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DEVELOPING A DECISION -MAKING FOR OUTSOURCING APPLYING FUZZY ANALYTICAL HIERARCHY PROCESS (FAHP)

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ABSTRACT
Outsourcing is nowadays a widespread practice in national and international companies since it allows them to better use time, energy, manpower, technology, capital, resources, etc. Thus, the appropriate selection of the outsourcer plays an important role in establishing the company's position in the market and contributes to its success. To facilitate the entrepreneur's reasoning for the choice of the best provider, to increase the efficiency of decision making in an uncertain environment, given the inherent uncertainty and imprecision of human decision making as well as future market and firm behaviors, we have developed a hybrid multi-attribute, multi-actor decision support model (FMAADM) to address the problem at hand. For this objective, we have combined the AHP concept with fuzzy logic reasoning.
For the validation of this proposed model, an experimental study was conducted to prioritize (03) services of outsourcing related to maintenance and industrial installation for the case of a manufacturing company of plastic products. The proposed model meets the objective sought and thus is retained for the selection of the best provider in a certain/uncertain context of multi-attribute and multi-actor.
Keywords: *Outsourcer, Decision making, FMAAD, AHP, Fuzzy set theory, FAHP...*

1. INTRODUCTION

Before starting the process, a definition of outsourcing is necessary [1]. The authors listed have a fairly common vision of the principles surrounding the concept of subcontracting. Marcel Capet2 and Jean Hoflack (1978) propose an economic definition of subcontracting that is characterized by two points: participation in the development of a final product that will be sold and dependence on the principal. According to them, this dependence is characterized by the fact that the product model did not exist

before the relationship between the principal and the outsourcer, but was produced on that occasion [2]. They define outsourcing as the relationship where the subcontractor develops under the direction of the principal a product element that will be sold by the latter. The relationship is characterized by participation in the development of a final product and dependence on the principal. This definition is too restrictive. It gives too much importance to the concept of dependence which can vary greatly from one company to another. Outsourcers try to reduce this dependence on a single client. There can be outsourcing even if the contractor has several principles.

Marcel Moisson (1972) interprets outsourcing or collaborative industrial production as following:

"a market mechanism according to which firms", or independent production units, by a mutual division of labor according to their capacities or specialties, cooperatively produce

products for the market. He also explains that subcontracting occurs when one company (called the principal) places an order with another company (called the subcontractor) for the production of a part or part of it [3], which will be sold by the principal. It is thus a contractual arrangement between the main firm and a sub-firm for [4]:

- the supply by the subcontractor, on the order of the principal firm, of parts, components, subassemblies, and assemblies that will be incorporated into a product sold by the principal firm;

- the processing of raw materials on behalf of the principal firm [5]. This definition is limited to the manufacturing field. The next definition is much more general and is the one chosen for this

research work. In his work on the integrated elements of company policy, Chaillou4 (1978) defines subcontracting as: "any work whose realization requires the intervention of an external agent from either the definition of the work (by realizing the detailed definition document), or the definition of the work methods (by realizing the method document), or the execution of the work itself (by executing the part of the service), this intervention being done until the complete completion of the work. This definition meets the concepts of:

- substitution to the principal in the execution of work by bearing the risks;
- subordination to the directives of the principal which will be more or less precise and elaborated.

Table 1. The Advantages And Disadvantages Of Outsourcing [6].

Advantages	Disadvantages
Cost reduction	Lose control
Time economy	Further need for coordination
Emphasis on core and strategic issues	Further dependency to outdoor organizations and institutes
Hidden costs clarification	High risk
Increased flexibility	
Increased accountability	
Quality improvement	
Easy access to resources and skills	
Gaining competitive advantage	

The selection of the most appropriate outsourcers is considered an important strategic decision that can have an impact on the performance of the client company's commitments. This section represents one of the main challenges related to the outsourcing of a function remains the choice of the partner. Indeed, “in order to get the best services, manufacturers usually invite several outsourcing companies to submit their offers and then select the best offer” [7]. In addition, working with the wrong partners has an impact on the financial and operational situation of manufacturers.

So, choosing the right outsourcer will be a matter of identifying the best provider that will best satisfy the customer. Price/quality, Financial stability, Professional competence, and Reputation are the most important selection criteria used by the client companies [8].

2. LITERATURE REVIEW

The MCDM is interested in solving decision problems that include multiple criteria [9]. There are many researches have been conducted on the problem of selecting the best available outsourcer in the markets. In [10], “the paper suggested a new fuzzy hierarchical technique of order preference by similarity to the ideal solution (TOPSIS) to evaluate the most appropriate business process outsourcing (BPO) decision”, , this method was originally developed by Ching-Lai Hwang and Yoon in 1981 and belongs to the category of MADM (Multi Attribute Decision Making), its main process is to determine the distance between the Positive Ideal Solution (fuzzy PIS) and the Negative Ideal Solution (fuzzy NIS) for each alternative in order to select the most appropriate one. However, in the existing FTOPSIS method, there are no consistency and reliability checks, as explained below. We believe that these two features are very important in any decision-making process, as they can lead to misleading results.

