Towards a Muticriterion Decision Support Approach: Integrating Weighted Linear Goal Programming to help SEROR Tlemcen Company

نحو منهجية لدعم القرار متعدد المعايير: دمج برمجة الهدف الخطي المرجح لمساعدة مؤسسةSEROR تلمسان

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Abstract :

This study aims to use the weighted linear goal programming and the hierarchical analysis methods in building a mathematical model that helps in the process of deciding the optimal project site for the major completion and construction workstation SEROR Tlemcen Company. We tried to model the project location's decision using the two methods, because the differentiation between sites is a multi-criteria problem and it can be solved using Lindo program.

These methods allowed us to find the optimal solution and choose the best location for the project, considering all the criteria.

Keywords : *Multicriterion Decision, Decision Making, Lindo program.*

Jel Classification Codes : *C61, M10, O22.*

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ملخص:

تهدف هذه الدراسة إلى استخدام أسلوب البرمجة الخطية بالأهداف المرجحة وأسلوب التحليل الهرمي في بناء نموذج رياضي يساعد في عملية اتخاذ قرار موقع المشروع الأمثل لمحطة انجاز وبناء الأعمال الكبرى لشركة *SEROR* تلمسان. حيث حاولنا نمذجة قرار موقع المشروع باستخدام الأسلوبين وذلك لأن مشكلة المفاضلة بين المواقع تعتبر مشكلة متعددة المعايير وحله باستخدام برنامج *lindo* .

حيث سمحت لنا هذه الأساليب بإيجاد الحل الأمثل واختيار الموقع الأفضل للمشروع آخذين جميع المعايير بين الاعتبار خصوصا عندما تكون الأساليب الرياضية التقليدية غير فعالة.

كلمات مفتاحية: قرار متعدد المعايير، اتخاذ قرار، برنامج Lindo.

تصنيف JEL: C61, M10, O22.

1. *INTRODUCTION*

Among the factors that contribute to the survival and continuity of any project is its right and ideal site. A bad site may be the reason for the failure of this project, because the decision to choose and locate the site is not only a strategic decision, but it is also considered an investment decision that is irrevocable once made. Its long-term results are difficult to determine, and therefore errors in this type of decisions are totally unacceptable. For this reason, we find that institutions of various kinds are searching for sites that are appropriate for their activities. For instance, the establishment of universities takes place in locations that have transportation, security, places for expansion ... etc., and the establishment of factories takes place in locations outside the city for they will be near the raw material as well as to avoid pollution and congestion during Cargo transportation, to mention but a few.

In other words, the project location decision is determined by many factors such as labor, raw materials, proximity to markets, energy ... etc. These factors’ importance varies from one project to another, and the poor identification of it leads to a certain bankruptcy of the project. In addition, it is found that the difficulty of this decision lies in the multiplicity of goals that must be achieved, as well as how to express the characteristics that differentiates each site from another one and in what manner. Whenever the decision-maker relied on an accurate, scientific, quantitative and comprehensive study, the more successful s/he will be in achieving the goals set for him. However, if those decisions were random; this will necessarily *lead to unsuccessful decisions, thus, the establishment of projects that are not economically feasible.*

The following study is an attempt to answer the following question:

How can a mathematical model constructed using the two methods of the weighted linear goal programming and the hierarchical analysis be helpful in differentiating between different project sites?

Significance of the study:

- *Many investments and projects failed because of the unsuccessful decisions, i.e. bad differentiation between various project locations;*
- *Urging decision makers to use these quantitative methods to rationalize their decisions.*

Study objectives:

The aim of this study is to identify the weighted linear goal programming and the hierarchical analysis methods, which are among the most important methods that can be relied upon in the process of differentiation between projects and making the best investment decision.

