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Using the Linear Programming Model to Improve Institutional Finance Decisions: An Applied Study on the Sherifian Office of Phosphates OCP (Morocco, 2023-2027)

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***Abstract*—Financing decision-making is one of the main challenges facing organizations in a complex and multi-alternative economic environment. In this context, this research ought to improve funding decisions by employing the linear programming model, in particular the transport model, supported by the simulation of linear weighting, in the distribution of financing resources within OCP to four strategic projects. The research aims to provide a quantitative model that supports decision-making in the absence of accurate data on demand, with a focus on achieving a balance Between the strategic priorities and financial constraints associated with the various sources of financing, represented in international bonds, strategic partnerships and international loans. The methodology relied on building a mathematical model that represents the funding relationships between projects and sources, and used linear weight simulation to determine the relative importance of each project, then the data was processed and analyzed using Python programming tools. The results showed that the proposed model contributed to providing an effective and objective funding distribution that reflects the relative importance of projects without exceeding the imposed restrictions, and also allowed flexibility in testing multiple scenarios and possible data updates. The added value of this model is highlighted in its ability to support decisions Finance in environments of uncertainty and a multitude of alternatives, providing a quantitative tool applicable at the level of strategic institutions. Thus, the research concludes that the integration of linear programming with linear weighting simulation constitutes a practical framework for improving the efficiency of resource allocation and enhancing the quality of financial decision in contemporary institutions. .**

***Index Terms*—linear programming, transfer problems, linear weighting simulation of weight distribution, institutional finance.**

I. Introduction

In light of the increasing economic challenges and complexities of the modern financial environment, improving institutional financing decisions has become critical to ensure the sustainability of institutions and enhance their competitiveness. Mathematical models have emerged as effective tools to achieve this goal, offering an accurate quantitative framework for analyzing financing alternatives and optimizing the allocation of financial resources. This study aims to explore how mathematical programming models, especially linear programming and transport models, can be used to improve financing decisions for organizations, focusing on practical applications in diverse contexts. OCP Group has launched the Green Investment Program for 2023-2027, which is part of its strategy to achieve carbon neutrality by 2040. This ambitious program aims to invest approximately 136578 million MAD in sustainable projects, including the development of renewable energies, water desalination, the production of green hydrogen and green ammonia, and the strengthening of industrial infrastructure associated with fertilizer production. This program is an advanced model for integrating environmental and economic objectives, where Adopting accurate quantitative analysis tools is required to effectively channel funding towards changing and complex strategic priorities. This study seeks to provide an advanced mathematical model based on linear programming and transport models, supported by linear weighting simulation, to improve the distribution of funding among strategic projects based on relative importance, and in accordance with available funding constraints, ensuring the highest levels of efficiency and transparency in resource management. The importance of this study lies in its theoretical and practical contribution. In theory, it offers a new framework for integrating mathematical models into financial decision-making, broadening the scope of the existing literature. In practice, the proposed model provides a viable tool for organizations to improve the allocation of financial resources, reduce costs, and increase efficiency. The problem of this research is the challenges faced by institutions when making decisions related to the distribution of financing resources between multiple projects in light of funding constraints and disparities in strategic priorities, with the absence of accurate data on the size of the funding demand for each project. This challenge is increasing in large institutions that rely on different sources of funding, which imposes the need for a quantitative model that helps in scientific and flexible decision-making. Based on this, the problem is that: How can the transport model, supported by linear weighting simulations, be employed to improve the efficiency of funding distribution in a multi-project and resource-constrained environment? This research seeks to achieve a set of theoretical and applied objectives, most notably building a mathematical model using linear programming ”transport model” to distribute funding in a systematic manner between multiple projects with the employment of linear weighting simulation to estimate the relative weights of projects in the absence of accurate data on demand and provide a quantitative tool that supports financing decision-making within institutions, as well as applying the model to the case of the OCP process. To test its validity and interpret its results while proposing practical recommendations that contribute to improving the efficiency of the allocation of financial resources. This study is divided into several main sections: it begins with a theoretical framework that identifies basic concepts such as institutional finance and mathematical models in finance, followed by a presentation of research gaps in the previous literature. The proposed mathematical model and its application methodology are then presented, followed by analysis and discussion of the results. Finally, the study concludes with recommendations for future research and a summary of the most prominent methodology: The research is based on a quantitative analytical approach, based on modeling the decision to allocate funding using linear programming, in particular the transfer model, which allows the distribution of resources between multiple units under quantitative constraints. This model was supported by linear weighting simulation that enables the conversion of qualitative estimates (materiality) into mathematical processable numerical weights. The model was applied to real-world OCP data, and Python and Excel Solver tools were used.To perform calculations, simulations, and quantitative analysis of the results.

