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Research Article

Sustainable Financing Model considering Project Risk

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Implementing various projects in each country leads to the development of that country. The necessity of implementing any project is to finance that project through different methods. In this regard, the cost of financing projects, determining the amount of financing from each technique, and the risk of financing projects are among the things that have caused problems for managers and decision makers. This study presents a new sustainable financing model for international projects in Iran. The main objectives are to minimize the financing cost and risk of funding the projects. Based on the proposed conceptual model based on fuzzy hierarchy analysis, it was observed that Iran's economic conditions, with a weight coefficient of 0.34, have the highest risk in financing projects. Therefore, a two-objective model was designed by determining the weighting coefficients to reduce costs and financing risks. Additionally, the epsilon constraint methods and NSGA II algorithm were used. Comparative results between the two algorithms show that financing projects must be changed to reduce the risk of sustainable financing of international projects, which can lead to an increase in the total cost of financing projects. On the other hand, it was observed that the NSGA II algorithm obtained 32 efficient answers (a combination of how projects are financed). Each of the received answers has advantages over the other solutions obtained. The epsilon constraint method also brought 11 efficient answers, demonstrating that the domestic capital market can provide 54.89% of the deficit budget of the country's international projects. Furthermore, 44.81% of the project deficit budget can be financed from a foreign bank loan source, and only 0.2% of the budget can be funded through the company's internal resources.

1. Introduction

Financing and preparing the necessary executive budget to carry out infrastructure projects and exploiting the relevant products and services has been a critical challenge in developing countries [1]. Due to the particular condition of developing countries and financial crises, it is impossible to provide the necessary capital to implement international projects. Thus, choosing the appropriate national financing method taking into account the financing risks of international projects such as sanctions, changes in exchange rates, and so on is an important issue [2]. In many global projects, the high volume of capital required and the high sensitivity of the project in terms of political, economic, and security issues have led to government officials' attention to financing. The needed funds can be provided with government support and funding for several projects. However, in infrastructural and international projects of the country that cannot be fully financed by the government (such as oil, gas, and petrochemical industries), there is a basic need for the presence of foreign investors and using foreign banks and institutions' facilities [3]. Project financing differs from traditional types of financing because the financier looks at the assets and revenues of the project to provide the loan. Project finance greatly minimizes risk to the sponsoring company, as compared to traditional corporate finance, because the lender relies only on the project revenue to repay the loan and cannot pursue the sponsoring company's assets in the case of default [4].

Considering the structure of the countries' public sectors and the existing problems and damages, we are witnessing the prolongation and inefficient implementation of projects in various sectors for reasons such as administrative and government bureaucracy, which in turn leads to a decrease in quality and service delivery. On the other hand, the government's budget and financial resources do not fully provide enough investment in these sectors [5]. Meanwhile, the existing potential and capacities of the countries make the need to take advantage of the expertise and innovation of the private sector regarding the implementation of international projects more than ever. The experiences of different countries of the world indicate that factors such as governments' limited financial and budgetary resources to provide international projects and the high demand in the field of investment in these projects have prompted countries to put all their efforts. Creating a suitable competitive environment for their activities, these efforts have crystallized in the form of public-private partnerships and have accelerated the economic development process of countries [6]. Finding a way to fund international projects is one of the first steps in ensuring that a project is completed [7]. In choosing the appropriate financing method in the feasibility stage of the project, one should pay attention to all the cases and demands of different sectors involved in the project (such as project size, project-related industry, contractors, buyers, suppliers, lending banks, and risk issues). Then, mathematical models are applied to determine the best method or methods of investment, considering the reduction of costs and risks. It should be noted that the structure used to finance a project in a country may not be effective everywhere due to differences in laws and conditions in different countries. The critical point in choosing the proper financing method according to each project and country's requirements is the project's amount [8, 9].

