Prospective Analysis for a Long-Term Optimal Labor Force Planning in Algeria (PALOLFA)

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Abstract. Objective programming models propose an explanatory framework to look at multi-criteria issues, including a couple of clashing targets. Genuine issues regularly include uncertain data, which makes weighted objective programming (WGP) models the most appealing decision. This article offers a WGP model that consolidates ideal resource distribution to simultaneously satisfy planned objectives on economic improvement, vitality utilization, workforce, and ozone-depleting substance (GHG) emanation decrease associated with key financial areas of Algeria. The model offers significant encounters to chiefs for fundamental arranging and adventure portions towards doable progression. We exhibit the authenticity and substantiality of the model through a numerical case.

Keywords: Sustainability · GDP · Energy consumption · Goal programming model · Work force · Environment

1 Introduction

The focus on sustainable development requires centered efforts to limit the use of ordinary assets, increased use of sustainable and renewable energy, ongoing efforts to minimize GHG emissions. The association between the use of vitality, economic growth and its consequences for natural debasement requires appropriate exchanges to create manageable strategies. Changes in economic development and demographics are
proponents of a precarious increase in sales gas (GHG) emissions and the use of characteristic assets. Greenhouse Emissions (GHG) are rising and accelerating due to the widespread use of petroleum-based sources of vitality, despite global efforts to reduce them. To meet the support challenge, the various objectives of support for economic development, use of vitality, population, society and condition should be taken into account. The objective of this paper is to meet certain and specific criteria for Algeria’s maintenance goals by 2025. As such, electricity demand in Algeria amounted to 63 TWh in 2014, an average annual growth rate of approximately 8.8 per cent in the last decade. This growth is mainly justified by Algeria’s population growth, which rose from 2.656 million in 1866 to 43.1 million in 2019. Electricity production in Algeria is mostly done by diesel; this raises major concerns, including an increase in the emission of CO2 and other particles and the increase in the electricity generation bill in a context of declining oil and gas production in Algeria. CO2 outputs in Algeria increased from 0.46 metric tons in 1993 to 2.82 in 2000 and 3.74 metric tons in 2014, with an increase of 571% over the entire period 1960–2014. It has been noted that the region (MENA) is considered the second most polluted region on earth after South Asia, making the highest CO2 levels per dollar of yield. The diagram below shows the evolution of electricity demand in Algeria in KWh per person.

In this paper, we show an objective programming way to deal with study the collaborations between objectives identified with power Gross domestic product development (G1), power utilization (G2), GHG emanations (G3), and a number of workers (G4) from different financial divisions and their commitment to the future monetary supportability objectives by the year 2025. GP models give a perfect structure that a chief can use to organize asset assignment within sight of numerous contending targets. GP models are gone for meeting the measured objectives as nearly as could reasonably be expected, where the Chief (DM) tries to limit the separations between the objectives and the genuine estimations of the criteria or target works in the choice technique. An objective is a numerical level the DM cravings to accomplish, for to every basis. As far as possible can be over-accomplished, under-accomplished or full-accomplished.

What is the optimal workforce for an energetic, environmental and economic aspects in Algeria based on goal programming approach using Weighted Goal Programming (WGP)? In other words, can a WGP be a solution to an optimal allocation of the workforce?

To answer the previous questions, we have decided to do this study. The remainder of this article is sorted out as pursues: Sect. 2 shows the review of literature, Sect. 3 presents the application of this study, Sect. 4 describes the solution, and finally, the conclusion is presented in Sect. 5.

2 Literature Review

In previous decades, an assortment of models for the distribution of vitality assets (management of quantitative and subjective criteria) have been created and examined. Strategy producers oversee issues related to the imperative and how they associate or
have an impact on economic/financial development and regular quality. Among the most influential are:

Bell et al. (2002) establish a WGP model to examine and study the effect of some atmospheric approach options in light of the cost and extent of ecological markers, such as rising global temperature, rising ocean levels, and concern for the biological community. The GP models for financial and natural collaborations have been linked in the organization and execution of manageable arrangements.

