(u_2),\tau_{Am}(u_2)) & \cdots & (\mu_{Am}(u_n),v_{Am}(u_n),\tau_{Am}(u_n)) \end{bmatrix}$$

If $\tau_A\ (u_i) = 0$ for every element, then it automatically reduces to a fuzzy set.

Definition: an *inituitionistic fuzzy set A* in E is an object of the following form:

$$A = \{\langle u, \mu_A(u), \mu_A(u)\rangle / u \in E\}$$

Where the functions, $\mu_A: E \to [0,1]$ and $v_A: E \to [0,1]$, define the degree of memebership and the degree of non-membership of the element $u \in E$, respectively and for every $u \in E: 0 \leq \mu_A(u) + v_A(u) \leq 1$.

If $\tau_A\ (u) = 1 - \mu_A\ (u) - v_A\ (u)$, then $\tau_A\ (u)$ is the degree of non-determinancy or hesitation of the $u \in E$ to a set A and $\tau_A\ (u) \in [0,1], \forall u \in E$.

It is easily seen that each fuzzy set is a particular case of the intuitionistic fuzzy set.

Also, if A is a fuzzy set the $\tau_A\ (u) = 0, \forall u \in E$.

Topsis Method

According to Wu and Liu (2011), the TOPSIS method was developed in 1981 by Huang and Yoou. 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. Some of the authors that applied the TOPSIS method are Wu and Liu (2011), Elanchezhian et al (2010), Ashrafzadel et al (2012), Kabir (2012), Boran et al (2009) and Izadikhai (2012).

The algorithm for TOPSIS under intuitionistic fuzzy as used by Boran et al (2009) is as follows:

Step 1: Determine the weights of decision makers

Step 2: Construct aggregated intuitionistic fuzzy decision matrix based on the opinions of decision makers (DMs)

Step 3: Determine the weights of the criteria

Step 4: Construct aggregated weighted intuitionistic fuzzy decision matrix.

Step 5: Obtain the positive ideal solution (PIS) and negative ideal solution (NIS)

S**tep 6:** Construct the separation measure (distance from PIS and distance from NIS) for each supplier.

Step 7: Calculate the closeness coefficient for each supplier using the result obtained in step 6

Step 8: Rank the alternatives suppliers using the closeness coefficients

Methodology

A random sample survey of 30 respondents each from 4 southern universities in Nigeria amongst whom are lecturers, estate procurement officers, management staff and decision makers (DMs) in the university system. The universities are: University of Benin, University of Ibadan. University of Lagos and Niger Delta University. The delphi questionnaires method was used in the survey, a total of

120 aforementioned questionaires were given to respondents and all were returned. The data from the survey 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.

Application of Intuitionistic Fuzzy TOPSIS to Contractor Selection

In determining the importance of DMs and their weights, the respondents are grouped into three DMs groups as DM1, DM2, and DM3 with different linguistic terms and weights with respect to their importance. For details, see Boran et al (2009). Applying the algorithm in section 2 as stated in Boran et al (2009), we have the aggregated weighted fuzzy decision matrix for the selection problem in table 1 as follows:

Table 1: Decision Matrix, PIS and NIS

B1 B2 B3 B4

A1= [0.8553 0.0598 0.0849 0.3202 0.0497 0.6301 0.2001 0.3604 0.4395 0.6062 0.1120 0.2818];

A2= [0.3743 0.4750 0.1507 0.0484 0.4363 0.5153 0.4444 0.0859 0.4697 0.1039 0.3410 0.5551];

A3= [0.5651 0.1506 0.2843 0.2857 0.3773 0.3370 0.1049 0.4459 0.4492 0.3228 0.3511 0.3261];

A4= [0.1047 0.1121 0.7832 0.3878 0.1609 0.4513 0.3416 0.1071 0.5513 0.3291 0.3880 0.2829];

A5= [0.6274 0.0216 0.3510 0.2751 0.2486 0.4763 0.4516 0.2277 0.3206 0.1968 0.6249 0.1783];