The most important and effective solution to achieve development goals in a country is the existence of a robust economic structure with an active financial market. Due to the lack of funding and financial savings in most developing countries, domestic facilities in such countries are not enough to raise capital to achieve development goals and national and international projects. Therefore, most of these countries have to have the required capital deficit. Therefore, most of these countries have to have the required capital deficit to provide themselves from external sources, and thus the tendency to attract external financial resources is formed. In financing the project, it can be done according to the type of project and the relevant industry, the amount of money and the time required for the project, the conditions of the country, the amount of the project in terms of political, economic and existing laws, the risks of each financing, and the level of sensitivity of the project in that country various methods for financing international projects were considered [10, 11, 12].

Types of financing include short-term or long-term loans, investment participation, conditional investment, sale of company shares, issuance of bonds (the last two methods are possible for large companies, of course), and so on. Whether related to the public or private sector, the financing of projects is done either through domestic resources or through the absorption of foreign resources [13]. In each of these methods, there are different options that the project employer finances his project according to his needs from one of these two methods [14]. There are various financing methods for each international project with different risks, including the cost of their unique capital. Therefore, financing for each project will include two indicators of capital cost and related risk.

Consequently, it is necessary to provide a sustainable financing model for international projects, considering the risks and costs of capital. Accordingly, the primary purpose of the proposed research is to present a two-objective mathematical model with the objectives of reducing the cost of capital (financing) and reducing the risk of financing international projects. Therefore, a set of international projects with different funding sources should minimize the total cost of funding international projects; however, this can increase the financing risks. Therefore, the creation of a mathematical model for decision-making, including the allocation of financial resources to each international project and the prioritization of funding, is investigated. The result of presenting this model will be the achievement of an efficient set of answers from funding international projects. The concept of capital cost is based on the assumption that the company's goal is to maximize shareholder wealth. Virtual units must accept designs that are at least more cost-effective than the cost of capital for that unit. In other words, the cost of capital is the minimum rate of return for new investments. The capital cost, called the required return, represents an investor's opportunity cost to invest in a company or project.

The main purpose of this article is to design a multi-objective mathematical model based on reducing capital costs and reducing the risk of financing international projects. The mathematical model is such that it can provide the source of financing for a series of international projects in Iran in a way that has the lowest capital cost and the lowest financing risk. Therefore, for this, a set of methods for determining the project's financial risk such as FAHP and accurate methods such as epsilon limit (EP) and meta-battery algorithms such as NSGA II have been considered. Solution methods provide managers with effective solutions (investment options) so that they can choose the most appropriate option based on budget, political, investment, and other restrictions.

Therefore, the main features of the article can be summarized as follows:

(i) Considering both the cost of capital and risk in financing international projects.

(ii) Providing a combined model of fuzzy hierarchical analysis and mathematical planning model in financing international projects.

(iii) Use of epsilon constraint method and NSGA II algorithm in solving the problem of financing international projects.

(iv) Prioritization and weighting of financing risks based on the fuzzy hierarchical analysis method.

This paper's structure is as follows. In the second part, the research background is stated, the research gap is determined, and finally, the research innovations are discussed. The third part presents a two-objective mathematical model for financing sustainable projects. Additionally, this section offers two-objective model solution methods and evaluation indicators of solution methods. In the fourth section, a case study in Iran (international projects) is studied, and the mathematical model results are presented. The fifth section concludes the findings and proposes future research proposals.

2. Literature Review

The significant and direct relationship between corporate financing and its size has been investigated in several studies. The internal variables affecting the financing of small and medium enterprises are their profitability and age. Profitability is a measure of the efficiency and effectiveness of the firm in using the assets owned. The hierarchical theory states that firms with more profitable weapons are less inclined to obtain facilities because they have more accumulated profits. The higher profit margin of the firm makes the banks more willing to increase the facilities.