Previous studies:

- ***Abdullah's study :*** *The researcher attempted to use goal programming and fuzzy goal programming technology to study the optimal planning for the aspects of investment in commercial investment expenses. The Khaleiji Commercial Bank was taken as a sample for the research, where she built the goal programming model under two objectives: the first is to maximize the return and the second is to reduce investment risks and then solve the model using Win QSB. The researcher concluded that using fuzzy goal programming technology in planning yields better results (Abdullah, 2014, p. 278).*
- ***Boumaaza and sifi's study:*** *In this study, the two researchers tried to apply hierarchical analysis method in determining the best location for Naftal GPL institution's store in Saida. Through their study, the researchers found that the hierarchical analysis method allows assigning weights to the criteria and ranking the sites according to preference. (Boumaaza & Sifi, 2015, p. 43)*
- ***Mabtouch and Adala's study:*** *Through this research paper, the researchers tried to drop the theoretical aspect of goal programming and formulate a model on the practical reality of the Tissemsilt Textile Foundation and obtain the optimal production plan by using the Excel Solver statistical program. The researchers*

concluded that the use of operational research methods in general and the goal-programming model in particular helps decision makers to solve some management problems. (Mabtouch & Adala, 2017, p. 22)

According to the previous studies, it is clear that the first study dealt with the use of goal programming using fuzzy goal programming technique to plan the optimal aspects of investment in commercial investment expenses. The second study dealt with applying the hierarchical analysis method in choosing the optimal store site. The third study, however, was conducted using goal programming in making investment decisions related to an optimal production plan for a production institution.

The current study differs from previous studies in that it is concerned with merging the weighted linear goal programming method, with the introduction of the relative deviation formula, and the method of hierarchical analysis. It aims at obtaining a mathematical model that enables decision makers to differentiate between various sites and choose the best one by using the Lindo program.

2. The most important concepts of the variables under study

2.1 Project site decision

The site decision is among the difficult strategic decisions faced by institutions. It means defining the place where the project will be established for the first time (Mohsen & Al-Najjar, 2006, p. 265). For example, defining a location to build a factory or one of the subsidiary warehouses. Furthermore, a distinction between the project's location and the project's site must be made (Abdelkader & Attia, 2014, p. 102).

Project location: Refers to the geographical area in which the project will be built.

The project site: Refers to the specific place where the project is located within the chosen geographical area. In other words, it is the place where all project departments, warehouses and workshops are located, and it is also called the industrial zone of the project.

2.2 Multi-criteria analysis

Through the decisions they take, institutions are trying to achieve either the lowest cost or maximum profit. However, considering the reality of the institution and the decision in its various aspects, it is found that it does not seek to achieve one goal but rather a set of implicit and important goals for its continuity and survival. These goals are expressed in various criteria, which are often branched (quantitative and qualitative variables), and are maximized, minimized, or both (Othmani, 1998, p. 03). In other words, it can be inconsistent, for example, searching for the optimal site among four different sites taking into consideration a set of criteria: the area of the site, its proximity to the main road, its distance from the population, the annual turnover.

2.3 Mathematical model definition

A mathematical model can be defined as a set of variables, interrelated and interconnected factors. They are linked with each other through a number of mathematical relationships (equations or variations) according to specific formulas that aim to clarify the nature of the studied problem with a description of the specifications of its external and internal variables (Muiead , 2004, p. 134).

2.4 The weighted linear goal programming method with the introduction of the relative deviation formula

It is considered one of the most important modern methods that can be used to locate the project or any other optional problem. It belongs to the linear goal programming types. The latter is an extension of the linear programming model (Morsi, 2002, p. 211) and it was created by the Americans (Cooper, Charnes, Ferguson) in 1955 AD. C. Romaero and M. Tamz 1998 define it: "as a mathematical technique that tends to be flexible and realistic in solving complex problems that take into account several goals and many variables and limitations" (Mehrdad, Carlos, & Dylan, 1998, p. 572). The mathematical formulation of the weighted linear goal programming model with the introduction of the relative deviations formula is as follows:

Relative deviations function: $MinZ = \sum_{i=1}^{i=k} \left(\frac{w_i n_i + w_i p_i}{g_i} \right)$

Goal functions: $\sum_{j=1}^{n} a_{ij} x_j - n_k + p_k = g_i$

Non-negative condition: $x_j \geq 0, (n_i, p_i) \geq 0$

Given that :

g_i: The target value to be reached for target i.

x_j: Decision variable.

a_{ij}: Coefficient of the contribution of the decision variable in achieving the target value.

n_i: The negative deviation of the target that shows the amount of failure in achieving the target value.

p_i: The positive deviation of the target that indicates the amount exceeding the target value.