In [11], the researchers applied the Fuzzy PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) method for the evaluation of IT outsourcing providers [12], that hybrid method is based on the mutual comparison of each pair of alternatives with respect to each selected criterion, this outranking method allows to rank the actions but does not allow to account for the quantitative differences related to these actions. In [13], they propose a hybrid model of MCDM (DEMATEL)(CRITIC) TOPSIS to evaluate and classify outsourcing providers in the manufacturing industry. In [14], the paper proposes an integrated and multi-criteria tool useful to monitor and improve the performance of an outsourced supply chain in order to define different scenarios/profiles in which the company could operate. However, this proposed method remains insufficient to assign the appropriate weighting to the choice criteria.

After reviewing the literature on the outsourcing problem for companies, a structured approach for this problem was developed in a fuzzy environment was not found.

The problem of selecting among the outsourcers available in the market can be formulated as the MCDM problem.

Since the existing environment is full of ambiguities, we apply the fuzzy AHP method for

the evaluation of the best outsourcer through four comparison criteria presented in table 2

3. LA METHODOLOGIE.

The model is based on a multi-criteria analysis, which uses the concept of AHP and the fuzzy logic technique.

a group of decision makers to weight a finite number of stimuli [15]. The multi-criteria method helps

decision by weighting the criteria (stimuli at level 1 of the decision) and the actions (stimuli at level 2)

on the respective criteria, and by aggregating the intermediate results, a procedure that allows to compute a final score for each action.

We are interested in a class of discrete and geometric scales (i.e., the geometric series) to express the gradations of the judgment (indifference, weak preference, strong preference, ...) when comparing one stimulus to another. The scale transformations do not change the stimuli's out-ranking relations, and they only slightly affect their weighting. affect their weighting only slightly.

These comparisons are established according to the judgment of the experts and presented not by exact values (principle of the excluded middle) but rather by fuzzy numbers, because, the vague nature of the gradations and the imprecision of the decision-makers are considered and led us to the introduction of fuzzy numbers to express the preferential judgments. We confine the work to numbers with triangular characteristic functions because the parameters follow a transparent algebra. In a simplified model, where all judgments have the same degree of imprecision, we obtain an analytical solution that allows us to study the propagation of fuzziness in a hierarchy of decision levels [16].

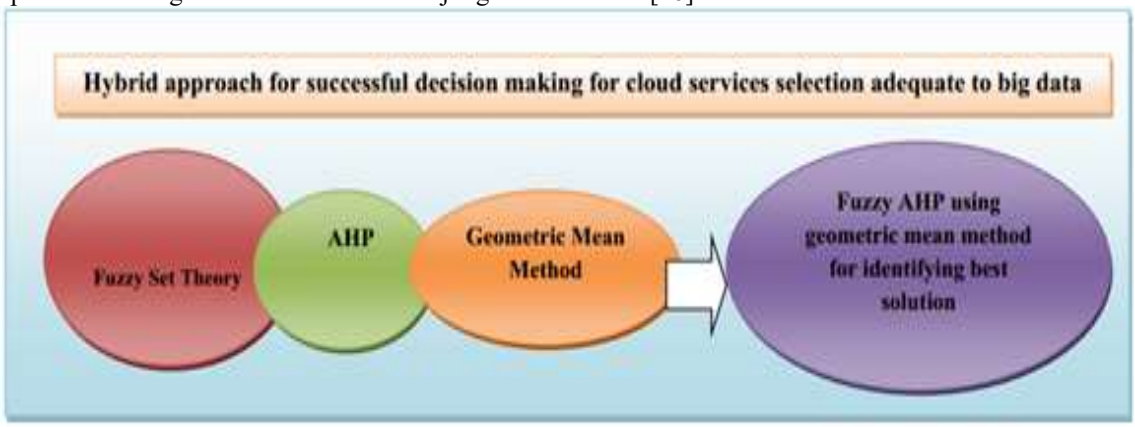

Figure 1. Proposed Approach [17].

Detailed steps of the hybrid approach are as follow see figure2:

Step 1: setting up the hierarchy structure.

This step consists in formulating the problem related to the choice of the best subcontractor in the form of a hierarchical structure in order to distinguish the simplicity and the clarity of the hierarchical relationships.

This structure must clearly define the desired objective which in this case of study: to select the subcontractor. Appropriate.

In order to obtain the best services, the client company invites several outsourcing companies to submit their offers, which are considered alternatives [18].

The ranking of these alternatives is based on well-defined and pre-defined criteria as illustrated in the following table.

Table 2. The Criteria Required By The Client Company.