On the other hand, the longer the company's payment period is, the more banks trust in the return of high-quality facilities, and the more attractive the company is to provide facilities for banks. In addition, startups often need a lot of external financing to maintain their internal resources in the early years of operation and are always trying to obtain facilities. Ebrahimnejad et al. [15] identified the most critical risks based on BOT financing of power plant projects. Then, the risk assessment in funding is done by the BOT method and is prioritized based on the fuzzy LINMAP method. The proposed framework was implemented in a real case study. Yousefi et al. [16] prioritized the financing methods used in the Tehran Renovation Organization through a hierarchical analysis method. In addition to prioritizing financing methods, this paper performed a sensitivity analysis to determine the impact of weight changes on the prioritization of various projects. Nourzai et al. [14] examined the effect of criteria on the financing method of the railway project using a questionnaire. They conducted their evaluation through partnership financing (BOO, BOT, and DBFO). Finally, the prioritization of railway funding projects was done through the AHP method. Mehr Ara et al. [17] sought to find the most appropriate method of financing Mahan Air. They surveyed 15 experts to prioritize financing methods using fuzzy hierarchical analysis. The results showed that in the financing of projects of international business companies from internal sources: loans, equity participation, installment sales, leasing, internal supply line, participation in profits and external financial sources, external financing line, construction, operation, transfer, and capital. Partnerships are in order of importance. Besides, closer inspection showed a significant relationship between different financing methods and project success.

Manzoor et al. [18] examined different models of public project financing based on two important features. The first is the long-term construction period and the second is the high cost of implementation. They stated that the use of Islamic financial innovations based on Islamic contracts can answer many of these needs. Kumar et al. [19] investigated the financial risk associated with highway infrastructure projects by identifying parameters such as traffic flow and project cost and modeled the risk by analyzing real-world PPP-based highway projects in India. They presented the tool of net present value (NPV) model and Monte Carlo simulation considering probability distributions for various input parameters and uncertainty associated with NPV. Li et al. [20] examined the financing risk of high-tech companies. They offered several ways to better address financing risks from the perspective of firms, financial markets, and government regulations. Bluhm et al. [21] analyzed the effects of these projects on the spatial distribution of economic activity in the host countries by examining projects geographically covered by the Chinese government in 138 countries between 2000 and 2014. The results show that Chinese investments in "bonded infrastructure" create positive economic overflows that lead to an equal distribution of economic activities in the areas where they are implemented. Barroco and Herrera [22] examined the selection factors of financing methods in the Philippines. They showed that project financing could raise the capital needed for renewable energy in developing countries. Wu et al. [23] assessed the financing risk of rural tourism projects and their comparative analysis using Vicker's multi-criteria decision-making method with fuzzy numbers. They stated that using the proposed method could fully consider the limited rationality of decision makers in an actual decision-making action. This study shows that from the perspective of financial providers, higher facilities for small companies are associated with more uncertainty than direct social loans paid. Ahmadabadi and Heravi [24] investigated the impact of essential success factors on PPP projects based on the developed PLS-SEM model. The results showed that the private sector's ability directly impacts the project's success during the construction period, and the government's ability is very effective in the operation phase of the project. In addition, the review of case studies according to the introduced model showed a transparent bidding process, risk allocation, and good participation of CSFs in PPP projects in developing countries.

Tan et al. [25] presented optimization models for innovative financing in the field of green energy technology. They presented two mathematical models. In the first model, the optimization of budget allocation to a set of independent innovative projects has been addressed, and in the second model, the allocation of limited project budget has been optimized to maximize the SRL of an emerging technology system. Noring [26] evaluated the effectiveness of different public/private consultation models for urban regeneration and land value absorption with the aim of maximizing returns. He introduced the PAC model for urban development and infrastructure financing, which is a combination of public and private models. This method has been used in the development of the city and port of Copenhagen in the extensive urban reconstruction and the city's subway system. In a quasi-natural experimental study, Li and Zhong [27] identified the cause-and-effect relationship between economic policy uncertainty and decision making on corporate investment financing. They have designed a model using structural reform and an input-output flowchart. The empirical results of this study show that the uncertainty of economic policies significantly hinders real investment and reduces the net debt issuance to private enterprises. Manzoor and Norouzi [28] focused on financing upstream Iranian oil and gas projects using cryptocurrencies in conventional contract models. As a result, using this method improves the efficiency of traditional oil and gas contract financing methods. Bahrololoum and Bakhtiar [29] discussed the most important criteria and efficient methods of financing thermal power plants in Iran. They prioritized efficient financing methods from 18 experts working in thermal power plant financing to collect information using the AHP method. The results show that financing through Islamic bonds (SUKUK) has the highest efficiency level among financing methods. The use of financing sources is the most critical criterion in choosing the most efficient financing for these projects in Iran. Hosseini and Ismailpour Moghadam [30] examined defense financing models through capital markets, considering the European Union and the United States as case studies. They proposed a financing model for Iran's defense-related industries and services through capital markets. The model estimation results show that larger companies have successfully attracted financial resources by issuing shares or accumulating profits. On the other hand, companies with more profitability have been more successful in financing by obtaining debt.