We chose this technique among the goal programming techniques that are related to the problem of selection, and the traditional normalization method, and percentage normalization method (Mousslim, 2005, p. 156) because it maintains the economic meaning and mathematical model of the problem under study, and this is what we do not find completely in the previous two techniques.

2.5 The hierarchical analysis process

It is considered one of the most important multiple criteria decision-making methods. It was developed in the seventies by the professor of mathematics Saaty Thomas. This method provides us with the ability to choose between many alternatives while considering all the criteria. It can even measure those criteria that cannot be quantified, which is considered among the advantages of this method, especially when the process of standards formulating is difficult. In addition, it depends on the relationship between criteria and the relationship between the alternatives for each criterion.

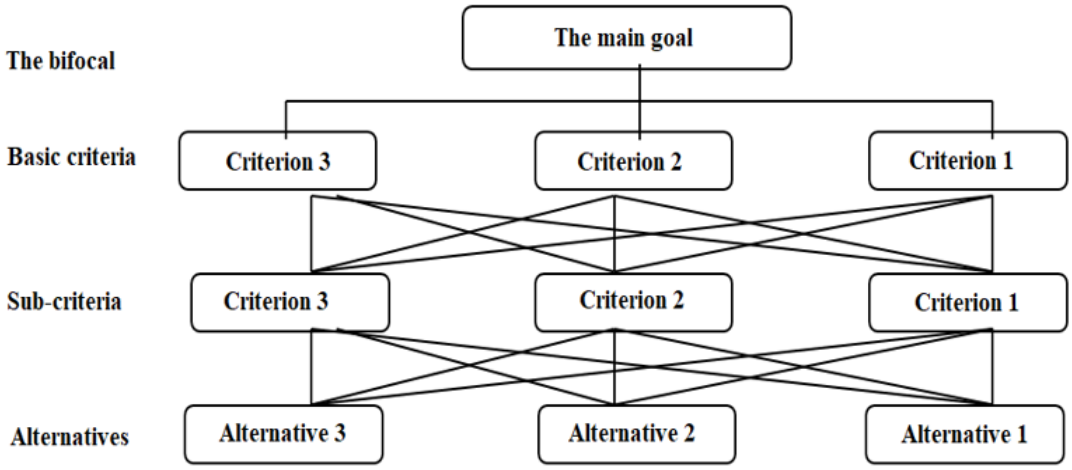
A. Hierarchical analysis method characteristics: The hierarchical analysis method is a differentiation method (Saaty, 2008, p. 18). Among its characteristics:

- It extracts priorities using the pair-wise comparison of the decision's elements with respect to each of the parent criteria, i.e. the higher level in the pyramid, so that the results of this comparison can be arranged in a matrix;
- Priorities are derived from the matrix by calculating what is known mathematically as an eigenvector, which is known as a "relative scale," and is considered the basis of the theory of the correct differentiation method;
- This method allows to calculate the extent of inconsistency in the previously given provisions;
- Priorities derived in this way achieve the characteristics of the relative scale, just like all other measures : meter, kg ... etc.

B. Stages of applying the hierarchical analysis method: The hierarchical analysis method involves the following stages:

- **Definition the problem:** At this stage, the nature of the problem is diagnosed, all the defined assumptions are clarified, the status of the decision is discussed, and the decision-makers begin introducing the decision (what do you want to achieve) where the provided answers present the potential goals (Keeney, 1996, p. 543).
- **Building a hierarchical form:** Here, a simplified identification of the problem takes place. The pyramid is formed from three levels, a first level for the primary objective of the decision, then a second level with the criteria for differentiation, and a third level that contains alternatives.