A6= [0.0844 0.4252 0.4904 0.5061 0.0550 0.4389 0.3178 0.1052 0.5770 0.6854 0.0585 0.2561];

A7= [0.4124 0.3690 0.2186 0.3801 0.4195 0.2004 0.1824 0.3255 0.4921 0.3120 0.2553 0.4327];

A8= [0.2344 0.2617 0.5040 0.4973 0.2732 0.2295 0.3851 0.3081 0.3068 0.3617 0.1549 0.4834];

A9= [0.3918 0.2684 0.3398 0.1724 0.5206 0.3070 0.1394 0.5073 0.3533 0.1032 0.4568 0.4400];

A10= [0.4787 0.2200 0.3013 0.4467 0.4212 0.1321 0.0665 0.2244 0.7091 0.3968 0.3153 0.2879];

PIS= [0.0844 0.4750 0.4406 0.5061 0.0497 0.4442 0.4516 0.0859 0.4625 0.6854 0.0585 0.2561];

NIS= [0.8553 0.0216 0.1231 0.0484 0.5206 0.4310 0.0665 0.5074 0.4261 0.1032 0.6249 0.2719];

Table 2: Separation measures based on Hamming Distance, closeness coefficients, and ranks of Contractors

H^+	H^-	Closeness Coefficient $H^-\|(H^++H^-)$	Contractors Rank
1.3105	1.1690	0.4715	A1 7
1.3363	1.2707	0.4874	A2 5
1.5309	0.8628	0.3604	A3 9
0.9475	1.7475	0.6484	A4 3
1.4822	0.9786	0.3977	A5 8
0.1889	2.2209	0.9216	A6 1
1.3404	1.3261	0.4973	A7 4
0.9828	1.8584	0.6541	A8 2
1.7819	0.8285	0.3174	A9 10
1.4395	1.3675	0.4872	A10 6
Computing time: 0.004698 seconds			

Table 1 shows the contractor selection problem considered in this study. We assumed 10 alternative contractors A1, A2...A10, with 4 criteria or attributes. B1 is the cost criteria; B2, B3 and B4 are the benefit criteria of quality, consistency, technical know-how and experience. The cost is quantitative, while the benefit criterion is qualitative. We obtained the PIS and NIS used in calculating the separation measures (H^+) and (H^-) using egs (10) of Boran et al (2009). The Hamming distance was adopted in calculating the separation measures (Yang and Chiclana 2009, Omosigho and Omorogbe, 2013).

A computer programme was written in matlab enviroment to give the result as shown in table 2. The result shows the contractors ordering (rank) as follows:A6>A8>A4>A7>A2>A1O>A1>A5>A3>A9, with A6, as the most preferred alternative, followed by A8 and A4 as the 2nd and 3rd preferred alternatives while Alternative A9 is the least preferred.

Conclusion

The current subjective approach to contractor selection in the system which is highly politicised is unacceptable if our universities are to meet vision 2020 of the Federal Government of Nigeria of being one of the top 20 economies by the year 2020. To this end, a template for the selection of contractor is proposed in this paper and should be strictly followed in the selection process in our university system. The attributes considered in this work are proposed top 4 criteria in the selection of contractors in the university system. This paper also proposed scientific techniques for handling human decision problem in the university system. Our literature search revealed several methods for solving MCDM problems, but some are cost minization based e.g., inventory based methods, volume discount, mathematical progrmming techniques, GA (Teimoury et al,2011, Mak and Cui, 2011, Mogri et al, 2010, Saen, 2010, Taleizadeh et al, 2011, and Woarawichai et al, 2010). And cost as a quantitative criterion is not a sufficient attribute for addressing contemporary selection problems

(Ho et al, 2010); therefore, a decision model that can accommodate both qualitative and quantitative is desirable. To this end, this paper used intuituionistic fuzzy TOPSIS to address the contractor selection problem in our university system. This is so, because it is able to accommodate as many qualitative and quantitative criteria with alternatives as one can imagine. Again, the method is highly amenable to humanistic systems such as the university education system we investigated in this paper. Other methods in literature are: AHP, ANP, CBR SMART, only strive in a crisp environment. However, we suggested that the 4 criteria used in this study should be uppermost in the selection of contractors in the system. Intuitionistic fuzzy TOPSIS provides timely pieces of information that will help in the selection process. It is concluded that applying scientific technique to humanistic system is most appropriate and rewarding because it leads to accuracy and development in the system.