Index	Criteria	Description
C1	Price/quality	Cost is important, but it should not be the only reason you choose a supplier. Lower prices may reflect lower quality goods and services which, in the long run, may not be the most cost-effective choice.
C2	Financial stability	It's always a good idea to make sure your supplier has enough cash on hand to deliver what you want, and when you want it. A credit check will help reassure you that they won't go bankrupt when you need them most.
C3	Professional competence.	Depending on the type of work to be performed, specific certifications/training must be completed to ensure that the subcontractor has all the technical and practical knowledge to perform the work safely and effectively [19]. While, managing training credentials is a daunting task, it is mandatory in order to meet your duty of due diligence, but also to ensure that the outsourcer will address the right behaviors to not compromise the safety of your employees.
C4	Reputation	It is important to validate the profile of the outsourcing company to ensure that it is recognized and registered, that it exists and that it respects the laws. Do not hesitate to ask for copies of legal or professional permits and licenses. It is important to always consider the size of the subcontractor, the scope of their work and their financial strength before awarding work to them. Remember, it is not always the one who offers the best price that is worthy of consideration. It's the one who can be trusted, who respects his commitments, who is safe, who employs a competent workforce, etc. To find out if this subcontractor is recognized in his field, look at his portfolio and his latest achievements. You can even contact their former clients or partners to find out more about their work habits, the quality of the work they do, their ability to meet deadlines, etc.

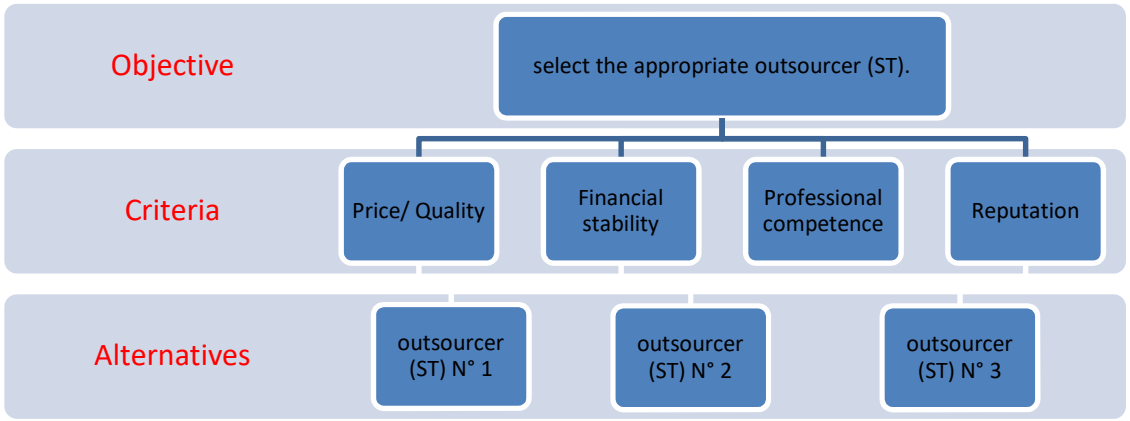

Figure 2. Decision Tree Structure.

To have in the end a simple and hierarchical tree structure as it is presented in the figure below

The following figure shows the steps to follow when dealing with the subject of choosing the best outsourcing company.

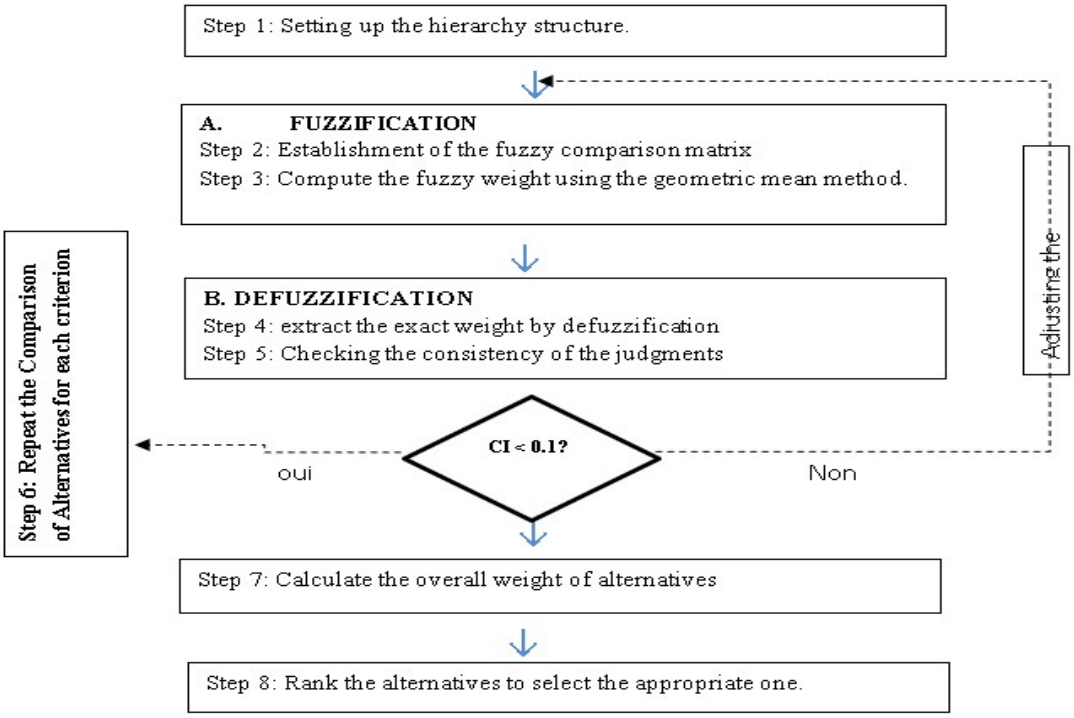

Figure 3. An 8-step proposed methodology for FAHP.