Fig.1. Hierarchical analysis model used in the process of evaluating alternatives



Source: Saaty (1996), The Analytic Hierarchy Process (AHP) for Decision-making, International Journal of Services Sciences, p. 18.

The pair-wise comparison and priority setting: Each alternative is evaluated for all alternatives, and each criterion is evaluated for all criteria, using the following table:

Table 1. Pair-wise comparison values

Degree of importance	Value
Equal preference	1
Preferring one alternative over the other	3
Strong preference for one alternative over another	5
A very strong preference for one alternative over another	7
Absolute preference for one alternative over another	9
Intermediate scores between previous values	2,4,6,8

Source: Alphonce (1996), Application of the Analytic Hierarchy Process in Agriculture in developing countries, University College Dublin, p. 99.

After building the hierarchy of the problem, the final priorities are determined from the numbers that are given during the pair-wise comparison between the criteria and the decision alternatives, based on the presented numbers in Table 1.

Hierarchical analysis uses systems thinking by building ideas hierarchically and uses causal thinking or interpretation through pair-wise comparison and by grouping.

- **Ensuring that the values given during the pair-wise comparison**

are logical: That is, measuring the success rate in giving the initial numbers during the pair-wise comparison by calculating the consistency rate, which is symbolized with the symbol CR. This is because the numbers of the pair-wise comparisons in the hierarchical analysis method are given with a subjective estimate, which is the basis for the obtained results. In order to avoid discrepancies in the estimates, finding a measure that determines whether the given values are logical or not is necessary.

$$CR = \frac{CI}{RI}$$

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

(CR): Consistency rate, **(CI)**: Consistency index, **(RI)**: Random consistency index, **(λ)**: The underlying root of the pair-wise comparison matrix, **(n)**: The number of items to compare, so that if:

$CR \leq 0.10$: This indicates a high degree of relative consistency in the answers.

$CR > 0.10$: The decision maker must review the items' pair-wise comparison numbers.

The values of the random consistency index are extracted from the following table:

Table 2. Random consistency index values

N	2	3	4	5	6	7	8
RI	0	0.58	0.90	1.12	1.24	1.2	1.41

Source: Essayid (1999), Some Quantitative Methods in Business, Dar Jamiiya, p.397.

- **Weighted evaluation of alternatives:** The overall weighted evaluation of the sites is calculated starting from the collection of weighted evaluation of the criteria for each site, where the latter is a multiplication of the priorities of each site in relation to the criterion in the weight of the criterion.
- **The analysis of results and decision-making:** In this step, the alternatives are arranged according to the percentages obtained, where the alternative with the highest percentage are the chosen ones.

3. Using the two methods of hierarchical analysis and the weighted linear goal programming in selecting the best location for the major SEROR project

Before moving into the practical study, we first introduce the company and present the project.

A Company for the Study and Realization of Western Works of Art of Algeria SEROR:

It is a public economic company, located in Tlemcen, operating under the tutelage of the management foundation for shareholders for public works, where the only contributor is the state. Its main activities are technical works, construction of water dams, construction of bridges and tunnels, maintenance, provision of expertise and engineering works.