References

Ashrafzadeh, M., Rafiei, F. M., Isfahani, N. M., & Zare, Z. (2012). Application of Fuzzy TOPSIS Method for the Selection of Warehose Location: A Case Study. *Interdisciplinary Journal of Contemporary Research in Business* 3(9), 655-671.

Atanassov, K. T. (1986). Intuitionistic Fuzzy sets. *Fuzzy sets and systems* 20, 87-96.

Boran F. E., Genc S., Kurt M. & Akay D. (2009). A multi-criteria intuitionistic fuzzy group decision making for supplier selection with TOPSIS method. *Expert Systems with Applications 36*, 11363–11368.

Carlsson, C.& Fuller, R. (1996). Fuzzy Multiple Criteria Decision Making: Recent Developments. *Fuzzy sets and systems* 78, 139-153.

Chai, J. & Liu. J.N.K. (2010). A Novel Multi-criteria Group Decision Making Approach with Intuitionistic Fuzzy SIR Method. *World Automation Congress.*

Elanchezhian, C., Ramnath, B.V., & Kesavani R., (2010) Vendor Evaluation Using Multi-criteria Decision Making Techniques. *International Journal of Computer Applications* 5(9), 4-9.

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, 16–24.

Izadikhah, M. (2012). Group decision making process for supplier selection with topsis method under interval-valued intuitionistic fuzzy numbers. *Advances in Fuzzy Systems Volume* 2012, Article ID 407942, 14 pages doi:10.1155/2012/407942.

Kabir, G., (2012). Third Party Logistic Service Provider Selection Using Fuzzy AHP and TOPSIS Methods. *International Journal for Quality Research* 6(1), 71-79.

Mak, K.L & Cui L.X (2011). Optimal Multi-Period Supplier Selection and Order Allocation in a Multi-Product Supply Chain incorporating Customers Flexibility" Proceedings of the World Congress on Engineering 2, London, U.K.

Mogri, M. M. Javadi, M. M., & Yazdian, S. A. (2010). Supplier Selection and order lost sizing using dynamic programming. *International Journal of Industrial Engineering Computations*

Omosigho S. E. & Omorogbe D. E. A. (2013). Supplier Selection Using Different Metric Functions. *Proceedings of The 5th*

Kingdom. Pp.51-57.

Saen, R. F. (2010). A New Algorithm for Ranking Suppliers in Volume Discount Environments. *Asia Pacific Management Review* 15(3), 341-358.

Soeini, R. A. et al (2012). Supplier selection based on multiple criteria. *International Journal on New Computer Architectures and Their Applications (IJNCAA)* 2(1): 258-273

Taleizadeh, A. A. Widyadama, G. A. Wee, H. M. & Biabani (2011). Multi products single machine Economic production Quantity Model with Multiple Batch Size. *International Journal of industrial Engineering Computations* 2, 213 – 224.

Teimoury E., Ansari H., & Fathi M. (2011). Fuzzy Queuing Approach for Designing Multi-Supplier Systems (Case: SAPCO Company) *International Journal of Industrial Engineering and Production Research*: 22 (1) pp 11-20.

Woarawichai, C., Kullpattaranirun, T., & Rungreunganum, V. (2010). Applying Generic Algorithms for Inventory Lot-sizing Problem with Supplier Selection under storage Capacity. *The 2nd RMUTP International Conference*; 122-126

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.

Yang, Y. & Chiclana, F. (2009). Intuitionistic Fuzzy Sets: Spherical Representation and Distances. *International Journal of Intelligent Systems, Vol.* 24, 399–420.