II. Study of the Literature

A. Previous Research

A study entitled: “The use of linear programming and goal programming models in the effectiveness of choosing the optimal production mix is a comparative study on engineering industry companies in the public and private sectors in Syria”, is one of the studies that aims to apply the models of linear programming and goal programming in the companies under study in order to choose the optimal production mix, and then compare the results of the application of the two models and the actual reality in public and private companies in the field of engineering industries, and conduct a sensitivity analysis of the results of solving these two models to reach alternatives and multiple options for the decision maker that help them choose the optimal production mix. The results can then be applied to companies that are similar in nature of work to the companies under study. In this study, (Al-Sheikh Hassan, 2024) relied on the descriptive approach in the theoretical framework of the research. As for the practical study, the researcher conducted a survey study by designing a survey list and distributing it to workers in the senior and middle management in the engineering industry companies under study, and then analyzing the answers using appropriate statistical methods and programs. The researcher also relied on the practical side by applying linear programming models and goal programming in the companies under study through building models, selecting them, analyzing their results, and conducting sensitivity analysis of the results of the models used. The study found that the use of linear programming and goal programming models in the companies under study helps to choose the optimal production mix effectively.

In the same vein, a study by (Aarab, 2020) entitled: “Improving the Performance of Economic Enterprises Using Numerical Linear Programming: A Case Study of the Metal Packing Corporation IMP Algeria”, aimed to show the importance of applying the numerical linear programming model on the metal packet institution, as well as understanding the productive activity of the institution and the resources involved in the production process. The study then built and analyzed the numerical linear programming model of the institution. The study relied on the descriptive approach when presenting the theoretical side by collecting scientific material from secondary sources, while the practical side was represented by applying the numerical linear programming model in the metal packages institution and solving the model using the LINDO program. The study found that the proposed production program enabled the institution to achieve profits that exceeded its actual earnings, highlighting the importance of linear programming in enhancing institutional performance and supporting effective decision-making, whether to maximize profits or reduce costs.

In this context, a study titled "The Use of Linear Programming Method in Planning the Optimal Production of Al-Mamoun Factory for the Year 2017 – Iraq" by (Faeq & Hassan, 2024) aimed to develop a scientifically grounded production plan to minimize resource waste and improve productivity. This approach allowed the utilization of surplus resources to increase production levels and meet the needs of citizens. The researchers adopted a descriptive method for the theoretical framework and used the IN CANE program to define the constraints of the linear programming model and analyze the data. The study concluded that linear programming resulted in an optimal production plan that involved fewer products than the actual plan but achieved a higher profit margin. Moreover, the study found a surplus in the number of workers at the Al-Mamoun factory.

On another level, the study by (Tayebnasab, Mohebali, Farhad, & Hamid Reza Maleki, 2021) titled "Linear programming model to reduce patient payments and increase hospital income at the same time in Iran" explored the application of a bi-level linear programming model in a specialized hospital setting. The goal was to maximize hospital income while simultaneously reducing financial burdens on patients. The researchers used a descriptive method for the theoretical part and applied a two-level linear programming model in the practical phase. Secondary data was collected from the Specialized Hospital in Iran in order to solve the model using statistical methods for operations research. The application of the linear programming model showed its effective role in the performance of the hospital, as the results indicated a decrease in the costs paid by the patient and an increase in hospital revenues.

B. *Theoretical Concepts*

Building the conceptual framework is an essential step in any scientific research because of its role in clarifying the basic concepts on which the analysis is based. In this context, the most important concepts related to the research topic will be presented and interpreted, with reference to approved scientific references.

In this context, institutional finance is defined as a type of financing provided by large financial institutions (such as banks, investment funds, and insurance companies) to productive or service institutions. This type of financing aims to support economic growth by financing major projects and providing the necessary liquidity for the continuity of economic activity. Institutional finance is a vital component of modern financial markets, contributing to more efficient resource allocation and supporting the stability of the financial system [15]. It also constitutes the backbone of the global financial system, with institutional financial institutions providing essential services to corporations, governments, and other large organizations. They also play a pivotal role in facilitating economic growth, capital formation, and maintaining financial stability [17].

On the other hand, financial decision-making is the essence of the administrative process within the institution, as it is related to choosing the most appropriate financing or investment alternatives in order to achieve the strategic objectives of the organization. These decisions include project financing, resource allocation, profit distribution, and cost and risk management. Financial decision-making is based on quantitative and qualitative bases that include financial analysis, predictive models, and risk assessment [6]. In this regard, finance is about decision-making, which requires weighing costs and benefits. When the benefits are bigger than the costs, the decision is a good one; when smaller, it is a bad one [13].

Moreover, mathematical models in finance refer to formulas and equations that are used to represent and analyze financial phenomena with the aim of understanding the behavior of markets and making decisions based on quantitative data. There are many of these models, including statistical models, linear programming, Markov series, probabilistic models, and simulation models. These tools provide the possibility of evaluating alternatives and predicting the outcome of decisions, thereby improving the quality of financial decision-making [26].

In the same vein, risk analysis is the process of identifying and assessing risks that may affect the outcome of a financial decision. These risks include market risk, credit risk, liquidity risk, and operational risk. Risk analysis improves the organization's resilience and ability to adapt to unexpected fluctuations through the use of tools such as Value at Risk (VaR) models and scenario simulation models [16].

Finally, optimization is a branch of applied mathematics used to find the best possible solutions under a set of constraints. In finance, optimization techniques are used to determine the optimal combination of funding sources or to maximize return with the least risk. Linear and nonlinear programming are among the most widely used optimization techniques in this field [10].

C. Identifying Research Gaps in Previous Studies

A review of previous studies that have been relied upon shows that they have made significant contributions to employing mathematical programming models to improve institutional performance, especially in the productive and operational aspects. However, a critical analysis of these studies reveals a set of scientific and methodological gaps that justify the need for a new study in this area.

With regard to limiting itself to the productive field without financial consideration, previous studies, such as the studies of Fidaa Sheikh Hassan, Aarab, Yassin Faeq and Marwa Hassan, have focused on the application of linear programming and goal programming to improve production performance or to choose the optimal production mix. The study of Tayebnasab *et al.* examined a two-tier model with the aim of improving hospital income and reducing costs for patients. Despite the importance of these efforts, these studies did not address strategic financial decisions as an area of application of these models. In particular, there was no attempt to improve financing structures, financial resource planning, or the trade-off between sources of financing and investment.

Accordingly, a clear gap emerges in the absence of a link between optimization models and financial decision-making within organizations, leaving a scientific gap in the literature. In terms of the limited types of models used, although these studies succeeded in applying tools such as linear or numerical programming or even simple binary models, they nevertheless remained within the traditional framework of mathematical programming.

Thus, these studies could not exploit the broad potential of advanced models such as multi-objective programming, which reflects the reality of organizations where multiple goals coexist (profit, risk, liquidity). Similarly, dynamic programming, which addresses time-varying decisions, and probabilistic programming, which takes into account uncertainty in the financial environment, were not explored. Hence, an additional gap emerges: the limited methodological diversity and the continued reliance on classical approaches despite the increasing complexity of financial environments.

With regard to the absence of overlap with the concepts of quantitative finance, previous studies do not indicate any real use of quantitative financial concepts and instruments, despite their increasing importance in supporting financial decision-making. Examples include risk management using optimization techniques, asset allocation models, variance analysis, options pricing, and composite financial instruments.

Accordingly, previous studies have remained isolated from recent literature on quantitative finance despite the direct relationship between these two fields. Thus, a third gap can be identified: the weak integration between mathematical programming and quantitative financial approaches, which reduces the effectiveness of the proposed models in real-world applications.

D. Justification of the Contribution of the Present Study

In light of the previous gaps, the current study makes a distinct scientific and academic contribution through several aspects. While the efforts of previous studies focused mainly on solving operational problems, this study aims to employ optimization models in developing financial decision-making within institutions. Specifically, the study proposes a model that helps in selecting the best financing structure, distributing financial resources efficiently, and comparing investment alternatives based on quantitative indicators.

Thus, optimization models are transformed from production-only tools into instruments that support strategic financial planning. On the other hand, the study aims to employ advanced mathematical models by going beyond traditional approaches and integrating linear programming into the proposed framework in order to better simulate complex financial realities.

This methodological shift contributes to providing a more flexible and realistic model, enabling decision-makers to evaluate financial alternatives more accurately within a rigorous mathematical framework. Consequently, the proposed approach enhances the applied value of the study and increases its usability within institutional decision-making environments.

III. METHODOLOGY

A. Description of the Methods Used

1) Linear Programming: Linear Programming is a mathematical tool used to solve optimization problems, and it has been widespread since the development of the simplex algorithm in 1947, which made it applied in various fields such as banking, education, transportation, forestry, and petroleum (Wayne L. Winston & Jeffrey B. Goldberg, 2004). Linear programming is primarily concerned with optimizing a linear objective function while respecting linear constraints including equality or inequality imposed on decision variables. It forms a basic foundation for many optimization techniques and is used in practice in areas such as production and transportation planning (Michel Goemans, 2015).

In addition, linear programming is defined as a mathematical method of allocating scarce resources in order to achieve a specific goal, which can be expressed in linear constraints. Thus, it contributes to making optimal decisions related to the allocation of human and material resources to achieve the maximum return or the lowest cost within a set of constraints (Students, 2016).

$$\min z = \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} X_{ij} \tag{III.1}$$

$$X_{ij} \geq 0 \tag{III.2}$$

In this research, the Transportation Model was applied as one of the applications of linear programming to represent the relationship between available sources of financing (such as loans, bonds, and partnerships) and the needs of the four targeted projects. This model aims to distribute funding in a way that balances supply (from sources) and demand (from projects), while taking into account the maximum limits of each funding source.

We chose linear programming because the nature of the problem (the problem of optimizing financing in OCP) is suitable for linear modeling. This approach provides a strict quantitative model for distributing funding from multiple sources to different projects in order to reduce costs while respecting the financial constraints of each source. In addition, this model is characterized by scalability and flexibility, allowing the addition of new sources of funding or the modification of variables and constraints.

2) Linear Weighting Simulations for Weight Distribution: Simulation is a set of processes that imitate real-world systems or processes over a given period, whether these systems are physical or computational. Simulation involves studying the system and observing the impact related to the operational characteristics of the system in the real world (Faez Hassan, 2020). To achieve this, assumptions must be made about how these systems operate. These assumptions usually lead to mathematical and logical equations that together form the system model (Al-Qutli, 2018).

When it becomes difficult to solve problems using analytical or numerical methods, simulation represents an important alternative approach. In many situations, it may be the only viable method for solving complex problems. Simulation methods rely on resampling techniques and the generation of random numbers and variables with specific characteristics (Bari, 2002).

3) Weight Function: The weight function is a mathematical tool used when performing operations such as addition, integration, or averaging in order to give certain elements greater importance or influence than others within the same set. The application of a weight function produces either a weighted sum or a weighted average.

Weighting functions are widely used in statistics and data analysis and are closely related to the concept of measurement. They can be applied in both discrete and continuous environments and are used in constructing mathematical frameworks known as "weighted calculus" (Jane, Michael, & Robert, 1980).

In this study, the Linear Weighting Method was adopted within a deterministic simulation framework in order to distribute financial resources among several projects in a quantitative and systematic manner. This method relies on assigning relative weights to each project, reflecting its priority or strategic importance within the framework of the approved investment plan.

Algorithm 1 Funding Distribution Algorithm Using Linear Weighting Simulation

Import required libraries: numpy, pandas, matplotlib, seaborn, Arabic_reshaper, bidi.algorithm Define Arabic reshaping function: reshape_ar(text) = get_display(Arabic_reshaper.reshape(text)) Define list of projects and reshape project names using reshape_ar Define dictionary of funding sources with corresponding total amounts Reshape funding source names using reshape_ar Define weight vector $weights$ such that $\sum weights = 1$ Define function distribute_exact(total, weights) to: Compute raw allocation: $raw = weights \times total$ Apply floor: $base = \lfloor raw \rfloor$ Compute $remainder = total - \sum(base)$ Identify indices with largest fractional parts Increment top remainder indices in $base$ Return final integer allocation each funding source s in sources Compute allocation using distribute_exact($amount_s$, weights) Store result as a pandas Series indexed by project names Combine all allocations into a pandas DataFrame Reshape DataFrame column names and index labels using reshape_ar Print allocation table and display sum totals for each funding source Plot stacked bar chart of the allocations using matplotlib Apply reshaped Arabic labels to title, axis labels, and legend Display the final plot

B. Justification of the Methods Used

We have chosen the linear weighting method in this study due to its simplicity, clarity, and effectiveness in

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dealing with decisions that require rational distribution of resources among multiple alternatives. This method is one of the applications of the SAW (Simple Additive Weighting) technique, where the decision-maker assigns an importance weight for each criterion. These weights are later used as coefficients multiplied by the numerical evaluations of each criterion, and the results are then aggregated to obtain the total score for each alternative. This process enables the construction of a clear and effective quantitative model for decision support [**?**].

As for digital simulations, they were adopted because they provide high flexibility in testing the distribution of funding under different scenarios without the need for accurate data on demand, which is consistent with the nature of the problem that depends on estimates and strategic directions rather than final quantitative data. Simulation is also considered an implementation of the model over time, bringing the model to life and showing how a particular object or phenomenon will behave. It is useful for testing, analysis, and training by representing realistic systems or concepts through a model [**?**].

Moreover, the model used is able to generate accurate and logical results while maintaining the sum of the original funding without decimals, thanks to the adopted algorithm that relies on approximation of values. This enhances the applicability of the results in practice. Overall, this choice combines quantitative accuracy with applied flexibility and provides an appropriate tool to support financing decision-making in strategic contexts.

1) Solver: Solver is an advanced analytical tool used to make data-driven decisions by building mathematical models based on techniques such as mathematical optimization, decision-making rules, Monte Carlo simulation, risk analysis, data mining, and forecasting. This tool is often integrated into the Excel environment through a range of products such as Analytic Solver, enabling analysts and managers to build complex decision models without the need for prior programming expertise.

These models are used to analyze uncertainty and allocate limited resources such as money, equipment, and human resources, often resulting in improved performance and significant financial savings. Solver has become a leading academic choice in business schools around the world, where it is taught in hundreds of universities and used in dozens of specialized scientific books [**?**].

We have chosen Excel Solver because it is easy to use and includes a visual interface within Excel without the need for programming. It helps in solving complex problems that may include hundreds of variables and constraints. In addition, it provides rapid analysis capabilities, allowing users to modify parameters and immediately observe the impact on results. Therefore, it is particularly suitable for research studies and scientific reports.

Algorithm 2 Algorithm for Distributing Funding Sources to Green Investment Program Projects (2023–2027)

Define Arabic project names and funding data for each source
Reshape Arabic text for correct display using `Arabic_reshaper` and `python-bidi`
Create a DataFrame *df* with projects as index and funding sources as columns
for each text element in the DataFrame columns and index **do**
    Apply Arabic reshaping and the bidi algorithm
end for
Generate a stacked bar chart from the DataFrame using `matplotlib`
Add title, axis labels, legend, and grid to the chart
Display the chart using `plt.show()`

2) Python: Python is a programming language that is currently used very widely. It was created by Guido van Rossum in the late 1980s. Python is a powerful language whose code can be easily and simply read, which makes it easier for programmers to quickly develop applications. In addition, Python can be executed on some of the most popular operating systems such as Windows and Mac OS [22].

Python is also considered a highly readable and versatile language, and its name is inspired by a British comedy group called Monty Python. Its syntax is straightforward and provides immediate error reports, making it an excellent choice for beginners and newcomers to programming [21].

Going back to its origin, Python is a high-level programming language created by Guido van Rossum in 1986 while working at the Centrum Wiskunde & Informatica research center. Since then, the language has continued to develop with the addition of many features, becoming one of the most popular programming languages ever [9].

Moreover, Python has been advancing at an exceptional rate compared to all other programming languages, and it has been the most widely used language since 2017 until now. It is also ranked as the second easiest language in the world after Ruby, while surpassing it in terms of performance, popularity, number of libraries, and technical support [2].

Finally, Python is a portable, dynamic, free, and extensible programming language. It allows (but does not require) the use of modular and object-oriented programming (OOP) approaches. Python was developed in 1989 by Guido van Rossum along with a large number of volunteers and contributors. It is a portable language, not only across various Unix systems but also on operating systems such as Mac, BeOS, NextStep, MS-DOS, and different versions of Windows [19].

Python was selected for this research due to its flexible, precise, and open-source programming environment, which allows the implementation of complex mathematical algorithms and the graphical representation of results, even in Arabic. This supports financial decision-making in the absence of accurate data. It is also scalable and easily updatable, which aligns with the requirements of the applied research on OCP.

C. Data Used

In this study, three sources of financing were relied upon, represented by financing through bonds, loans, as well as partnerships with companies, as shown in the following tables.

The first table aims to provide a comprehensive overview of the loans granted to OCP projects, specifying the financing banks, loan amounts, and the targeted projects. The table highlights the diversity of banking funding sources and their contributions to various environmental and industrial sectors.
Table 1 show that the largest loans were directed towards water desalination and green hydrogen projects, while renewable energy and climate technology projects received relatively lower funding. This reflects the company's preference for projects with direct strategic impact and higher banking financing costs. The second table shows the different bond issuances aimed at financing OCP projects, with details on maturity dates, amounts, and interest rates. This demonstrates the importance of bonds as a financing tool to secure long-term resources

Table 2 indicates that the company relied on multiple maturity issuances to distribute financial risks and achieve a balance between interest obligations and the total financing amount. The additional releases in February 2025 also reflect the company's flexibility in meeting changing financial needs. As for partnerships, two partnerships have been signed, the first with ENGER and the second with IFC Bank, but so far, the value of the partnerships has not been declared either for OCP or other companies.

IV. Results and Discussion

A. Presentation of Results

Within the framework of this study, and after applying the transportation model for the distribution of OCP project financing, which has a total value of 136578 million MAD, the analysis focused on four main projects: industrial infrastructure and fertilizers, water desalination, green hydrogen and ammonia, as well as renewable energies and climate technology.

The financing structure is based on three main sources of funding: loans, bonds, and partnerships. The obtained results reveal the pattern of financial resource distribution allocated to each project. This discussion aims to analyze how these resources are distributed and to evaluate the efficiency of this allocation in meeting project demand and directing funding according to project priorities. From the table 3, it is evident that international partnerships were allocated evenly across all projects, while loans and bonds were directed to specific projects. This reflects different financing strategies for each source, with partnerships representing a long-term strategic approach, whereas loans and bonds tend to cover specific needs.

The fourth table shows the final distribution results after using Excel Solver to optimize funding allocation, achieving the minimum total cost while meeting all project requirements.