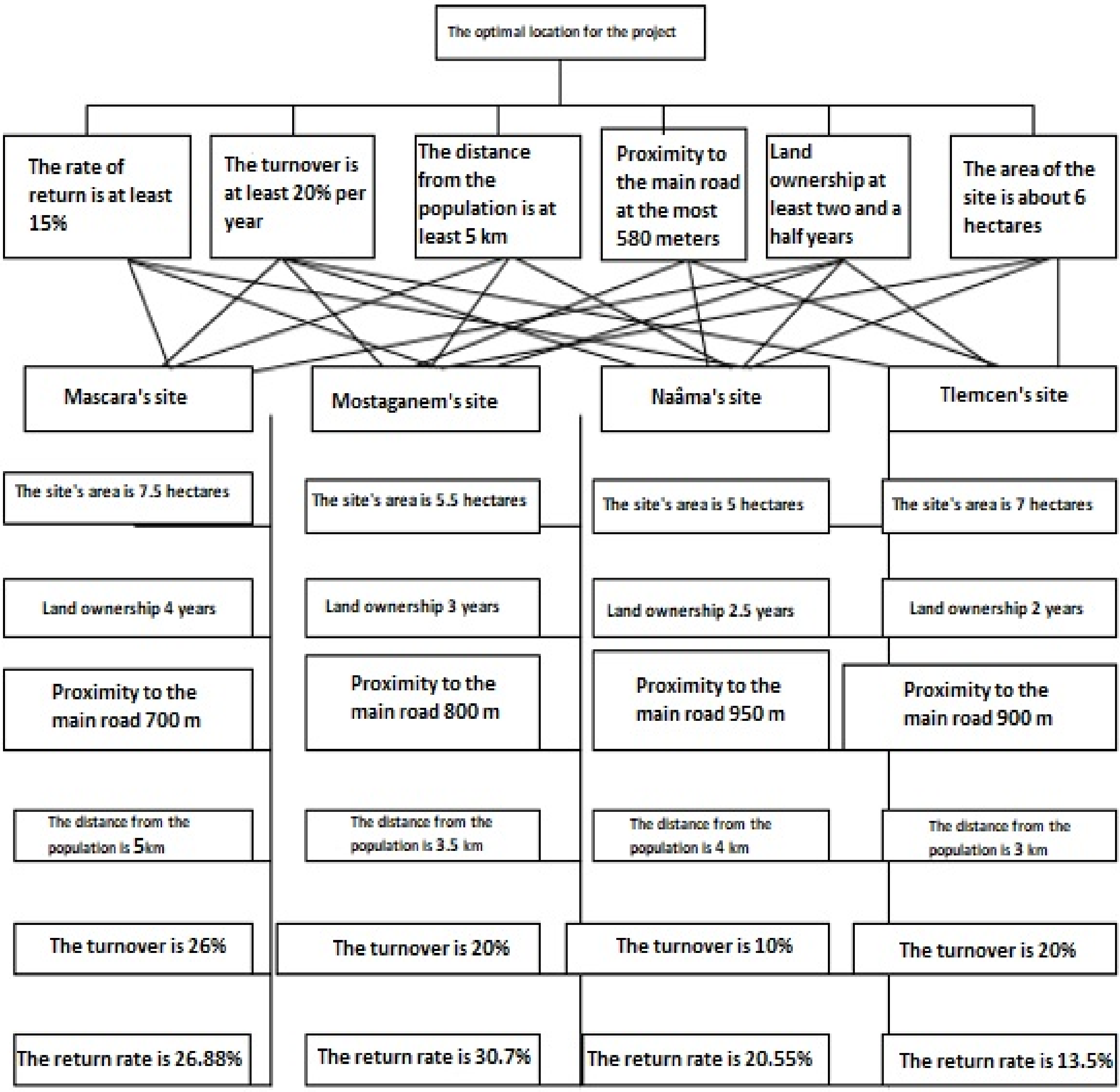
Presentation of the project:

The project involves the establishment of an additional station for the completion and construction of major artistic works to support Oran station. The station should be close to the workshops. Four locations were subject to discussion (Tlemcen, Naâma, Mostaganem, Mascara) where we will try, with the participation of the decision makers of the company, to reach the best site using the two methods.

3.1 Using the hierarchical analysis method

A. Building the hierarchical form stage

Fig.2. The hierarchical form of the company's decision regarding the construction site of building a completion station and the company's major works



Source: Prepared by the researcher and in direct interview with the company's decision-makers.

B. The stage of pair-wise comparison and setting priorities

In this stage, we do a pair-wise comparison of the sites according to each criterion starting from the analysis of Fig.2 and from the principle of the hierarchical analysis method, which is represented in pair-wise relative preference. The results of this stage are shown in the following table:

Table 3. The pair-wise comparison matrix of sites according to each criterion

The two-way approach to sites according to the area of the site's criterion				
	Tlemcen's site	**Naâma's site**	**Mostganem's site**	**Mascara's site**
Tlemcen's site	1	3	1	5
Naâma's site	0.33	1	0.33	3
Mostganem's site	1	3	1	5
Mascara's site	0.2	0.33	0.2	1
The two-way approach to sites according to the land ownership 's criterion				
	Tlemcen's site	**Naâma's site**	**Mostganem's site**	**Mascara's site**
Tlemcen's site	1	0.33	0.14	0.11
Naâma's site	3	1	0.2	0.14
Mostganem's site	7	5	1	0.2
Mascara's site	9	7	5	1
The two-way approach to sites according to the proximity to the main road 's criterion				
	Tlemcen's site	**Naâma's site**	**Mostganem's site**	**Mascara's site**
Tlemcen's site	1	5	7	0.33
Naâma's site	0.2	1	3	0.2
Mostganem's site	0.14	0.33	1	0.14
Mascara's site	3	5	7	1
The two-way approach to sites according to the distance from the population 's criterion				
	Tlemcen's site	**Naâma's site**	**Mostganem's site**	**Mascara's site**
Tlemcen's site	1	7	5	1

Naâma's site	0.14	1	0.33	0.14
Mostganem's site	0.2	3	1	0.2
Mascara's site	1	7	5	1

The two-way approach to sites according to the turnover 's criterion

	Tlemcen's site	**Naâma's site**	**Mostganem's site**	**Mascara's site**
Tlemcen's site	1	1	0.14	0.12
Naâma's site	7	7	1	0.2
Mostganem's site	7	7	1	0.2
Mascara's site	8	8	2	1

The two-way approach to sites according to the rate of return's criterion

	Tlemcen's site	**Naâma's site**	**Mostganem's site**	**Mascara's site**
Tlemcen's site	1	0.33	0.11	0.14
Naâma's site	3	1	0.12	0.16
Mostganem's site	9	8	1	0.5
Mascara's site	7	6	2	1

Source: Prepared by the researcher, and in direct interview with the company's decision-makers

Table 4. Pair-wise comparison matrix of criteria according the goal

I / J	**The area of the site**	**Land ownership**	**Proximity to the main road**	**Distance from the population**	**The turnover**	**The rate of return**
The area of the site	1	4	4	7	0.33	0.5
Land ownership	0.25	1	5	0.5	0.5	0.5

Proximity to the main road	0.5	0.2	1	0.16	0.12	0.14
Distance from the population	0.14	2	6	1	4	3
The turnover	3	2	8	0.25	1	3
The rate of return	2	2	7	0.33	0.33	1

Source: Prepared by the researcher, and in direct interview with the company's decision-makers.

Then we do the initial evaluation of the first criterion "site area":

Table 5. The original site evaluation matrix for the "site area" criterion

The area of the site	Tlemcen's site	Naâma's site	Mostganem's site	Mascara's site
Tlemcen's site	1	3	1	5
Naâma's site	0.33	1	0.33	3
Mostganem'ssite	1	3	1	5
Mascara's site	0.2	0.33	0.2	1
Total	2.53	7.33	2.53	14

The area of the site	Tlemcen's site	Naâma's site	Mostganem's site	Mascara's site	The average of rows
Tlemcen's site	0.39	0.40	0.39	0.35	0.38
Naâma's site	0.13	0.13	0.13	0.21	0.15
Mostganem's site	0.39	0.40	0.39	0.35	0.38
Mascara's site	0.07	0.04	0.07	0.07	0.06

Source: Prepared by the researcher.

$$a_{11} = {}^{1}/_{2.53} = 0.39$$

$$a_{12} = {}^{3}/_{7.33} = 0.40$$

$$a_{13} = {}^{1}\!/_{2.53} = 0.39$$
$$a_{14} = {}^{5}\!/_{14} = 0.35$$

C. The stage of ensuring that the values given during the pair-wise comparison are logical

Consistency ratio = Consistency index / Random index

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

First: Weighting the results with the values of the original matrix columns

$$(0.38).1 + (0.15).3 + (0.38).1 + (0.06).5 = 1.51$$
$$(0.38).0.33 + (0.15).1 + (0.38).0.33 + (0.06).3 = 0.58$$
$$(0.38).1 + (0.15).3 + (0.38).1 + (0.06).5 = 1.51$$
$$(0.38).0.2 + (0.15).0.33 + (0.38).0.2 + (0.06).1 = 0.26$$

Second: The consistency matrix

$${}^{1.51}\!/_{0.38} = 3.97$$
$${}^{0.58}\!/_{0.15} = 3.86$$
$${}^{1.51}\!/_{0.38} = 3.97$$
$${}^{0.26}\!/_{0.06} = 4.43$$

And from it we calculate λ:

$$\lambda = 4.04$$
$$CI = {}^{(4.04 - 4)}\!/_{(4 - 1)} = 0.013$$

That is, the consistency rate = ${}^{0.013}\!/_{0.9} = 0.014$

The evaluation of the first criterion's (site area) results:

Table 6. The evaluation of the first criterion's (site area) results

The criterion: the area of the site	Tlemcen's site	Naâma's site	Mostganem's site	Mascara's site	Consistency rate
Priority	0.38	0.15	0.38	0.06	0.014

Source: Prepared by the researcher.

We found that the consistency rate is less than 0.10. This indicates that there is a high degree of consistency concerning the initial evaluation, that is, there is no inconsistency in the pair-wise comparison numbers we gave to sites.

From these results, it is clear that the evaluation of the first criterion (the site area) for the site of Tlemcen is 0.38, for Naâma is 0.15, for Mostaganem is 0.38, and for Mascara is 0.06

Which means that in terms of the site area's criterion: Tlemcen's site and Mostaghanem's site are equal in preference and they are almost three times better than Naâma's site, and the previous three are almost six times and two times better, respectively than Mascara's site. That is to say, if the company takes this criterion as a basis for comparison, it will cancel the second and third sites and compare the rest with other criteria.

We follow the same steps regarding the rest of the criteria. The results of the six criteria for the company's problem are shown in the following table:

Table 7. The evaluation of the six criteria results for the company's problem's summary

The site / criterion	Tlemcen's site	Naâma's site	Mostganem's site	Mascara's site	Consistency rate
The area of the site	0.38	0.15	0.38	0.06	0.013
Land ownership	0.04	0.08	0.25	0.61	0.10
Proximity to the main road	0.31	0.10	0.05	0.52	0.08
Distance from the population	0.42	0.05	0.10	0.42	0.02
The turnover	0.06	0.06	0.21	0.62	0.09
The rate of return	0.05	0.08	0.58	0.28	0.03

Source: Prepared by the researcher.

According to the results of Table 7, we find that if the company took:

- ✓ The site area criterion as the basis for comparison, it will choose either Tlemcen's site or Mostaganem's site.
- ✓ The land ownership's criterion as the basis for comparison, it will choose Mascara's site.
- ✓ The proximity to the main road's criterion as the basis for comparison, it will choose Mascara's site.

- ✓ The distance from the population's criterion as the basis for comparison, it will choose Mascara's site.
- ✓ The turnover's criterion as the basis for comparison, it will choose Mascara's site.
- ✓ The rate of return's criterion as the basis for comparison, it will choose Mostaganem's site.

We found that the consistency rate for all the original tables is less than 0.10 which indicates the extent of success in the initial evaluation, and therefore the validity and accuracy of the obtained results.