Borges and Antunes (2003) utilize fluffy numerous target choice bolster model to concentrate on the connections between the vitality and economy division in Portugal.

Pohekar and Ramachandran (2004) display a complete overview of different sorts of multi-criteria choice models for supportable vitality arranging.

Diakoulaki et al. (2005) talk about the development of MCDA methodologies, with regards to the rising issues confronted by energy organizers and different partners in vitality arranging and related choice circumstances.

Osborne et al. (2005) display a survey of accessible writing and give proposals to applying multi-criteria choice examination systems in environmental tasks. Late commitments around there affirm the pertinence of multi-criteria approach.

Zhou et al. (2006) introduce a study of different choice investigation thinks about including vitality and the earth to emphasize the significance and expanded consideration among the examination group to utilize multi-criteria basic leadership techniques.

André et al. (2009) look at lexicographical, weighted and max-min GP models in order to concentrate on the impact of technological choice gadgets, for example, immediate and roundabout expenses, natural assessments and open consumption for macroeconomic elements, for example, economic development, inflation, unemployment, open deficit and ecological objectives of Spain.

Daim et al. (2010) are developing an FGP model for building a sensible energy source portfolio aimed at meeting inexhaustible resources’ 25 per cent power demand by 2025 in Oregon, USA.

GP models have been utilized for vitality plants area (San Cristóbal, 2012b), demonstrating a sustainable power source portfolio (Daim et al. 2010).

A multi Sector economy, imperative, conditional upon inevitable evaluation of changes in the budgetary framework and essentiality mechanism established by Oliveira and Antunes (2011) to assess the related mutual effects on a methodology for Portugal.

Ballarin et al. (2011) have developed a multi-period WGP model to recognize the ideal land mix to boost the creation of salary and biomass vitality in Rovigo in Italy.

Huang et al. (2011) have been analyzing ecological application trends and devices of MCDA over the last two decades to decide that the creation of natural applications is essential due to increased unpredictability of choice and access to data.

WGP and Fluffy GP approach are the most generally utilized variations, here, San Cristóbal (2012a) builds up a GP demonstrate in light of the natural/output-input direct programming model considering monetary, social, vitality and ecological objectives connected to Spain. In a few ways, our model was persuaded and motivated by this work above.

Multi-criteria GP decision models are closely linked to the need to research, budget and characteristic issues in order to help boss make reasonable arrangements. MCDM
models indeed consider various parameters to be central to the procedure specification process and to be used to screen and pick options. Oliveira et al. (2014) outline from the beginning straightforward approaches to integrating input–output research with multi-goals models that are useful for technicians to study the economic, imperative and the social basis of possible change.

Chang (2014) utilizes a GP model to distinguish the critical CO2 emanating segments for streamlined creation structure connected to focus discharge decrease in China.

In recent years, Jayaraman et al. (2016b) have proposed a soft GP display that integrates the ideal distribution of assets to achieve at the same time the common objectives of monetary advancement, use of vitality, labor and reduction of GHG outflows related to the significant financial segments of the United Arab Emirates.

In another research, Jayaraman et al. (2016a) agreed on a few innovations in various sectors and fields of the United Arab Emirates, which they acquired by using a stochastic objective model of programming based on a situation the ideal estimate for works.

Following this, Jayaraman et al. (2016b) used a weighted Objective Programming Model that discusses GHG, GDP, use of vitality and Gulf Cooperation Council Countries members.