Adekoya et al. [31] compared the efficiency of US green and conventional bond markets to achieve environmental sustainability from a financial perspective. Using the fractional integration technique, they showed that the entire green and conventional bond markets are still inefficient, suggesting that green and conventional investors can earn more by anticipating future bond price trends. There is also evidence that the green bond market continues to be more volatile during the global health crisis than during the global financial crisis. Ari and Koc [32] introduced alternative equity-based financing models. They did this by developing an agent-based model and scenario-based computer simulations for financing solar power plants. Simulation results show that the proposed model significantly reduces wealth inequality for the given case study, while conventional debt-based financing models increase inequality. Bahadoran-Baghbaderani and Mohamadi [33] legally examined the most critical restrictions on foreign investment and project financing in implementing these contracts. They ranked the position of these restrictions in the preevaluation of EPCF contracts compared to other conventional commercial contracts in Iran. This study represents the result of surveys conducted on 60 contracting entities and employers with experience in EPCF contracts. The results illustrated that contractors and employers in Iran did not welcome these contracts. The reasons are the lack of EPCF matching contracts by the management and planning organization, the lack of forecasting the process of using the contract in the law on tenders, the long time to finance the contract, and sometimes the inability of the contractor to finance zero to one hundred projects. As a result, despite all its benefits, it is not only faced with a positive approach from contractors and employers, rather it ranks first among the most challenging service and investment contracts compared to other standard commercial contracts.

Morea and Gebennini [34] introduced a new model of project financing and environmental efficiency for sustainable investment. Egor [35] investigated the financing problems of large infrastructure projects in Russia and China and proposed ways to improve and develop financing in Russia. In this research, scientific knowledge methods such as induction, inference, analysis, synthesis, generalization, and description were used. Gamel et al. [36] deepened the understanding of people's motives for investing in wind energy projects. Further analysis shows that subjective norms, perceived behavioral control, consumption characteristics, and investor experience have a statistically significant effect on wind energy investment goals. However, attitude towards wind energy investments is not a significant predictor of investment intention. Khojimamatovich et al. [37] conducted a case study in Uzbekistan for financing macro-level activities and projects and outlined the country's current situation and investment prospects. Therefore, they provided recommendations on the feasibility of a system of financing investment activities in Uzbekistan. Maslov [38] identified and analyzed the prerequisites for sharing benefits and costs in determining the effectiveness of financing public-private partnership projects. He used economic and mathematical modeling methods to calculate the effectiveness of public-private partnership projects. He stated that the systematic reinvestment of personal funds causes a gradual increase in income. Pranata et al. [39] investigated the use of crowdfunding as an alternative source of financing infrastructure projects, especially in developing European and American countries. They compared 4 crowdfunding platforms (Oneplanetcrowd, Convergence Finance, Citizenergy, and Infrashares) in Europe and the US that successfully raised capital for infrastructure projects. Tavakolan and Nikoukar [40] presented a hybrid metaheuristic algorithm to solve a multi-objective optimization problem in planning and financing construction projects. The main purpose of this model is to provide a Pareto chart that shows the trade-off between project duration and financing cost by considering different durations for each project activity and different financing options.

In Table 1, the research gap among the most important articles published in the field of project financing in different countries has been examined.

By reviewing the relevant literature, it can be seen that a small number of research studies have provided mathematical models for financing projects by considering risk. Since risk is considered as an important factor in the financing of international projects of any country in line with its development, in this article, the FAHP method has been used to weight and prioritize risks. Also, a two-objective

Table 1: Examining the research gap in the field of project financing.