D. The weighted evaluation stage for each criterion

At this stage, we calculate the relative weights of each criterion for pair-wise comparison using Table 4 by following the same previous steps. The results of this stage are shown in the following table:

Table 8. Results of the weighted evaluation for each criterion

The Criterion	The area of the site	Land ownership	Proximity to the main road	Distance from the population	The turnover	The rate of return
The relative weight of the criteria	0.25	0.08	0.02	0.25	0.23	0.15

Source: Prepared by the researcher.

Based on Table 8, we conclude that the relative importance of the six criteria for the company is as follows:

The preference for the site's area criterion is 25%, followed by the criterion of distance from the population by 25%, after it the criterion of the turnover by 23%, then the criterion of the rate of return by 15%, and the land ownership criterion by 8%, and finally the criterion of proximity to the main road by 2%.

The ratios obtained from the method of hierarchical analysis will be included in the weighted linear goal-programming model in the next stage

3.2 The mathematical formulation of the weighted linear goal-programming model, with the introduction of the relative deviation formula

Starting from the hierarchical form of the completion and construction of the major business of the company site's decision, and after entering the ratios obtained from the method of hierarchical analysis, we can formulate the mathematical model of the problem as follows:

$$MinZ = \frac{0.25\delta_1^-}{6} + \frac{0.25\delta_1^+}{6} + \frac{0.08\delta_2^-}{2.5} + \frac{0.02\delta_3^+}{580} + \frac{0.25\delta_4^-}{5} + \frac{0.23\delta_5^-}{20} + \frac{0.15\delta_6^-}{15}$$

$$\begin{cases} 7x_1 + 5x_2 + 5.5x_3 + 7.5x_4 + \delta_1^- - \delta_1^+ = 6 \\ 2x_1 + 2.5x_2 + 3x_3 + 4x_4 + \delta_2^- - \delta_2^+ = 2.5 \\ 900x_1 + 950x_2 + 800x_3 + 700x_4 + \delta_3^- - \delta_3^+ = 580 \\ 3x_1 + 4x_2 + 3.5x_3 + 5x_4 + \delta_4^- - \delta_4^+ = 5 \\ 20x_1 + 10x_2 + 20x_3 + 26x_4 + \delta_5^- - \delta_5^+ = 20 \\ 13.5x_1 + 20.55x_2 + 30.7x_3 + 26.88x_4 + \delta_6^- - \delta_6^+ = 15 \\ x_1 + x_2 + x_3 + x_4 = 1 \\ x_j = \{0.1\}(j = 1..4) \\ \delta_i \geq 0(i = 1..6) \end{cases}$$

3.3 Solving the model using the Lindo program

We get the following results:

Table 9. Results of solving the model

Variables	Deviations			The economic function
X1=0	n5=0	n3=200	n1=0	Z=5
X2=0	p5=5	p3=0	p1=1	
X3=0	n6=0	n4=0	n2=0	
X4=1	p6=8	p4=0	p2=2	

Source: Prepared by the researcher based on the output of LINDO

3.4 Decision-making

Using the weighted linear goal-programming method and the hierarchical analysis method, we find that the company must evaluate the project in the fourth location (Mascara), because it will achieve most of the goals that the company desires.

4. *CONCLUSION*

Through this study, we find that choosing the project site is a very difficult decision for any institution to make. The project's success is closely related to its location. For this reason, a deep study that includes all the relevant aspects through which we define (the goal, the criteria, the alternatives) must be prepared. In order to simplify this decision, searching for an appropriate method to model this decision is necessary.

We concluded that the best method that enable us to model this type of decision the weighted linear goal-programming method with the introduction of the relative deviation formula. This is not only because all the criteria are taken into consideration, but because it also maintains the true values of each criterion. Thus, In order to reduce the subjective assessment in assigning weights to the criteria, a hierarchical analysis method should be used because of the advantages it has in this field.

In light of the previous results, the researcher recommends the following:

Decision makers in Algerian institutions should use modern quantitative methods to rationalize their decisions and establish a branch in the company specific to the quantitative techniques that are applied in management, along with employing specialized competent staff.

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