Step 2: Establishment of the fuzzy comparison matrix.

The most important step in the FAHP method is the establishment of the comparison matrix [20], in fact the experts of the client company are first to define the weighting of each criterion via a comparison in advance, then to compare the service providers (outsourcing company) according to each of the criteria according to a comparison scale

A. Fuzzy set theory (definition and basic principles) see figure (4) [21]:

A fuzzy set is defined as follows: "If X is a universe of discourse and x is a particular element of X, then a fuzzy set has defined on X and can be written as a collection of ordered pairs A = {(x, μÃ(x), x ϵ X}" [22].

"The membership function completely defines (MF) the fuzzy set" [23]. "A membership function provides a measure of how similar an element is to a fuzzy set" [22]. "Membership functions can - either be chosen by the user arbitrarily" [24], based on the user's experience (user-chosen MF) the user's experience (the MF chosen by two users could be different based on their experiences, perspectives, etc.) [23]- "or be designed using machine learning methods (e.g., artificial neural networks, genetic algorithms, etc.) (Continue) There are different forms of membership functions: triangular, trapezoidal, etc.

In this work, we use a triangular membership function is specified by three parameters {a, b, c} a, b and c represent the x-coordinates of the three vertices of μA (x) in a fuzzy set A" [22].

(a: lower bound and c: upper bound where membership degree is ze Si $a \leq x \leq b$ where membership degree is 1) [:

$$\mu_{\tilde{A}}(x)=\begin{cases} x-b/b-a & \text{Si } b\leq x\leq c \\ x-a/b-c & \text{Sinon} \\ 0 & \end{cases}$$

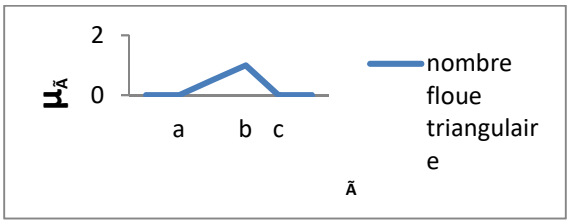

Figure 4. Triangular Membership Function.

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In this case the fuzzy number "Ã" can be expressed in the vector form Ã = (a ; b ; c)

- basic operations between fuzzy numbers

Consider Ã 1= (a1; b1; c1) and Ã 2= (a2 ;b2 ;c2) two triangular fuzzy numbers

Ã 1+ Ã 2= (a1+a2; b1+b2; c1+c2)

K* Ã 1= (Ka1; Kb1; Kc1)

Ã 1* Ã 2= (a1*a2; b1*b2; c1*c2)

- Ã 1= (-a1; -b1; -c1)