# Ref	Objective	Mathematical model	Uncertainty	Risk	Solution approach	Case study
Eyiah and Cook [41]	Financing small and medium-scale contractors	—	—	—	Survey and questionnaire	The Bank for Housing and Construction (BHC) in Ghana
Singh and Kalidindi [42]	Identifying the various aspects of PPP road projects	—	—	✓	Questionnaire	PPP road projects in India
Ohiare [43]	Estimating the investment requirements and financing options for rural electrification	✓	—	—	Interview and questionnaire	Rural energy Projects in Nigeria
Chen et al. [44]	Identification of project financing risks	—	—	✓	Content analysis AHP	Beijing subway line 4 and Indian Dabhol Power Project
Barroco and Herrera [22]	Clearing barriers to project finance for renewable energy	—	✓	—	Content analysis PLS-SEM	Renewable energy projects in the Philippines
Ahmadabadi and Heravi [24]	Investigation of the interrelation between success criteria (SC) and critical success factors (CSFs)	—	—	✓	PLS-SEM	Highway projects in Iran
Klagge et al. [7]	Financing of renewable energy projects	—	—	✓	Statistical analysis	Two large-scale renewable energy projects in Kenya
Yemelyanov et al. [45]	Reduction of financing investment costs	✓	—	—	Statistical analysis	Natural gas in Western Ukraine
Roth et al. [46]	Reduction of financing investment costs	✓	—	—	Survey and impact analysis	Renewable energy projects in the European Union
Spasenic et al. [47]	Risk assessment of financing renewable energy projects	—	✓	✓	FMEA-DST	A small hydropower plant project in Serbia
Tavakolan and Nikoukar [40]	Time and total cost of financing international projects	✓	✓		NSGA II	Construction project in Iran
Pranata et al. [39]	Investigating various financing methods	—	—	—	Statistical analysis	Infrastructure projects in Europe and America
This paper	Cost-scheduling of financing international projects	✓	✓	✓	FAHP Epsilon constraint NSGA II	International projects in Iran

model is presented by reducing financing cost and reducing financing risk, and EP and NSGA II methods are used to achieve different decision options.

3. Presenting a Mathematical Model for Financing International Projects

Due to the particular situation of developing countries and the relevant financial crises, preparation of the necessary executive budget to carry out infrastructure projects besides exploiting the products and services has been faced with different challenges. Thus, choosing the appropriate national financing method considering the international projects' risks are essential issues (such as lack of investment in the design stage, the existing historical background, political and international conflicts, Iran's economic situation, elections, sanctions against Iran, world economic conditions, limited resources, government goals, and so on). Accordingly, this section presents a two-objective model for sustainable financing of international projects to reduce financing and international projects' financing risk. Consequently, international projects should be funded according to each project's net profit, tax rate, current debts, etc., based on various available resources.

Therefore, the two-objective model of sustainable financing of international projects can be modeled to reduce financing and reduce the financing risk of international projects based on the following assumptions:

(i) Projects are considered that are seeking funding and facing budget deficits.
(ii) Projects can be financed in three ways (internal resources of the company, capital increase through the parent company (internal capital market), and the use of bank loans (external resources)).
(iii) Financing is done only for working capital and purchase of fixed assets.
(iv) The maximum use of each funding source is known.
(v) The expected profit per share is considered in mathematical modeling.
(vi) The risk of project financing is uncertain.

Based on the assumptions mentioned above, the financing model can be expressed by defining the following symbols:

Sets

I: collection of international projects $i = \{1, 2, \ldots, I\}$

J: funding sources $j = \{1, 2, \ldots, J\}$

K: inter-unit loan set and dividend distribution to the parent company $k = \{1, 2, \ldots, K\}$

R: project risk set $r = \{1, 2, \ldots, R\}$

Parameters

a_i: profit before interest and project tax i

b_i: net project profit i

c_j: the capital cost of financing source j

T: tax rate

h_i: amortization of project i during the planning period

I_i: current debt plus the current portion of project long-term debt i during the planning period

d_i: dividends paid on project i per share during the planning period

w_i: the amount required for project i to be financed

v_i: minimum earnings per share for the project i

n_i: number of project shares i

p_{ij}: maximum capacity to use source j for unit i

δ_{rj}: risk weight r in financing from source j

Decision variables

X_{ij}: the amount of financing unit i from source j

Y_{ik}: the amount of cash flow output of unit i in option k.

The mathematical equations of the two-objective model of sustainable financing in international projects are expressed as

$$\min Z_1 = \sum_{i=1}^{I} \sum_{j=1}^{J} c_j . X_{ij}, \tag{1}$$

$$\min Z_2 = \sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{r=1}^{R} \delta_{rj} . X_{ij}, \tag{2}$$

$$\text{s.t.: } b_i + h_i + I_i - d_i + \sum_{j=1}^{J} X_{ij} - \sum_{k=1}^{K} Y_{ik} = w_i, \quad \forall i \in I, \tag{3}$$

$$\frac{\left(a_i - \sum_{j=1}^{J} c_j . X_{ij}\right)/1 - T}{n_i} \geq v_i, \quad \forall i \in I, \tag{4}$$

$$X_{ij} \leq p_{ij}, \quad \forall i \in I, \ j \in J, \tag{5}$$

$$X_{ij}, Y_{ik} \geq 0, \quad \forall i \in I, \ j \in J, \ k \in K. \tag{6}$$

Equation (1) shows the total cost of financing international projects.

Therefore, in this regard, after determining the share of each financing method, the corresponding financing cost will be applied.

Equation (2) refers to the entire risk of international funding projects. In this regard, each financing type has a unique risk level.

Therefore, in this regard, based on the financing amount of each international project and the risk weight determined by the FAHP method, the overall risk of project financing is determined.

Equation (3) demonstrates the supply of each of the international projects. Equation (4) ensures that each project's minimum earnings per share are estimated. Also, equation (5) shows the maximum capacity to use each financing source for each project. According to these relations, the international projects' sustainable financing is based on the two-objective model of total financing cost and total financing risk.

In this regard, to determine the weight of the impact of each risk in the mathematical model, the fuzzy hierarchy analysis method has been used by presenting a conceptual model as described in Figure 1.

Given the various steps to achieve the results, the flowchart in Figure 2 shows how to finance international projects based on the mathematical model and the conceptual model presented.

The fuzzy hierarchical analysis method for prioritizing and weighting the project risks, the epsilon constraint method, and the NSGA II algorithm for solving the two-objective mathematical model and forming the Pareto front are discussed.

4. Methodology

In this part of the article, the method of fuzzy hierarchical analysis to determine the weight coefficients of risks of each project based on the conceptual model of Figure 2 is first described.

4.1. Fuzzy Hierarchical Analysis. In many real-world issues, human judgments and perceptions are not definitive. The theory of fuzzy sets was proposed in 1965 to address the uncertainty of decisions. Fuzzy sets are sets with membership degrees that are defined. A triangular fuzzy number can be defined as $\widetilde{A} = (l, m, u)$ whose membership functions are given by

$$\mu_{\widetilde{A}}(x) = \begin{cases} \dfrac{x - l}{m - l}, & l \leq x \leq m, \\[2ex] \dfrac{u - x}{u - m}, & m \leq x \leq u, \\[2ex] 0, & \text{otherwise,} \end{cases} \tag{7}$$

in which l and u are the lower and upper bounds of the fuzzy numbers $\widetilde{A}$ and m, respectively, are its middle values. If we assume that there are two fuzzy numbers $\widetilde{A_1} = (l_1, m_1, u_1)$ and $\widetilde{A_2} = (l_2, m_2, u_2)$, then the following operators can be defined as

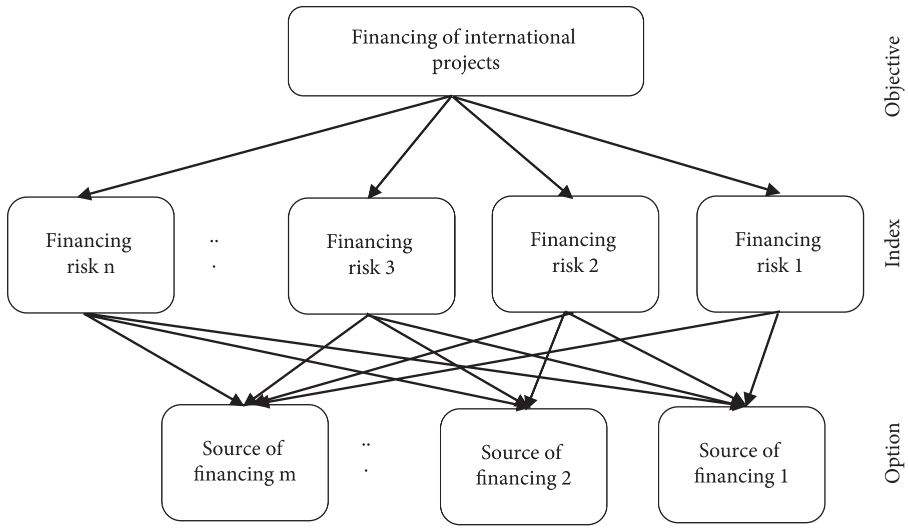

Figure 1: Conceptual model of hierarchical analysis of financing international projects.

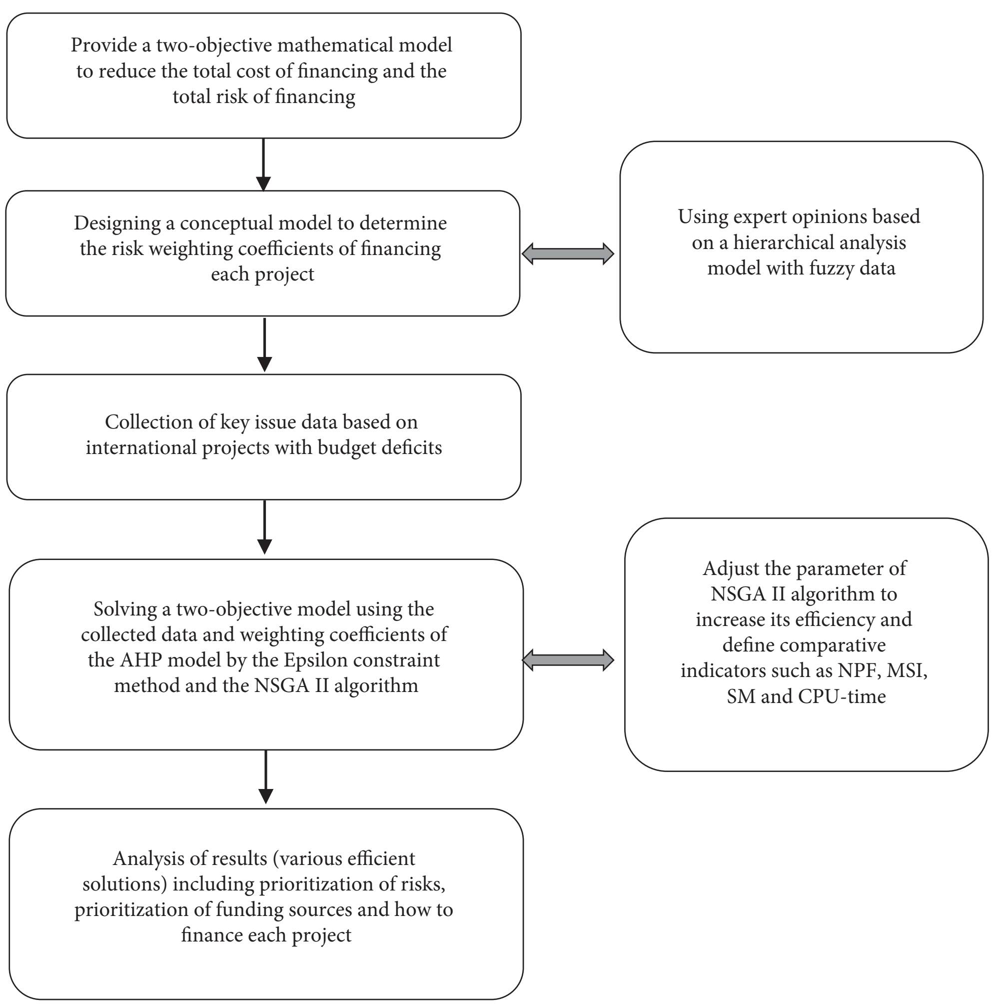

Figure 2: Flowchart of how to achieve the financing of sustainable projects.

$$\begin{aligned}
&\widetilde{A_1}\oplus\widetilde{A_2} = (l_1, m_1, u_1) + (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2),\\
&\widetilde{A_1}\otimes\widetilde{A_2} = (l_1, m_1, u_1)\otimes(l_2, m_2, u_2) = (l_1 \times l_2, m_1 \times m_2, u_1 \times u_2),\\
&\widetilde{A_1} - \widetilde{A_2} = (l_1, m_1, u_1),\\
&\frac{\widetilde{A_1}}{\widetilde{A_2}} = \frac{(l_1, m_1, u_1)}{(l_2, m_2, u_2)} = \left(\frac{l_1}{l_2}, \frac{m_1}{m_2}, \frac{u_1}{u_2}\right),\\
&\widetilde{A_1}^{-1} = (l_1, m_1, u_1)^{-1} = \left(\frac{1}{l_1}, \frac{1}{m_1}, \frac{1}{u_1}\right).
\end{aligned} \tag{8}$$

Hierarchy analysis is a decision-making method based on expert opinions used to prioritize and weight the criteria and options of the problem. This method can determine the importance of each criterion based on pairwise comparisons between criteria through quantitative and qualitative evaluation. Due to the uncertainty of data and comparisons, this method can deal with fuzzy and uncertain numbers, which can be achieved based on the following steps:

Step 1: a pair matrix is created according to equation (9) in which the experts have made their pair comparisons. Table 2 shows that the nine-spectrum scale has been used to perform the quantification method.

$$\widetilde{A} = \begin{pmatrix} 1 & \widetilde{a}_{12} & \cdots & \widetilde{a}_{1n} \\ \widetilde{a}_{21} & 1 & \cdots & \widetilde{a}_{2n} \\ \cdots & \cdots & \ddots & \cdots \\ \widetilde{a}_{m1} & \widetilde{a}_{m2} & \cdots & 1 \end{pmatrix}. \tag{9}$$

Step 2: the opinions of different experts are collected based on equation (10), written as

$$\begin{aligned}
l_{ij} &= \left(\prod_{k=1}^{K} l_{ijk}\right)^{1/K},\\
m_{ij} &= \left(\prod_{k=1}^{K} m_{ijk}\right)^{1/K},\\
u_{ij} &= \left(\prod_{k=1}^{K} u_{ijk}\right)^{1/K},
\end{aligned} \tag{10}$$

where K is the total number of experts.

Step 3: the fuzzy weight matrix is calculated. To this end, first, the fuzzy comparison values are computed as

$$\widetilde{r}_i = \left(\prod_{j=1}^{n} \widetilde{a}_{ij}\right)^{1/n}. \tag{11}$$

Then, the fuzzy weights of each criterion are defined by

$$\widetilde{w}_i = \widetilde{r}_i \otimes \left(\widetilde{r}_1 \oplus \widetilde{r}_2 \oplus \widetilde{r}_3 \oplus \cdots \widetilde{r}_n\right)^{-1}, \tag{12}$$

in which $\widetilde{r}_i$ represents the geometric mean of the fuzzy numbers and $\widetilde{w}_i$ the weight of each criterion.

Equation (13) is used to control the fuzzy weight obtained for each criterion, and equation (14) is employed to normalize the weight of the criteria.

$$w_i = \frac{(lw_i + mw_i + uw_i)}{3}, \tag{13}$$

$$w_r = w_i \textstyle\sum_{i=1}^{n} w_i. \tag{14}$$

In this way, the weight of each risk in sustainable financing of international projects is obtained based on experts' opinions. After determining the weight of the risks and the collected data, the two-objective model of solution and the efficient solutions obtained should be examined. Therefore, epsilon constraint and NSGA II algorithm methods are proposed to solve the two-objective model described in each of the following methods.

4.2. