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Application of the Fucom Method Accompained by SAW-WASPAS Method for the Selection for the Pump

Bonu Sandeep Kumar[1]
Department of Mechanical Engineering, A.U college of Engineering, Andhra University, 530003
Visakhapatnam, India

Prof. K. Venkata Subbaiah[2]
Department of Mechanical Engineering, A.U college of Engineering, Andhra University, 530003
Visakhapatnam, India

***Abstract*—** **Nowadays, having the greatest product is something that everyone aspires to. Choosing the greatest product has become more difficult in the present day, since numerous products seem to have excellent specs as well. Thus, is generally regarded as an MCDM issue, where the best material is picked based on a given set of competing criteria, and this plays a vital part in its correct functioning. The designers of these MCDM challenges don't typically know how many criteria they should use to arrive at the best possible decision. It's best to limit the number of criteria to seven plus or minus two and make sure they're not interdependent. The Full Consistency Method (FUCOM) is a novel multi-criteria problem-solving approach presented in this research. In the model, two sets of constraints are required to meet the weight coefficients' optimum values. On the basis of pairwise comparisons of criteria, the model was validated by comparing it to two other subjective models (SAW and WASPAS).**

Keywords*— Full Consistency Method (FUCOM); Simple Additive Weighting (SAW); Weighted Aggregate Sum Product Assessment (WASPAS);

I. INTRODUCTION

In every company, product selection is a continuous process. Indeed, when the environment evolves, new technology is produced, and new preferences emerge, the product should profit from these advances; otherwise, what is seen to have contributed value now may not be perceived to have added value tomorrow. Jute, for example, has long been used as a packing material. However, since technology and customer tastes have changed, the same product is no longer deemed to have additional value, and hence its demand has decreased. Product selection is critical for an organisation since it determines the firm's influence and image with its consumers.

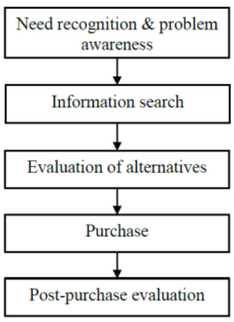

Figure 1: The process for the selection of product

A. Need recognition and problem awareness:

Consumers begin this process by identifying their problem or need and then considering which product or kind of product would best address it. An issue or need must be identified before a consumer would even consider buying a product, and this is the most critical step in the process.

B. Information search:

The second step of the consumer decision process is information search. When a consumer has a specific problem or requirement, they are more inclined to hunt for answers within or outside at this stage. Similarly, consumers search for value in a possible product or service when they are evaluating the market. In this time, the consumer's options become clearer to them.

C. Evaluating alternatives:

When making a purchasing decision, consumers must consider all of their options before making a final decision. For each product and brand, shoppers evaluate each one on a scale of characteristics that might potentially provide them an edge. Evoked sets — the brands and goods they evaluate — are the possibilities that consumers explore during their problem-solving. Consideration sets, also known as the evoked set, are typically restricted in relation to the full number of options available. In the case when a consumer spends a significant amount of time comparing products and services, they are considered to be engaged in protracted problem resolution.

D. Purchase:

At this point, consumers have made their final selection and are ready to make their purchases. During this time, the consumer may decide to buy the most preferred brand since he has evaluated all other options and assessed the value it will provide him.

E. Post-purchase behavior:

To put it another way, post-purchase behaviour refers to a customer's final evaluation of whether or not he is pleased with a purchase. This may have a significant influence on whether or not the customer returns to make another purchase from the brand or looks at other products in their line of business. A customer's obligation to express his or her thoughts on the purchase may lead him or her to influence the buying choices of others.

F. Market surveys helps to understand the customer:

Market research is required to get a feel of the clients and their demands. A market study will provide the merchant ideas for extra items to sell as well as how to plan and conduct marketing initiatives.

G. *More is not always better:*

Customers often seek just one or two particular things in a store and pay little attention to the rest. A more limited product range that meets the demands of the consumer allows the shop to operate more efficiently since stock reserve expenses are decreased.

H. *Expensive vs. cheap:*

There is an inverse relationship between price and volume of sales: cheaper things sell more units, but more expensive ones sell fewer units but make more money. It's important to strike a balance between high-volume goods with low profit margins and low-volume things with higher profit margins, while still satisfying the needs of the customer base. Brands and market conditions must be taken into consideration when deciding what products to sell. The present situation determines whether a lower price for lesser quality goods is better than a higher price for greater quality goods. Customers looking for both low-cost and high-quality items should have a wide variety of alternatives to choose from in the product selection.

I. *Report's help analyze which products sold better:*

"By weekdays" – provides an overview by day to show the best-selling day.

"By hours" – provides an overview by hour to show the best-selling hour.

"By Customer" – gives a breakdown of sales by customer group to help determine which customers should be the focus of the next marketing campaign in order to increase revenue.

"By Location" – provides an overview of the sales by shop.

"By Product" – displays the products sold during the specific period. 7

"By Product Group"– shows the best-selling product groups and the product groups that could be targeted during the next campaign.

"By Document" – gives a breakdown of sales by document, together with the quantities sold, discounts applied, and the corresponding VAT rates. It's easy to see discrepancies in numbers using "By Document," such as when the cash and receipts report displays one amount while the sales and sales turnover report shows a different one.

"Sales Summary" – shows the chosen period's sales totals as well as the VAT paid on those totals. When a longer time period is specified, the sales amount and the exact VAT rates that were applied are both presented by month of calendar year.

J. *Factors influencing when choosing products:*

1. Quality

People buy products because they are confident in their efficacy. Either from personal experience with the product or through demonstration advertising, consumers have seen the results and are more likely to purchase that brand because of the well-established reputation for superior quality. Innovative formulation services are required to generate a high-quality product recipe for a company. Manufacturing processes must also be tested to ensure that they are reliable and consistently produce a high-quality product.

2. Claims

Many consumers believe that the product's advertising is of major importance. If you're searching for a product that meets your specific objectives and needs, you'll want to know everything about it, from "fragrance free" and "all-natural" to "cleans in under 3 minutes." The opposite is true: false remarks may quickly damage customer trust in a business. An independent laboratory should be hired by companies to verify product claims and test product efficacy so that they may make the best claims on the market.

3. Innovation

While the product their great-grandmother used may have been great for many generations of consumers, most people are always on the lookout for something better. Keeping your audience engaged and attracting new customers requires a willingness to go outside the box. Because it requires an in-depth knowledge of the product, innovation is also one of the most challenging elements for firms to implement individually. In order to keep their products fresh, manufacturers use analytical laboratories to examine and improve current recipes, as well as create new items. The employment of analytic chemistry in these facilities allows for the creation of products that are more effective, have a better look and a longer shelf-life.

4. Safety

Regardless of whether a product is "all-natural" or "very flammable," safety testing and labelling are essential to ensuring the safety of customers and the brand's reputation. Specified analytical laboratories conduct verification investigations and stability testing in order to verify claims and detect any potential dangers. In addition, they provide services like as reformulation and failure analysis in the case of product recalls, in order to identify defects in the production process.

5. Competitor comparison

If a competitor's product is better in every way, it doesn't matter what the other factors on this list say about buyers' need for helpful and trustworthy products. Performing a rival product analysis may provide valuable insight into marketing claims and can reveal, among other things, why the competitor's product is more effective than the one being analysed and why it is brighter, stronger, and lasts longer.

K. *Objective of the Study*

Everyone nowadays wants to get the greatest product. The selection of the best product is becoming more difficult in the present day, as most products seem to be quite excellent in terms of specs as well. As a result, things are becoming more challenging at the moment. Many aspects must be considered before selecting a product. The factors investigated for pump selection may reveal a connection, therefore forming a hierarchical relationship is included as additional object.

All of the criteria may not have equal weightage, therefore determining the weightage of variables and ranking them using SAW and WASPAS in order to consider ideas for optimising the pump selection based on the results. The formatter must build these components while taking into account the following requirements.

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II. METHODOLOGY

For the first time, FUCOM (Pamuar et al., 2018) provides a unique method for establishing the weights of criteria in multicriteria decision making. According to specified criteria, a multi-criteria decision-making issue is one in which the best choice is selected from a set of possibilities. Maximize the number of criteria (j = 1, 2,..., n) while keeping the number of alternatives (A = 1,2,..., m) in mind, and then solve the equation for x using the restriction that A = [a1, a2,..., am]. It is possible to calculate the values of each criterion fij for each option ai under consideration, namely fij = fj(ai), There is a direct correlation between the ith criterion and the ith alternative for each attribute value.

Issues in the real world may not be as grave as they seem on the surface. Therefore, the significance factors of individual criteria must be adjusted using appropriate weight coefficients for the criterion, such that their sum is one.. In multi-criteria decision-making models, determining the proper weights of criteria is always a unique and subjective undertaking. This is a crucial stage that has a significant impact on the ultimate decision-making result due to the large weight coefficients in certain systems. So this study focuses on the problem of discovering criterion's weights, and a new FUCOM model for determining the weight coefficients of criteria is proposed. Consequently This method satisfies the comparison consistency criteria while accurately estimating the weight coefficients of all components that are being compared at a particular level of hierarchy.

To put it another way, in practise, the relative preference of criteria I to criterion j is determined by subjective judgements rather than real measurements. There are other deviations from the ideal ratios of wi/wj aij (where wi and wj represents criteria weights of criterion I and criterion j). There will be inconsistency in problem solving and a decrease in the dependability of the conclusions if it is determined, for example, that A is much more important than B, B than C and C than A. This is especially true when a large number of pairwise criteria comparisons must be performed. To the maximum extent possible, FUCOM reduces comparison errors due to: (1) a minimum number of comparisons (n-1) and (2) limits applied when calculating the optimal values of criteria. FUCOM lets you check the model's accuracy by determining the error value for the obtained weight vectors and the divergence from perfect consistency (DFC). On the other side, the BWM and AHP models create redundancy in the pairwise comparison, making them less vulnerable to judgement errors, while the FUCOM methodological methodology overcomes this problem. FUCOM is used to get the weight coefficients of the criteria.

Step-1: The assessment criteria C = 'C1,C2,...,Cn' are rated in the first phase of the process. The criteria are ranked in order of importance, beginning with the criterion with the greatest weight coefficient and working down to the criterion with the lowest weight coefficient. In this way, the weight coefficients for each criterion are arranged according to their predicted values:

$$C_{j(1)} > C_{j(2)} > \ldots > C_{j(k)}$$

K is the rank of the observed criteria in the dataset. The symbol of equality is used instead of ">" when two or more criteria are judged to be of equal importance.

Step-2: Ranks of the criteria are compared in the second phase, and the relative priority (k/(k+1), where k indicates the rank of the criterion) is established for each one of the assessment criteria. The criterion of the Cj(k) rank has an advantage over the criterion of the Cj(k+1) rank because of the relative importance of the assessment criteria (k/(k+1)). For example: in expression (2.1), the vector comparing the relative importance of the assessment criteria is produced.

$$\Phi = (\varphi_{1/2}, \varphi_{2/3}, \varphi_{k/(k+1)}) \qquad (2.1)$$

where $\varphi_{k/(k+1)}$ represents the significance (priority) that the criterion of the $C_{j(k)}$ rank has compared to the criterion of the $C_{j(k)}$ rank.

Step-3: In the third step, the final values of the weight coefficients of the evaluation criteria $(w_1, w_2, \ldots, w_n)^T$ are calculated. The final values of the weight coefficients should satisfy the two conditions:

(1) that the ratio of the weight coefficients is equal to the comparative priority among the observed criteria ($\varphi_{k/(k+1)}$) defined in Step-2, i.e. that the following condition is met:

$$\frac{w_k}{w_{k+1}} = \varphi_{k/(k+1)}$$

(2) In addition to the condition (3), the final values of the weight coefficients should satisfy the condition of mathematical transitivity, i.e., that $\varphi_{k/(k+1)} \otimes \varphi_{(k+1)/(k+2)} = \varphi_{k/(k+2)}$. Since $\varphi_{k/(k+1)} = \frac{w_k}{w_{k+1}}$ and $\varphi_{(k+1)/(k+2)} = \frac{w_{k+1}}{w_{k+2}}$, that $\frac{w_k}{w_{k+1}} \otimes \frac{w_{k+1}}{w_{k+2}} = \frac{w_k}{w_{k+2}}$ is obtained. Thus, yet another condition that the final values of the weight coefficients of the evaluation criteria need to need to meet is obtained, namely:

Step-4: Summing all the values of the alternatives obtained (summing by rows):

$$Q_i = [q_{ij}]_{1\times m}$$

$$q_{ij} = \sum_{j=1}^{n} v_{ij}$$

Step-5: Determining a weighted product model by applying the following equation:

$$P_i = [p_{ij}]_{1\times m}$$

$$p_{ij} = \prod_{j=1}^{n} (v_{ij})^{w_j}$$

Step-6: Determining the relative values of alternatives Ai:

$$A_i = [a_{ij}]_{1\times m}$$

$$A_i = \lambda \times Q_i\,(1 - \lambda) \times P_i$$

The coefficient λ ranges from 0, 0.1, 0.2, …, 1.0.

Step-7: Ranking the alternatives.

The highest value of alternatives implies the best-ranked one, while the smallest value refers to the worst alternative.

A. *Simple Additive Weighting*

Another option for dealing with multi-attribute decision making is SAW (Simple Additive Weighting). Each option's weighted performance scores across all parameters are tallied using the SAW technique. A process of normalizing the choice matrix (X) to a scale that may be compared to all current option ratings is required by the SAW approach.

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$$r_{ij} = \frac{x_{ij}}{Max(x_{ij})}$$

j ij

The weights of all criteria are obtained by using the formula number three. With rij is the normalized performance rating of alternatives on attribute C_i A_i; i = 1,2, ..., n and j = 1, 2,..,n. Preference value alternative (vi) using the formula number four.

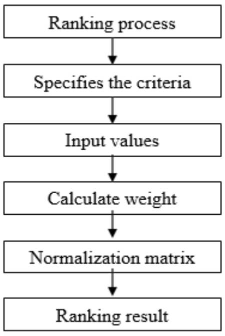

Figure 2: shows the model of the MCDM method.

B. WASPAS Method

To put it another way, WASPAS is a unique combination of the weighted sum model (WSM) and the weighted product model (WPM) (WPM). By virtue of their mathematical simplicity and accuracy, WSM and WPM techniques have been widely regarded as inefficient decision-making tools. A flexible manufacturing system, a flexible production cell, an automated guided vehicle, an automated inspection system, and an industrial robot were all used in this research to demonstrate its usefulness. The WASPAS technique has been shown to be a good fit for all five of these problems. The optimal 1 value is defined for each of the described difficulties, and the effects of varying values on the WASPAS technique are also examined.

LINGO 19.0

LINGO is a comprehensive tool designed to make building and solving Linear, Nonlinear (convex & non-convex/Global), Quadratic, Quadratically Constrained, Second Order Cone, Semi-Definite, Stochastic, and Integer optimization models faster, easier and more efficient. LINGO provides a completely integrated package that includes a powerful language for expressing optimization models, a full featured environment for building and editing problems, and a set of fast built-in solvers. The recently released LINGO 19.0 includes a number of significant enhancements and new features.

LINGO is a software tool designed to efficiently build and solve linear, nonlinear, and integer optimization models.

LINGO 8.0 includes several new features, including:

1. A new global solver to confirm that the solution found is the global optimum,
2. Multi-start capability to solve problems more quickly,
3. Quadratic recognition and solver to identify quadratic programming (QP) problems,
4. A faster and more robust Dual Simplex solver,
5. An improved integer solver to enhance performance in solving many types of problems,
6. Linearization capability to transform common non-smoothed functions to a series of linear functions,
7. Infeasible and unbounded analytical tools to help identify model definition problems,
8. A decomposition feature to identify if a model contains independent sub models,
9. A thread safe DLL for various classes of models, and
10. More fun than ever before!

III. CASE STUDY

Choosing the best pump overhaul mechanization is entirely reliant on accurately determining, selecting, and evaluating key factors. In order to allocate weights to the listed criteria, we looked at their importance and the people in charge of mechanical overhauls.

Table 1: Shows the criteria and criteria description

Criteria	Criterion description
Purchase price (C_1)	When making an investment decision, the purchase price should not be decisive to the buyer, but it has a significant impact on the final decision. In an unsystematic approach, once the basic conditions are met, the purchase price is often a decisive factor.
Age (C_2)	The age or year of production characterizes the production period manufactured recently have better specifications and options for adjustment to the requirements.
Working hours (C_3)	Utilization time is one of the most important criteria the less the hours of the utilization are, the lesser possibility of its breakdown is.
Maximum discharge capacity (C_4)	Maximum discharge capacity is a criterion that represents the discharge capacity
Maximum head (C_5)	Maximum head is a criterion that represents the height that a pump can lift.
Ecological factors (C_6)	Noise generated
Supply of spare parts (C_7)	All necessary spare parts that are subject to frequent replacements, and their delivery is being waited for weeks, so, the repairs of the means are long lasting. This criterion is in a group of qualitative criteria

Table 2: Shows comparison of criteria by three decision-makers

	DM1	DM2	DM3
C_1	5	5	5
C_2	4	2	2
C_3	1	1	1
C_4	2	3	3
C_5	3	4	4
C_6	7	7	7
C_7	6	6	6

Determining the significance of criteria according to Petrović et al. (2017) is one of the most important stages in a decision-making process

A. *Determining the Weight Values of Criteria for DM1*

Step-1: In the first step, the decision-makers rank the criteria:

C3 > C4 > C5 > C2 > C1 > C7 > C6.

Step-2: In the second step (step 2b), the decision-maker performs a pairwise comparison of ranked criteria from step-1. The comparison is made with respect to the first-ranked criterion C1.

Table 3: The significance of criteria for DM1

Criteria	C_3	C_4	C_5	C_2	C_1	C_7	C_6
$\varpi_{C_{j(k)}}$	1	2.2	3.8	4.5	5	6.5	7

Based on the obtained significance of the criteria, the comparative significance of the criteria is calculated:

$$\varphi_{c_3/c_4} = 2.20/1.0 = 2.20;$$

$$\varphi_{c_4/c_5} = 3.8/2.20 = 1.73;$$

$$\varphi_{c_5/c_2} = 4.50/3.8 = 1.18;$$

$$\varphi_{c_2/c_1} = 5.00/4.50 = 1.11;$$

$$\varphi_{c_1/c_7} = 6.50/5.00 = 7.00;$$

$$\varphi_{c_7/c_6} = 7.00/6.50 = 1.08.$$

Step-3: The final values of weight coefficients should meet two conditions:

1) The final values of weight coefficient should meet the condition (3), i.e., that: w3 / w4 = 2.20;
w4 / w5 = 1.73; w5 / w2 = 1.18; w2 / w1 = 1.11; w1 / w7 = 1.30; w7 / w6 = 1.08.
2) In addition to the condition (3), the final values of weight coefficients should meet the condition of mathematical transitivity, i.e., that:

$$\frac{w_3}{w_5} = 2.20 \times 1.73 = 3.81.$$

$$\frac{w_4}{w_2} = 1.73 \times 1.18 = 2.04.$$

$$\frac{w_5}{w_1} = 1.18 \times 1.11 = 1.31.$$

$$\frac{w_2}{w_7} = 1.11 \times 1.30 = 1.44.$$

$$\frac{w_1}{w_6} = 1.30 \times 1.08 = 1.40.$$

```
Local optimal solution found.
Objective value:                              0.6500000
Objective bound:                              0.6500000
Infeasibilities:                              0.7017866E-06
Extended solver steps:                              1
Total solver iterations:                          286
Elapsed runtime seconds:                         0.17

Model Class:                                    MINLP

Total variables:                      52
Nonlinear variables:                   7
Integer variables:                    11

Total constraints:                    57
Nonlinear constraints:                11

Total nonzeros:                      151
Nonlinear nonzeros:                   22

Linearization components added:
    Constraints:                      44
    Variables:                        44
    Integers:                         11

                       Variable           Value        Reduced Cost
                              E       0.6500000            0.000000
                             W3       0.4100815            0.000000
                             W4       0.1866602            0.000000
                             W5       0.1081946            0.000000
                             W2       0.9177510E-01        0.000000
                             W1       0.8218477E-01        0.000000
                             W7       0.6882905E-01        0.000000
                             W6       0.5927484E-01        0.000000

                            Row    Slack or Surplus      Dual Price
                              1       0.6500000           -1.000000
                              2        0.000000            0.5000000
                              3       0.2568421            0.000000
                              4       0.6500000            0.000000
                              5       0.6500000            0.000000
                              6       0.2678389            0.000000
                              7       0.4022631            0.000000
                              8        0.000000            0.5000000
                              9       0.6500000            0.000000
                             10       0.1874737            0.000000
                             11       0.6498000            0.000000
                             12       0.6500000            0.000000
                             13        0.000000            0.000000
```

By solving this model, we obtain the final values of weight coefficients for: (0.082, 0.091, 0.410, 0.186, 0.108, 0.059, 0.068) τ and the deviation from a complete consistency, a result = 0.001. After calculating, it can be concluded that the most important criterion is working hours. For this element, the final value of the weight coefficient is 0.410.

B. *Determining the Weight Values of Criteria for DM2*

Step-1: In the first step, the decision-makers ranked the criteria:

C3 > C2 > C4 > C5 > C1 > C7 > C6.

Step-2: In the second step (step-2b), the decision-maker performs a pairwise comparison of ranked criteria from step-1. The comparison is made with respect to the first ranked criterion C3. The comparison is based on scale [1,9]. Thus, we obtain significance for the criteria.

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Table 4: The significance of criteria for DM2

Criteria	C_3	C_2	C_4	C_5	C_1	C_7	C_6
$\varpi_{C_{j(k)}}$	1	2.8	3.5	3.5	4.2	5.5	6.5

Based on the obtained significance of the criteria, the comparative significance of the criteria is calculated:

$$\varphi_{C_3/C_2} = 2.80/1.0 = 2.80;$$

$$\varphi_{C_2/C_5} = 3.5/2.80 = 1.25;$$

$$\varphi_{C_5/C_4} = 3.50/3.50 = 1.00;$$

$$\varphi_{C_4/C_1} = 4.20/3.50 = 1.20;$$

$$\varphi_{C_1/C_7} = 5.50/4.20 = 1.30;$$

$$\varphi_{C_7/C_6} = 6.50/5.50 = 1.18.$$

Step-3: The final values of weight coefficients should meet two conditions:

1) The final values of weight coefficient should meet the condition (3), i.e. that: w3 / w2 = 2.80;

w2 / w4 = 1.25; w4 / w5 = 1.00; w5 / w1 = 1.20; w1 / w7 = 1.30; w7 / w6 = 1.18

```
Local optimal solution found.
Objective value:                              0.1613858E-02
Objective bound:                              0.1613858E-02
Infeasibilities:                              0.6826524E-03
Extended solver steps:                                   15
Total solver iterations:                                364
Elapsed runtime seconds:                               0.20

Model Class:                                          MINLP

Total variables:                     52
Nonlinear variables:                  7
Integer variables:                   11

Total constraints:                   57
Nonlinear constraints:               11

Total nonzeros:                     151
Nonlinear nonzeros:                  22

Linearization components added:
    Constraints:                     44
    Variables:                       44
    Integers:                        11

                     Variable           Value        Reduced Cost
                            E       0.1613858E-02        0.000000
                           W3       0.3990046            0.000000
                           W2       0.1425674            0.000000
                           W4       0.1150539            0.000000
                           W5       0.1160539            0.000000
                           W1       0.9402520E-01        0.000000
                           W7       0.7718716E-01        0.000000
                           W6       0.6410794E-01        0.000000

                          Row    Slack or Surplus      Dual Price
                            1       0.1613858E-02       -1.000000
                            2       0.3216385E-03        0.000000
                            3       0.1613858E-02        0.000000
                            4       0.1613690E-02        0.000000
                            5        0.000000            0.000000
                            6        0.000000            0.3389741
                            7        0.000000            0.3734796
                            8        0.000000            0.000000
                            9       0.1613858E-02        0.000000
                           10        0.000000            0.000000
                           11        0.000000            0.000000
                           12       0.1613858E-02        0.2875463
                           13        0.000000            0.000000
```

By solving this model, we obtain the final values of weight coefficients for: (0.094, 0.140, 0.398, 0.115, 0.116, 0.064, 0.077)τ and the deviation from a complete consistency, a result = 0.004. After calculating, it can be concluded that the most important criterion is working hours. For this element, the final value of the weight coefficient is 0.398.

C. Determining the Weight Values of Criteria for DM3

Step-1: *In the first step, the decision-makers ranked the criteria:*

C3 > C2 > C4 > C5> C1 > C7 > C6.

Step-2: In the second step (step-2b), the decision-maker performs a pairwise comparison of ranked criteria from step-1.

Criteria	C_3	C_2	C_5	C_4	C_1	C_7	C_6
$(\varpi_{C_{j(k)}})$	1	2.8	3.5	3.5	4.5	6	7

Based on the obtained significance of the criteria, the comparative significance of the criteria is calculated:

$$\varphi_{c_3/c_2} = 2.80/1.0 = 2.80;$$

$$\varphi_{c_2/c_5} = 3.5/2.80 = 1.25;$$

$$\varphi_{c_5/c_4} = 3.50/3.50 = 1.00;$$

$$\varphi_{c_4/c_1} = 4.50/3.50 = 1.29;$$

$$\varphi_{c_1/c_7} = 6.00/4.50 = 1.34;$$

$$\varphi_{c_7/c_6} = 7.00/6.00 = 1.17.$$

Step-3: The final values of weight coefficients should meet two conditions:

1) The final values of weight coefficient should meet the condition (3), i.e., that: w3 / w2 =2.80,

w2 / w5 =1.25, w5 / w4 =1.00, w4/ w1 = 1.29, w1/ w7 = 1.34, w7/ w6 = 1.17.

```
Local optimal solution found.
Objective value:                              0.1847237
Objective bound:                              0.1847237
Infeasibilities:                              0.4977528E-07
Extended solver steps:                                9
Total solver iterations:                           1925
Elapsed runtime seconds:                           3.13

Model Class:                                      MINLP

Total variables:                     52
Nonlinear variables:                  7
Integer variables:                   11

Total constraints:                   57
Nonlinear constraints:               11

Total nonzeros:                     151
Nonlinear nonzeros:                  22

Linearization components added:
    Constraints:                     44
    Variables:                       44
    Integers:                        11

                     Variable           Value        Reduced Cost
                            E       0.1847237            0.000000
                           W3       0.1101526            0.000000
                           W2       0.4183894            0.000000
                           W4       0.1120637            0.000000
                           W5       0.0507868            0.000000
                           W1       0.1701993            0.000000
                           W7       0.6517734E-01        0.000000
                           W6       0.5023091E-01        0.000000

                          Row    Slack or Surplus      Dual Price
                            1       0.1847237           -1.000000
                            2       0.7832284E-01        0.000000
                            3       0.1655216            0.000000
                            4       0.5024045E-01        0.000000
                            5       0.1717369            0.000000
                            6        0.000000            0.3652090
                            7        0.000000            0.3652090
                            8        0.000000            0.000000
                            9        0.000000            0.000000
                           10        0.000000            0.000000
                           11       0.1847237            0.000000
                           12        0.000000            0.2695819
                           13        0.000000            0.000000
```

By solving this model, we obtain the final values of weight coefficients for: (0.095, 0.170, 0.418, 0.110, 0.112, 0.050, 0.065)τ and the deviation from a complete consistency, a result = 0.001. After calculating, it can be concluded that the most important criterion (Table-4.6) working hours. For this element, the final value of the weight coefficient is 0. 418.Authors and Affiliations.

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Table 5: The criterion values for each decision-maker and values obtained by applying a geometric mean

DM1	DM2	DM3	The values obtained by applying a geometric mean
0.082	0.094	0.095	0.090
0.091	0.140	0.170	0.129
0.410	0.398	0.418	0.409
0.186	0.115	0.110	0.133
0.108	0.116	0.112	0.112
0.059	0.064	0.050	0.057
0.068	0.077	0.065	0.070

The final values of weight coefficients were obtained by LINGO software. From the table of results, it is clear in that this case working hours (C3) and maximum load capacity (C4) are the most important criteria.

Table 6: Shows a formed multi-criteria model consisting of ten alternatives and seven criteria

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
1	7.950	10	5012	4000	5400	5	7.67
2	12.900	10	7140	3000	3500	7	7.67
3	17.800	9	6500	5000	4500	7	5
4	19.300	19	4312	3000	6000	3	3.67
5	10.870	18	12000	3000	4000	5	3
6	30.400	7	4800	4000	4000	7.67	9
7	8.093	25	1200	4000	5900	3	5
8	29.800	11	3720	3000	5100	9	9
9	13.750	17	15350	4500	4800	3	5
10	18.297	13	6122	3000	4000	5	7
	Min 7.950	Min 7	Min 3720	Max 5000	Max 6000	Max 9	Max 9

Table 7: Normalized matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
1	1.000	0.700	0.742	0.800	0.900	0.556	0.852
2	0.616	0.700	0.521	0.600	0.583	0.778	0.852
3	0.447	0.778	0.572	1.000	0.750	0.778	0.556
4	0.412	0.368	0.863	0.600	1.000	0.333	0.408
5	0.732	0.389	0.310	0.600	0.667	0.556	0.333
6	0.262	1.000	0.775	0.800	0.667	0.852	1.000
7	0.982	0.280	0.310	0.800	0.983	0.333	0.556
8	0.267	0.636	1.000	0.600	0.850	1.000	1.000
9	0.578	0.412	0.242	0.900	0.800	0.333	0.556
10	0.434	0.538	0.608	0.600	0.667	0.556	0.778
	0.090	0.129	0.409	0.133	0.112	0.057	0.070

There are ten alternatives (pumps). Each pump has their own criteria. Each pump has their criteria. The respected criteria have its own values.

For pump 1, there are seven criteria For pump 2, there are seven criteria For pump 3, there are seven criteria

For pump 10, there are seven criteria.

Weighting the normalized matrix, so that the previously obtained matrix needs to be multiplied by the weight values of criteria that are present in the table 5

Table 8: Shows the weighted product model for the alternatives

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
1	0.090	0.090	0.304	0.106	0.101	0.032	0.060
2	0.055	0.090	0.213	0.080	0.065	0.044	0.060
3	0.040	0.100	0.234	0.133	0.084	0.044	0.039
4	0.037	0.048	0.353	0.080	0.112	0.019	0.029
5	0.066	0.050	0.127	0.080	0.075	0.032	0.023
6	0.024	0.129	0.317	0.106	0.075	0.049	0.070
7	0.088	0.036	0.127	0.106	0.110	0.019	0.039
8	0.024	0.082	0.409	0.080	0.095	0.057	0.070
9	0.052	0.053	0.099	0.120	0.090	0.019	0.039
10	0.039	0.069	0.249	0.080	0.075	0.032	0.054

IV. RESULTS AND DISCUSSION

Table 9: Ranking of the alternatives

	P	A	RANK
1	0.776	0.779	2
2	0.660	0.604	6
3	0.656	0.666	4
4	0.630	0.653	5
5	0.426	0.439	10
6	0.734	0.752	3
7	0.458	0.492	8
8	0.768	0.793	1
9	0.412	0.442	9
10	0.593	0.595	7

A. Ranking the alternatives:

The option with the greatest value is the best-ranked one, while the one with the lowest value is the worst. Thus, the Full Consistency Method (FUCOM) approach is used to choose the best option from among the alternatives.
The FUCOM approach was used to determine the relative weights of criteria, whereas the WASPAS method was used to rank them. Based on the model's conclusions, a solution that satisfies the present demands has been identified, which is sensitivity analysis and debate.
Sensitivity analysis is a logical phase in most multi-criteria decision-making procedures. The findings of the SAW technique), the WASPAS method were used for the sensitivity analysis of this model.

Table 10: Shows the sensitivity analysis of model for the alternatives

	SAW	RANK	WASPAS	RANK
A_1	0.782	2	0.779	2
A_2	0.608	6	0.604	6
A_3	0.675	5	0.666	4
A_4	0.677	4	0.653	5
A_5	0.452	10	0.439	10
A_6	0.769	3	0.752	3
A_7	0.526	8	0.492	8
A_8	0.817	1	0.793	1
A_9	0.471	9	0.442	9
A_{10}	0.598	7	0.595	7

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V. CONCLUSIONS

The outcomes of this research show that a new reliable approach for determining weight coefficients of criteria is urgently required. It is expected that other authors will promote FUCOM since it is based on a very basic mathematical apparatus. It also makes it possible to generate reasonable and dependable weight coefficients, which aid in making rational decisions and producing reliable results. Because of this, the use of this paradigm is critical.

1. As an aid to executives, FUCOM uses a basic algorithm and a suitable scale to help them cope with their own subjectivity when prioritizing criteria.
2. The ability to generate optimal weight coefficients using FUCOM and evaluate them based on the consistency of the results is another key feature of the software.
3. We may also reduce decision-making risk by employing the FUCOM model, which employs a simple mathematical apparatus to allow us to prioritise certain criteria for evaluating events in accordance with the demands of the decision-present maker.
4. In addition, FUCOM gives us the optimal weight coefficient values and reduces the subjective influence and consistency of expert selections on the final weight values of the criterion.
5. The model's robustness and objectivity are shown against other models in the third section of the research. It is clear that the results obtained are very consistent.
6. Sixth, completing the n1 criteria comparison yields the same results as the SAW and WASPAS models. This is a big advantage. It has also been shown that the model can be used to a number of measuring scales to capture the preferences of experts. The novel FUCOM methodology is compared to subjective approaches like SAW and WASPAS in the research.

7. The FUCOM technique is better than the others in terms of consistency, based on all of the instances included in the comparison. It is vital to note that the number of criteria comparisons varies significantly, especially when it comes to the SAW approach.

8. On the other hand, FUCOM's results reveal significantly less volatility in the weight coefficients of the criterion than the ideal values, compared to the subjective models evaluated. DFC0 deviance was found in a substantial number of tests, which indicated that the weight coefficients of the criteria were similar to the optimal values. Because the FUCOM approach creates modest additional variances, the results are more reliable and are typically comparable to ideal values, according to this study.
9. FUCOM's advantages need the creation and execution of software for real-world applications. All of the advantages stated in the post will be considerably more accessible to consumers as a result.

Our last suggestion is to include additional theories of uncertainty, such as neutrosophic and fuzzy sets, rough numbers, grey theory as well as other uncertainty theories. If uncertainty theories are used to build FUCOM, expert preferences may be processed even when comparisons are made on the basis of data that is either partially or very little understood. Allows the decision-preferences maker's to be expressed in a more clear and concise manner, while yet acknowledging that there may be instances when the decision-maker does not have all of the facts.

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