TABLE I
LOANS PROVIDED FOR A COMPANY PROJECT OCP

Banks	**Loan Value (Million Dirhams)**	**Target Project**
IFC	1088.26	Renewable energies and climate technology
KFW	2162.4	Green hydrogen, ammonia and desalination
EBRD	2103.44	Desalination
AFDB	1511.4	Desalination
CACF	181.368	Desalination
CIF	201.52	Renewable energies and climate technology
Total	**7249 M MAD**	

Source: Produced by the author using data from the institution

TABLE II
BONDS ISSUED FOR A COMPANY PROJECT OCP

	History Due	
Publications	**2 May 2034**	**2 May 2054**
May 2024 release	12312.5M MAD at 7.5% interest	7387.5M MAD at 6.75% interest rate
Additional release in February 2025	2537.25M MAD	746.25M MAD

Source: Produced by the author using data from the institution

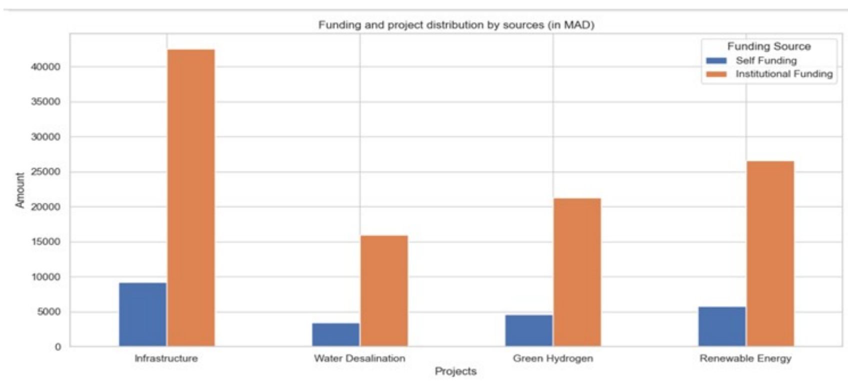

Fig. 1. Chart of Funding Allocation Using Linear Weighting Simulation for Weight Distribution (Python Output Produced by the Author)

TABLE III
DISTRIBUTED SPREADSHEET

	Industrial Infrastructure & Fertilizers	**Desalination**	**Green Hydrogen and Ammonia**	**Energies and Climate Tech**
Financing & Loans	0	5418	541	1290
International Bonds	9197	3449	4599	5748
International Partnerships	42534	15951	21267	26584
Total (Ask)	51731	24818	26407	33622

Source: Produced by the author using data from the institution

The table 4 indicates that bank loans were directed entirely to the industrial infrastructure and fertilizers project, while bonds focused on other main projects. International partnerships covered all four projects evenly, reflecting efficient allocation of financial resources according to project priorities and the goals of the Green Investment Program for the period 2023–2027.

$$\text{Min } Z = 26584 \times 33622 + 15951 \times 24818 + 21267 \times 26407 + 0 \times 7249 + 9197 \times 22993 + 42534 \times 21489 \quad \text{(IV.1)}$$

$$Z = 2\,976\,756\,582 \quad \text{(IV.2)}$$

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TABLE IV
DISTRIBUTION RESULTS AFTER USING THE EXCEL SOLVER PROGRAM

	Industrial Infrastructure & Fertilizers	Desalination	Green Hydrogen and Ammonia	Energies and Climate Techn
Financing & Loans	7249	0	0	0
International Bonds	22993	0	0	0
International Partnerships	21489	24818	26407	33622
Total (Ask)	51731	24818	26407	33622

Source: Produced by the author using data from the institution

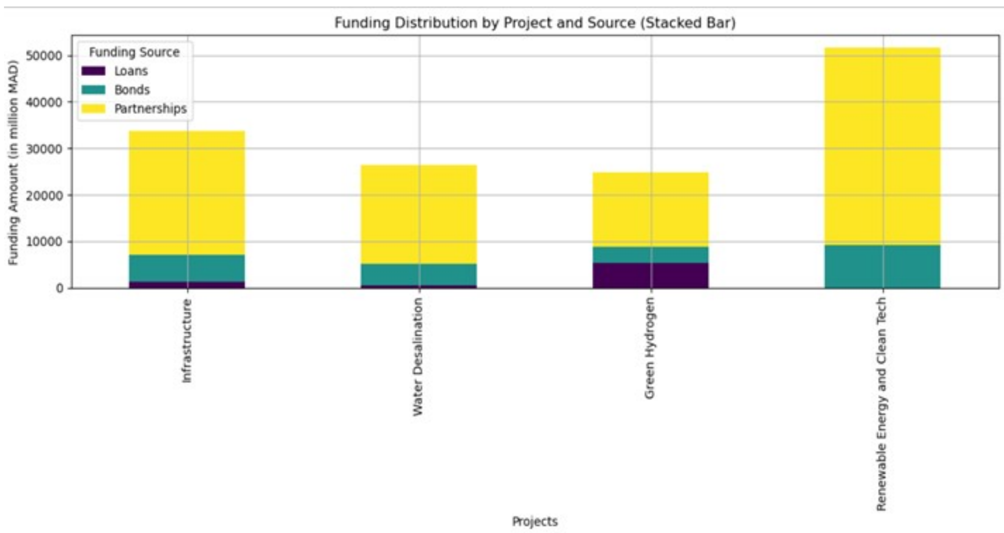

Fig. 2. Chart of Funding Sources Allocation to the Green Investment Program Projects (2023-2027) (Python Output Produced by the Author)

Through the results obtained from the above table, we note that the total offer value is equal to the total value of the demand which is 136578 million dirhams, which will contribute to solving the table directly without adding an imaginary column or row. Which is added with the aim of balancing the total values of demand and supply as for the distribution of funding sources, we note that international companies were directed to the four projects with similar values for a total of 106335.97 Million dirhams. This shows that it is the lowest cost of the three sources. International bonds were also directed to the same project only at a value of 22,993 million dirhams, which means that they were likely resorted to after exhausting the maximum allocated amount of strategic partnerships. While the international loans were fully directed to the industrial infrastructure and fertilizer project, they only used partial financing of the latter in the amount of 7249 million MAD, which indicates that it is relatively more expensive and therefore will only be used when needed. To cover the remaining demand and from here it appears to us that it has Greater emphasis was placed on the infrastructure project, which received funding from the three sources worth 51,731 million MAD. This reflects its great importance in the Green Investment Program for the period between 2023 and 2027 as for projects. that received a value of 0 in some funding sources This means that they have not received any funding from the available funding sources due to the fact that if they take funding from sources with a value of zero, it will become a cost Funding is high. Hence, we note that loan financing reflects the desire of the institution to use high-cost and interest financing in projects that achieve a quick return, of course, after directing it mainly to the industrial infrastructure project. As for bond financing, it represents a suitable medium term financing tool, which makes it suitable for projects that require stable financing without the need for rapid recovery as is the case with loans. Finally, partnership financing reflects the strategic dimension of these projects within the framework of sustainable development and energy transition, which also confirms the interest of international partners in supporting projects with environmental dimensions and positive effects on environmental resources. As for the achieved result MIN Z =2976756582 , it represents the lowest possible cost to achieve the financing targets within the framework of improving the financing decisions of the Green Investment Program for the period 2023-2027.

B. Comparison of Results with Previous Studies

In light of the results of the current study, which relied on a linear programming model supported by linear weighting simulation, an optimal distribution of financing resources was reached among four OCP strategic projects, based on two main sources of financing: international bonds and partnerships. The Solver tool in Excel was used to solve the model, allowing great flexibility in adjusting criteria and funding constraints and simulating multiple scenarios. This approach made it possible to account for the relative importance of each project, especially in the absence of accurate demand data. The results showed the efficiency of this approach in improving resource allocation and balancing financing constraints with strategic objectives, while remaining reusable and adaptable to market changes.

Compared to previous studies, the methods and methodologies used are diverse, but the common denominator is the pursuit of improved resource allocation and support for managerial and productive decisions. For example, a study relied on linear programming models and goal programming to choose the optimal production mix in engineering industry companies in Syria and focused on sensitivity analysis to offer alternatives to decision makers. The study employed numerical linear programming using the LINDO program [1], [4] to present a model that achieves profits exceeding the actual results observed in an Algerian institution, highlighting the importance of mathematical models in improving economic performance.

On the other hand, another study aimed to plan optimal production in an Iraqi factory using the IN CANE program [7], where the model demonstrated the ability to allocate resources efficiently and reduce waste, resulting in increased profitability. At the service level, Tayebnasab *et al.* [23] proposed an advanced two-level linear programming model to reduce patient payments while simultaneously maximizing hospital income in a complex healthcare environment requiring a balance between social and financial objectives.

In terms of the methods used, our study is characterized by the adoption of linear weighting simulation as a decision-support mechanism. Unlike some previous studies that relied on goal programming or binary models, this study focused on a unified linear programming framework using the Solver tool to generate the optimal solution based on estimated weights. This model is simpler and more flexible, particularly in environments that lack accurate data or require easy-to-use decision-support tools.

Therefore, the present study can be considered both complementary and distinctive. It provides a simplified and effective model that combines widely available analytical tools (Excel/Solver) with a linear weighting approach, making it practically applicable within financial environments characterized by uncertainty and data scarcity. The results also reinforce the applied value of linear models in improving funding allocation, consistent with previous studies that demonstrated the feasibility of these models in different production and service contexts.

C. Discussion of Practical Implications and Limitations

The transportation model is an analytical tool that enables the distribution of funds to be organized in a deliberate manner, especially when multiple projects and diverse funding sources are involved. By applying this model to the situation of OCP, several practical advantages can be derived, as well as a number of challenges that may affect the accuracy and feasibility of the results. In practice, this model provides an effective support tool that assists decision-makers within the company, as it offers a quantitative framework based on linear programming and transportation models. This framework helps determine the optimal allocation of funding between different projects, based on the available financing sources and the needs of each project.

In addition to improving resource utilization, the model helps reduce waste and maximize the use of available financial resources, particularly when there is disparity in financing capacities among different sources (such as costly loans versus free or semi-free partnerships). Moreover, the model is flexible and easily updatable, as the data allocated to each project can be modified when new information becomes available. The model also provides an analytical perspective on the distribution of financing according to its source (bonds, loans, and partnerships), which contributes to understanding the level of dependence on each financing instrument and evaluating its potential risks or suitability. Furthermore, the same model can be reused for future projects simply by modifying the initial data, making it a long-term planning tool for financial decision-making.

However, despite the practical advantages offered by the model, several limitations must be considered. First, the model does not incorporate a temporal dimension, meaning that it does not provide funding distribution across time phases (short, medium, or long term), while some projects may require financing over multiple years.

Second, the model ignores detailed economic feasibility. It does not evaluate the financial return or economic viability of each project, relying instead on estimated weights, which may affect its accuracy in complex financing situations.

Third, the model ignores the interaction between funding sources, as each financing source was analyzed independently without examining potential overlaps or complementarities between them, such as covering specific costs through a mix of financing sources.

Fourth, the absence of sensitivity and risk analysis is another limitation. The model does not test how the funding allocation would change if the weights or the total available budget were modified. Such analysis is essential in real-world environments where financial conditions and data can change rapidly.

V. Conclusion

This study found significant results that enhance the effectiveness of using linear programming models and linear weighting simulation techniques in improving financing decisions within OCP. The financial transportation model demonstrated the ability to distribute resources optimally among four strategic projects, taking into account different sources of financing, especially international bonds and international partnerships. This contributed to achieving the lowest possible cost of financing within realistic financial constraints.

In the same vein, the use of simulation techniques, such as the Linear Weighted Scoring Model, enabled the integration of multiple criteria including the cost of funding and the degree of risk, resulting in more balanced and objective financing decisions. The results showed that diversifying funding sources provides greater financial and strategic flexibility compared to relying on only one source of funding.

Moreover, the study showed that the model is flexible and adaptable to changing financial data, making it a reusable tool in long-term investment planning. Overall, the results confirm that quantitative models such as linear programming and simulation represent practical and effective tools that support decision-makers in addressing financing complexities and help identify optimal alternatives according to the company's priorities and objectives.

However, it is necessary to note some limitations that may affect the accuracy or comprehensiveness of the results. The model does not take into account the time dimension of funding distribution, ignores detailed economic analysis of each project, and addresses funding sources independently without considering potential overlap or complementarity between them. In addition, no sensitivity analysis or testing of the impact of changing data such as budget or weights was conducted, which is necessary to ensure that the model adapts to changing economic conditions.

Based on the above, this study provides a set of research recommendations to improve financing decision-making and enhance its effectiveness in applied business environments. First, future research should study the impact of global market fluctuations on optimal financing models by exploring how interest rates and international bond markets influence financing decisions in large industrial companies such as OCP. Second, a comparison between linear programming results and artificial intelligence models could be conducted to analyze the effectiveness of techniques such as neural networks or genetic algorithms in improving funding decisions.

Third, the model could be expanded to include risk analysis by integrating uncertainty through stochastic programming or Monte Carlo simulation to evaluate funding decisions in unstable environments. Fourth, the development of multi-criteria decision-making (MCDM) models such as AHP or the Linear Weighted Scoring Model alongside linear programming could help incorporate environmental and social considerations. Fifth, future work could include a comparative study between different Moroccan companies to analyze the efficiency of various financing sources. Sixth, long-term dynamic analysis of financing decisions could be performed by developing a dynamic programming model that examines the impact of financing on a company's financial performance over several years. Finally, future studies may explore the integration of Islamic finance instruments such as Musharaka and Mudaraba into traditional mathematical models and assess their impact on profitability and Shariah compliance.

In practical applications, the Linear Weighted Scoring Model and its simulation techniques represent effective quantitative tools that play a pivotal role in supporting financial decision-making, especially in contexts requiring the evaluation of multiple criteria. This methodology is widely used in several practical applications, particularly in investment budget planning, where it contributes to the allocation of financial resources among projects according to well-defined strategic priorities.

It also provides opportunities for investment portfolio management by allocating assets based on criteria such as expected return, risk, and liquidity, ensuring balanced portfolios aligned with investors' objectives. In the field of banking and corporate finance, the model is valuable for analyzing financing alternatives and selecting the most appropriate source, whether loans, bonds, or partnerships, based on criteria such as financing cost, repayment period, and risk level.

Furthermore, it is useful for assessing the relative feasibility of investment projects, analyzing costs and benefits, and directing resources toward high value-added activities. The model also helps prioritize investment spending under financial constraints and supports financial performance analysis using multiple indicators.

Finally, linear weighting simulation provides a framework for testing multiple scenarios and evaluating the flexibility of financing decisions under changing market conditions. This enhances organizational adaptability and supports long-term financial planning. Thanks to these characteristics, the model represents a flexible and comprehensive framework for making financial decisions based on quantitative and objective analysis.

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