$\frac{1}{Ã\,1} = (\frac{1}{c1}; \frac{1}{b1}; \frac{1}{a1})$

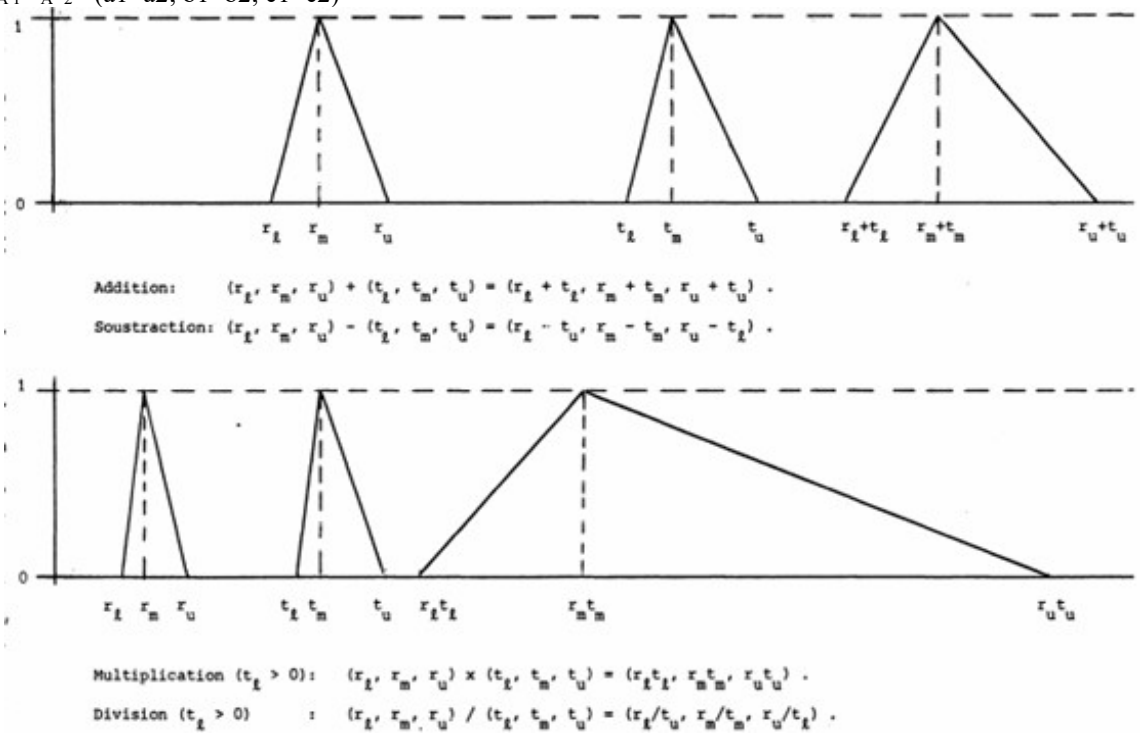

Figure 5. Arithmetic Operation On Two Fuzzy Members Ř = (Rl, Rm, Ru) Et Ť = (Tl, Tm, Tu) With Triangular Characteristic Functions.

The comparison is done according to a scale presented in the following table, where each linguistic term of comparison is associated with a triangular fuzzy number [25].

Table 3. The Linguistic Vaiables And Their Corresponding Fuzzy Numbers.

Linguistic scale	Triangular fuzzy scale
Equally preferred	(1 ; 1 ; 1)
Fairly preferred	(2 ; 3 ; 4)
Very preferred	(4 ; 5 ; 6)
Strongly preferred	(6 ; 7 ; 8)
Absoluty preferred	(8 ; 1 ; 1)
The intermittent values between 2 adjacent scale	(1 ; 2 ; 3)
	(3 ; 4 ; 5)
	(5 ; 6 ; 7)
	(7 ; 8 ; 9)

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Paired comparison analysis is used to compare options two at a time (hence the name) and decide the relative importance of each compared to the others using the fuzzy triangular comparison scale mentioned above [26].

By applying this approach to compare the criteria required by the client company in Table 4.

Table 4. The Criterias Fuzzy Evaluation Matrix.

	Price/quality	Financial stability	Professional competence	Reputation
Price/quality	(1 ; 1 ; 1)	(1 ; 2 ; 3)	(3 ; 4 ; 5)	(5; 6 ; 7)
Financial stability	($\frac{1}{3}$; $\frac{1}{2}$; 1)	(1 ; 1 ; 1)	(1 ; 2 ; 3)	(2 ; 3 ; 4)
Professional competence	($\frac{1}{5}$; $\frac{1}{4}$; $\frac{1}{3}$)	($\frac{1}{3}$; $\frac{1}{2}$; 1)	(1 ; 1 ; 1)	(1 ; 2 ; 3)
Reputation	($\frac{1}{7}$; $\frac{1}{6}$; $\frac{1}{5}$1)	($\frac{1}{4}$; $\frac{1}{3}$; $\frac{1}{2}$)	($\frac{1}{3}$; $\frac{1}{2}$; 1)	(1 ; 1 ; 1)

Step 3: Calculate the fuzzy weight using the geometric mean method

Geometric mean

"The geometric mean, like all averages, indicates the central or typical tendency of a series of values" [27]. Which is only the values given to a criterion when comparing between criteria.

According to BUKLY, to calculate the geometric mean Ri of a criterion i, one multiplies the values of comparison dij of this criterion compared to the other criteria, then take the n the root of the result. The nth of the root corresponds to the number of values [28].

$\check{R}i=\sqrt[n]{\prod_{j=1}^{n} dij}$ =

$\sqrt[n]{di1 * di1 * di3 * di4 * \dots\dots\dots * din}$

Eigen value

To calculate Eigen value Wi of a criterion i, we multiply its geometric mean Ri with the inverse of the sum of the geometric means.

$WI=\check{R}\ i* (\sum_{j=1}^{n} Rj)^{-1} = \frac{\check{R}i}{\check{R}1*\check{R}2*\dots.*\check{R}n}$

Normalisation

Table 5. Calculating Geometric Mean, Eigen Value.