Omrani et al. (2018) present two weighted objective planification by programming models reasonable improvement in 26 areas of Iran continuously in 2030. Their study aims to provide specialists with a system that balances the relationship between financial and social conditions and finds an appropriate choice for a macroeconomic and provincial organization. Now, the proposed WGP models allocate an ideal degree of the workforce to achieve predefined goals, including social, financial and ecological elements. Both models demonstrate that the use of GDP and vitality in transport areas should be improved, and it is now essential for the government to agree on real choices to achieve the targets. As such, an approach to be adopted is an appropriate arrangement for the use of clean vitality, for example, solar, wind, nuclear, hydroelectric to achieve the goal of the use of vitality. It is noted that planning has been proposed for the case of Iran, by Omrani, H., Valipour, M., and Emrouznejad, A. (2018) based on the weighted objective programming model.

In the context of Algerian analysis, Ghouali et al. (2020) examine the relationships between the types of renewable energy in order to define the optimal number of renewable energies plants in Algeria, through the combination of geographically, climatically an environmental parameter,, using a multicriteria analysis focused on multi-source, multi-sink networks and job numbers. Zaitseva et al. (2020) present a complex programming approach to optimizing the regional allocation of jobs. They describe two models for the optimal distribution of labor resources and provide numerical examples for possible options to formulate the task.

Jia et al. (2020). Their study is focused on urbanization theory, labor movement and the analysis of the connection between industrial agglomeration and the development status of rural work surplus and dynamic urbanization phases. Shanxi Province is considered a case study. In order to provide proposals for shifting rural labor and for harmonious implementation of the regional population urbanization program, the development of cooperation and mutual tolerance is examined.
3 Our Application

A. Data Analysis
In this investigation, we have utilized the accompanying six (6) economic areas: (i) agriculture, (ii) hydrocarbon, (iii) industry, (iv) Building, Public Works and Water Supply (BPWWS), (v) Services Merchants, (vi) Non-Merchant Services. Sectorial information for different monetary, ecological, work markers for Algeria was acquired from various information sources. Table 1 condenses the per-capita commitment of every choice variable utilized in the model.

Table 1. Sectorial indicators for Algeria.

| Decision variable | Sector (unit)           | GDP Per Capita in million DZ | Electricity consumption per capita (GWH) | GHG emissions per capita (Kton (Gg) CO₂) |
|-------------------|-------------------------|-------------------------------|-----------------------------------------|----------------------------------------|
| X₁                | Agriculture             | 2.35206127                   | 0.001845067                             | 0.008160519                            |
| X₂                | Hydrocarbon             | 12.7468124                   | 0.043969836                             | 0.400124841                            |
| X₃                | Industry                | 0.66383686                   | 0.010015909                             | 0.009636654                            |
| X₄                | BPWWS                   | 1.09303430                   | 0.000480341                             | 0.001862493                            |
| X₅                | Services merchants      | 1.66932532                   | 0.002336639                             | 0.002949927                            |
| X₆                | Non-merchant services   | 0.87613276                   | 0.001364563                             | 0.00154727                             |

Table 2 describes the objective characteristics for the year 2025 evaluated and the parallel/similar rates of growth for the four metrics used in the model. The number of workers in Algeria is forecast at 19,219 million by 2025.

Table 2. Projected values for the identified goals for the year 2025.

| Goal by 2025               | Value                      | Converted value              |
|---------------------------|----------------------------|-----------------------------|
| GDP growth (G1)           | 195,367 Billion USD        | 21353918.458621 Million DZ  |
| Electricity consumption (G2)| 90.76 TWh (90.76 Billion KWh) | 90760 GHW                   |
| GHG emissions (G3)        | 161 321 K ton              | –                           |
| Number of employees (G4)  | 19,219,000                 | –                           |

B. Goal Programming Model
The GP model is a remarkable method of taking decisions and solving multi-target problems. GP models simultaneously consider several opposing expectations. The GP
model structure offers the best solution that the DM can make. Charnes et al. built the first GP model in 1955, which was later applied to Charnes and Cooper, Lee and Clayton.

GP models are closely linked in many fields, e.g. quality control, advertisement, bookkeeping and money-related sections of stock management, production, HR, and board operations. According to Aouni and Kettani, the GP is assisted by a group of researchers and specialists. Should \( f(x) \) be the vector of the upgraded parameters, \( g_i \) is the vector of the goals and \( D \) is the logical collection, the basic numerical description of the GP model shall be as follows:

\[
\text{Min } Z = \sum_{i=1}^{p} \delta_i^+ + \delta_i^-
\]

Subject to
\[
f_i(x) + \delta_i^- - \delta_i^+ = g_i; \quad i = 1 \ldots p;
\]
\[
x \in D;
\]
\[
\delta_i^-, \delta_i^+ \geq 0, \; i = 1 \ldots p
\]

Where \( \delta_i^- \), \( \delta_i^+ \) are, individually, negative and positive variations in the degree of yearning (objectives) \( g_i \), \( i = 1 \ldots p \). Another and alternative definition of the GP model that is useful in the future is Weighted Goal Programming (WGP) that can figure as pursues (Fig. 1):

\[
\text{Min } Z = \sum_{i=1}^{p} w_i^+ \delta_i^+ + w_i^- \delta_i^-
\]

Subject to
\[
f_i(x) + \delta_i^- - \delta_i^+ = g_i; \quad i = 1 \ldots p;
\]
\[
x \in D;
\]
\[
\delta_i^-, \delta_i^+ \geq 0, \; i = 1 \ldots p
\]

Where \( w_i^+ \), \( w_i^- \) are the weights deviations.

![Fig. 1. Electricity Consumption in Algeria (Source: U.S. Energy Information Administration)](image-url)
C. Model formulation

Using the data from Table 1, and the goals for the four criteria set at \( g_1 = 21353918 \), \( g_2 = 90760 \), \( g_3 = 161321 \), and \( g_4 = 19219000 \). The WGP model depicted in condition (2) with loads \( w_i \) equivalent to 0.25 can be planned. The GP model includes the accompanying criteria:

**Gross Domestic Product**

\[
f_1(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8) = 2.35206127 \times X_1 + 12.7468124 \times X_2 + 0.66383686 \times X_3 + 1.0930343 \times X_4 + 1.66932532 \times X_5 + 0.87613277 \times X_6
\]

**Electricity consumption**

\[
f_2(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8) = 0.00184507 \times X_1 + 0.04396984 \times X_2 + 0.01001591 \times X_3 + 0.00048034 \times X_4 + 0.00233664 \times X_5 + 0.00136456 \times X_6
\]

**GHG emission**

\[
f_3(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8) = 0.00816052 \times X_1 + 0.40012484 \times X_2 + 0.00963665 \times X_3 + 0.0018624 \times X_4 + 0.00294993 \times X_5 + 0.00154727 \times X_6
\]

**Total work force**

\[
f_4(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8) = X_1 + X_2 + X_3 + X_4 + X_5 + X_6
\]

\[
\text{Min } Z = 0.25 \times (D_{11} + D_{12}) + 0.25 \times (D_{21} + D_{22}) + 0.25 \times (D_{31} + D_{32}) + 0.25 \times (D_{41} + D_{42})
\]

Subject to:

\[
2.35206127 \times X_1 + 12.7468124 \times X_2 + 0.66383686 \times X_3 + 1.0930343 \times X_4 + 1.66932532 \times X_5 + 0.87613277 \times X_6 + D_{11} - D_{12} = 21353918.45862.
\] (3)

\[
0.00184507 \times X_1 + 0.04396984 \times X_2 + 0.01001591 \times X_3 + 0.00048034 \times X_4 + 0.00233664 \times X_5 + 0.00136456 \times X_6 + D_{21} - D_{22} = 90760
\] (4)
0.00816052 * X₁ + 0.40012484 * X₂ + 0.00963665 * X₃ + 0.00186249 * X₄ + 0.00294993 * X₅ + 0.00154727 * X₆ + D₃₁ − D₃₂
\[\text{=} \quad 161321 \quad (5)\]

\[X₁ + X₂ + X₃ + X₄ + X₅ + X₆ + D₄₁ − D₄₂ = 19219000 \quad (6)\]
\[X₁ ≥ 865000 \quad (7)\]
\[X₂ ≥ 207289 \quad (8)\]
\[X₃ ≥ 1465000 \quad (9)\]
\[X₄ ≥ 1895000 \quad (10)\]
\[X₅ ≥ 2991112 \quad (11)\]
\[X₆ ≥ 3421599 \quad (12)\]
\[D_{ij} ≥ 0 \quad (13)\]

Some comments on the above formulation.

- The target capacity includes the weighted summations of every rule concerning its looking at the goal.
- Requirements (3) to (6) show a clear relationship between the degree of achievement of each model, the comparative goals even, the deviations. The lighter the variations, the louder the gaps between the rate of achievement and the goals.
- The remainder of the requirements, (7) to (13) force that the ideal arrangement needs to protect in any event the present number of occupations, which is a reasonable assumption.

4 Solutions

Table 3 displays the arrangement of the model acquired using LINGO. The yield demonstrates the proximity of a surprising non-zero variance in D₂₂. In order to fulfill all the four requirements in the model, an enormous measure of the essence requirement cannot be fulfilled from inexhaustible sources can be deciphered as desired; The use of hydrocarbon-based fuel to meet the vitality requirement, truth be told, would expand GHG outpourings and this, subsequently, will impact the estimations of different deviations associated with the GP model. Thus, to achieve the maneuverability objectives and master the expansion of GHG’s emissions the main wise choice is to change the portfolio of vitality with renewable and ecological sources of vitality such as atomic, solar and oleic energies and this to meet the essential needs for development in Algeria.
5 Conclusion

The ecological choices necessary for the energy and ecological transition are challenging to implement because they require complex compromises and are, therefore, multi-faceted choices. In this article, we have developed a model of objective weighted professional programming that allows the ideal asset circulation to respond synchronously to the objectives until 2025, expected in terms of financial advancement, use of vitality, workforce and reduction of GHG emissions, associated with key economic sectors of Algeria.

The model offers a numerical legitimization for further speculations to change the game plan of vitality blend in Algeria. (The assessment showed in our model features the centrality of substitute’s procedures (green) vitality sources). As such, the orientation of the Algerian economy towards sources of ecological vitality is the central element of the model we have proposed in this paper. Therefore, the implementation of our model obliges decision-makers to take a double approach to energy transition and ecological transition. Such an approach was made in the face of a hostile national and international context. Moreover, Algeria is facing a rapid increase in energy demand multiplied by a decline in oil and gas production and marked by an international context agitated by diplomatic conflicts, competition from shale gas and the drastic consequences of the Covid-19 pandemic on the world economy.

Use of techniques toward this way will positively influence the GDP, upgrading the frail degree of participation in relating the comparing target work. The ongoing and current progressions in atomic power plants, handling wind vitality, and concentrated sunlight-based vitality fill in as a declaration to the influential position of Algeria towards accomplishing a maintainable improvement continuously 2025.

| Deviations | Value | Reduced cost | Variable | Value | Reduced cost |
|------------|-------|--------------|----------|-------|--------------|
| D11        | 0.000000 | 1.078856    | X1       | 8650000.0 | 0.000000 |
| D12        | 0.000000 | 0.9211444   | X2       | 207289.0   | 0.000000 |
| D21        | 0.000000 | 2.000000    | X3       | 9446121.0  | 0.000000 |
| D22        | 27666.43  | 0.000000    | X4       | 18950000.0 | 0.000000 |
| D31        | 0.000000 | 2.000000    | X5       | 2991112.0  | 0.000000 |
| D32        | 37963.31  | 0.000000    | X6       | 3814478.0  | 0.000000 |
| D41        | 0.000000 | 0.9280002   |          |        |              |
| D42        | 0.000000 | 1.072000    |          |        |              |
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