	Price/quality	Financial stability	Professional competence	Reputation	Geometric mean Ři	Eigen value Wi	Normalisation Ni = $Wi/\sum_{j=1}^{n} Wj$
Price/quality	(1 ; 1 ; 1)	(1 ; 2 ; 3)	(3 ; 4 ; 5)	(5 ; 6 ; 7)	(1.97 ;2.63 ;3.20)	(0.30 ;0.52 ;0.86)	(0.51 ;0.52 ;0.48)
Financial stability	($\frac{1}{3}$; $\frac{1}{2}$; 1)	(1 ; 1 ; 1)	(1 ; 2 ; 3)	(2 ; 3 ; 4)	(0.90 ;1.32 ;1.86)	(0.14 ;0.26 ;0.50)	(0.23 ;0.26 ;0.28)
Professional competence	($\frac{1}{5}$; $\frac{1}{4}$; $\frac{1}{3}$)	($\frac{1}{3}$; $\frac{1}{2}$; 1)	(1 ; 1 ; 1)	(1 ; 2 ; 3)	(0.51;0.70 ;1)	(0.10 ;0.14 0.27;)	(0.16 ;0.14 ;0.15)
Reputation	($\frac{1}{7}$; $\frac{1}{6}$; $\frac{1}{5}$)	($\frac{1}{4}$; $\frac{1}{3}$; $\frac{1}{2}$)	($\frac{1}{3}$; $\frac{1}{2}$; 1)	(1 ; 1 ; 1)	(0.33 ;0.41 ;0.56)	(0.05 ;0.08 ;0.15)	(0.09 ;0.09 ;0.08)
∑	($\frac{176}{105}$; $\frac{23}{12}$; $\frac{38}{15}$)	($\frac{32}{12}$; $\frac{23}{6}$; $\frac{11}{2}$)	($\frac{16}{3}$;$\frac{15}{2}$;10)	(9 ;12 ;15)	(3.71;5.06 ;6.63)	(0.58 ;1 ;1.78)	(1 ;1 ;1)

B. Defuzzification

In our case the numerical value "A" of a fuzzy number Â= (a1; a2; a3) is found by applying the following formula: $A=\frac{a1+8a2+a3}{10}$

Step 4: extract the exact weight by defuzzification.

Table 6. Local Weights Of Comparison Criteria.

Criteria	Weight
Price/quality	51.56 %
Financial stability	25.96 %
Professional competence	14.36 %
Reputation	08.10 %

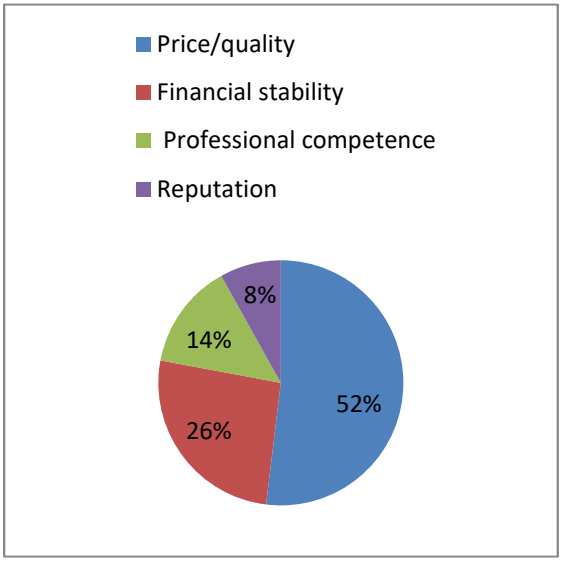

Figure 6. Criteria Weighting.

Step 5: Checking the consistency of judgements.

Consistency index

Ci= $\frac{\lambda max - n}{n-1}$ / avec λmax =$\sum_{i=1}^{n}(\sum_{j=1}^{n} rij * wi)$ appelé indice d'erreur

Uncertainty Ratio

To check if our opinions are consistent in our rating, "Mr. SAATY proposed what is called the "Consistency Ratio", which is a comparison between the consistency index and the random consistency index (RI) or in formula CR= CI/CR" [29].

Table 7. Consistency Index Of Random Matrices.

n	1	2	3	4	5	6	7	8	9	10
R	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

"If the value of the consistency ratio is less than or equal to 10%, the inconsistency is acceptable, otherwise we should consider revising our subjective judgments" [30].

λmax= (1.8; 3.9; 9.7) So, λmax= 4.27 Ci= 0.09 and CR= 0.1 ≤0.1 acceptable judgments

Step 6: Comparison of the alternatives according to each criterion

Applying the same approach to find the alternatives according to each selection criteria required by the client company.

The consistency of the calculation is reflected in the index of consistency, so as long as this index is close to 0, the more the calculation is coherent and precise.

tables 8, 9, 10, 11 illustrate the evaluation of the available contractors

Table 8. The Fuzzy Comparaison Matrix For The" Price/Quality " Criteria.

	ST N° 1	ST N° 2	ST N° 3	Geometric mean Ři	Eigen value Wi	Normalisation $Ni = Wi/\sum_{j=1}^{n} Wj$
ST N° 1	(1; 1 ; 1)	(2; 3 ; 4)	$(\frac{1}{3}; \frac{1}{2}; 1)$	(0.87 ;1.14 ;1.58)	(0.18 ;0.30 ;0.54)	(0.30 ;0.30 ;0.30)
ST N° 2	$(\frac{1}{4}; \frac{1}{3}; \frac{1}{2})$	(1; 1 ; 1)	$(\frac{1}{7}; \frac{1}{6}; \frac{1}{5})$	(0.33 ;0.38 ;0.46)	(0.07 ;0.10 ;0.16)	(0.11 ;0.10 ;0.10)
ST N° 3	(1; 2 ; 3)	(5; 6 ; 7)	(1 ; 1 ; 1)	(1.71 ;2.9 ;2.76)	(0.35 ;0.60 ;0.94)	(0.59 ;0.60 ;0.57)
∑	$(\frac{9}{4}; \frac{10}{3}; \frac{9}{2})$	(8; 10; 12)	$(\frac{31}{21}; \frac{10}{6}; \frac{11}{5})$	(2.91 ;3.81 ;4.8)	(0.60 ;1 ;1.65)	(1 ;1 ;1)
λmax= (1.40 ; 2.9 ; 6.40)→ 3.10						

Ci=0.05 then Cr=0.09 ≤ 0.1 → acceptable judgments.

Table 9. The Fuzzy Comparaison Matrix For The" Financial Stability " Criteria.

	ST N°1	ST N°2	ST N°3	Geometric mean Ři	Eigen value Wi	Normalisation $Ni = Wi/\sum_{j=1}^{n} Wj$
ST N°1	(1; 1 ; 1)	$(\frac{1}{7}; \frac{1}{6}; \frac{1}{5})$	$(\frac{1}{3}; \frac{1}{2}; 1)$	(0.36 ;0.43 ;0.58)	(0.07 ;0.11 ;0.18)	(0.11 ;0.11 ;0.12)
ST N°2	(5; 6 ; 7)	(1; 1 ; 1)	(2; 3 ; 4)	(2.15 ;2.62 ;3.03)	(0.45 ;0.66 ;0.96)	(0.68 ;0.66 ;0.64)
ST N° 3	(1; 2 ; 3)	$(\frac{1}{4}; \frac{1}{3}; \frac{1}{2})$	(1 ; 1 ; 1)	(0.63 ;0.87 ;1.14)	(0.13 ;0.22 ;0.36)	(0.20 ;0.22 ;0.24)
∑	(7; 9; 11)	$(\frac{39}{28}; \frac{3}{2}; \frac{17}{10})$	$(\frac{10}{3}; \frac{9}{2}; 6)$	(3.14 ;3.93 ;4.76)	(0.66 ;1 ;1.51)	(1 ;1 ;1)
λmax= (1.60 ; 2.98 ; 5.70)→ 3.11						

Ci=0.0655 then Cr=9.095 ≤ 0.1 → acceptable judgments.

Table 10. The Fuzzy Comparaison Matrix For The" Professional Competence " Criteria.

	ST 1	ST2	ST3	Geometric mean Ri	Eigen value Wi	Normalisation $Ni = Wi/\sum_{j=1}^{n} Wj$
ST N°1	(1; 2 ; 3)	$(\frac{1}{4}; \frac{1}{3}; \frac{1}{2})$	(1 ; 1 ; 1)	(0.63 ;0.87 ;1.14)	(0.13 ;0.22 ;0.36)	(0.20 ;0.22 ;0.24)
ST N°2	(5; 6 ; 7)	(1; 1 ; 1)	(2; 3 ; 4)	(2.15 ;2.62 ;0.03)	(0.45 ;0.66 ;0.96)	(0.68 ;0.66 ;0.64)
ST N°3	(1; 1 ; 1)	$(\frac{1}{7}; \frac{1}{6}; \frac{1}{5})$	$(\frac{1}{3}; \frac{1}{2}; 1)$	(0.36 ;0.44 ;0.58)	(0.08 ;0.11 ;0.18	(0.11 ;0.11 ;0.12)

Σ	(7; 9; 11)	$(\frac{39}{28}; \frac{3}{2}; \frac{17}{10})$	$(\frac{10}{3}; \frac{9}{2}; 6)$	(3.14 ;3.93 ;4.76)	(0.66 ;1 ;1.51)	(1 ;1 ;1)
λmax= (1.60 ; 2.98 ; 5.70) → 3.11						

Ci=0.0655 then Cr=9.095≤0.1 → acceptable judgments..

Table 11. The Fuzzy Comparaison Matrix For The"Reputation" Criteria.

	ST 1	ST2	ST3	Geometric mean Ri	Eigen value Wi	Normalisation Ni = $Wi/\sum_{j=1}^{n} Wj$
ST 1	(1; 1 ; 1)	(3 ; 4 ; 5)	(6 ; 7 ; 8)	(2.62;3.03;3.42)	(0.52 ;0.71 ;0.96)	(0.73 ;0.71 ;0.68)
ST 2	$(\frac{1}{5}; \frac{1}{4}; \frac{1}{3})$	(1; 1 ; 1)	(1; 2 ; 3)	(0.58 ;0.79 ;1)	(0.11 ;0.18 ;0.28)	(0.16 ;0.18 ;0.2)
ST 3	$(\frac{1}{8}; \frac{1}{7}; \frac{1}{6})$	$(\frac{1}{3}; \frac{1}{2}; 1)$	(1 ; 1 ; 1)	(0.34 ;0.41 ;0.55)	(0.07 ;0.09 ;0.155)	(0.1 ;0.09 ;0.11)
Σ	$(\frac{53}{40}; \frac{39}{28}; \frac{3}{2})$	$(\frac{13}{3}; \frac{11}{2}; 7)$	(8; 10; 12)	(3.55 ;4.24 ;4.97)	(0.71 ;1 ;1.40)	(1 ;1 ;1)
λmax= (1.76; 2.99; 5.2)→3.09						

Ci=0.045. then Cr=0.078 ≤ 0.1 → acceptable judgments.

Local weights of alternatives according to each comparison criterion.

	Price/quality	Financial stability	Professional competence	Reputation
ST N° 1	30.30 %	11.10 %	11.26 %	22.08 %
ST N° 2	10.09 %	66.10 %	66.66 %	66.66 %
ST N° 3	59.61 %	22 .80 %	22.08%	11.26 %

Step 7: Calculate the overall weight of alternatives.

Result= local weights of criteria (W_i) *global weights of alternatives

$$\begin{bmatrix} W1 \\ W2 \\ Wn \end{bmatrix} * \begin{bmatrix} w11 & w12 & w1m \\ w21 & w22 & w2m \\ wm1 & wm2 & wmm \end{bmatrix}, \quad \text{where m is the number of} \quad (21)$$

Table 12. Overall Weight Of Altenatives.

	Overall weight
ST 1	23%
ST 2	36 %
ST 3	41 %

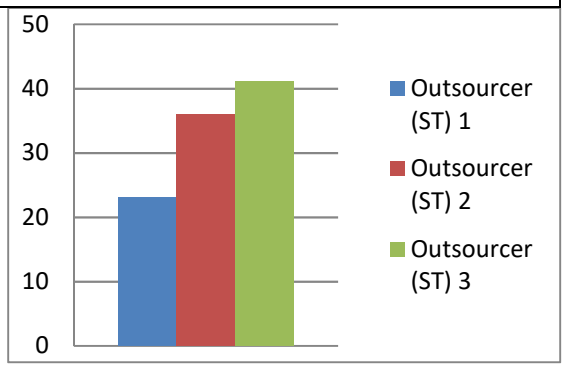

Figure 8: Overall Weight Of Alternatives

Step 8: Rank the alternatives to select the appropriate one

Table 13. Final Ranking Of Providers.

Available outsourcers	Ranking	The appropriate outsourcer
Outsourcer (ST) N° 1	3	ST N° 3
Outsourcer (ST) N° 2	2	
Outsourcer (ST) N° 3	1	

4. RESULTAT ET DISCUSSION

Table 13, shows the final ranking of the three outsourcers (ST) according to their priority values. Indeed, ST3 is ranked as the first, while ST2 and ST1 are ranked second and third respectively. Therefore, ST3 is the most appropriate for the company as the best provider.

This ranking may vary if the company's experts have changed the weights assigned to each decision criterion. Moreover, for a company that gives more importance to quality than the other criteria, ST2 will be the most appropriate for it.

The number and choice of indicators have a huge influence on the model established and affect the result obtained. Indeed, for the same providers and just by introducing another additional criterion in the approach or for example changing the weighting of the criteria it requires more numerical calculations to evaluate the ranking order of the alternatives and therefore the result may change. Hence, the particularity of our proposed model. More than a method for making decisions, the FAHP gives the company more flexibility and diversity of choice, since each change in the weights assigned to the criteria generates a possible change in the ranking. Thus], the results will differ from one company to another.

Moreover, applying the same approach, the research work [31] dealing with the outsourcing of information systems (IS) proposes a structured methodology based on a fuzzy group decision making approach to evaluate and select the information system project (ISP) through seven decision criteria, namely risk, management, economics, technology, resources, quality and strategy.

The results obtained showed that the combination of the AHP method and the fuzzy concept to rank and prioritize the outsourcing services to be outsourced is a useful and practical tool to make a traceable and reliable decision much more manageable and flexible than the classic AHP method used in the work [32] whose decision criteria chosen are: Expectation, risk and environment applied in the business process domain.

5. CONCLUSION

In this article, we have analyzed the problem of selecting the best outsourcer available on the market. This analysis shows the complexity of the situation since a good outsourcer must combine all the criteria (good cost, good quality, short lead time and an excellent reputation) this is difficult to have.

The model developed combines the AHP method presented by Thomas SAATY adopted to the multi criteria and multi actor problem and the fuzzy reasoning introduced by Zadeh in 1965, which provides a new mathematical tool to deal with the uncertainty of information that is not considered in the AHP method. The FAHP method solves the challenge of selecting the best contractor available in the market for outsourcing through comparison matrices between all the contractors available in the market according to predefined criteria to end with a ranking of the contractors.

The value of this model is its flexibility and its adaptation to different requirements. Indeed, we can have different results with the same subcontractor but with a modification of the weight of the criteria. And as long as the companies are not at the same distance from the criteria, the result obtained can be considered exclusive for each company.

6. LIMITATION

The result obtained remains relative, in fact, the addition or deletion of a comparison criteria, the calculations must be redone. In addition, for the same alternatives and the same comparison criteria, with just one weighting change of one of the criteria, the final ranking of the alternatives will vary.

For all of the above reasons, the proposed method remains sensitive and relative, since each client company requires its own criteria with particular weightings, which makes it difficult to predict the results.

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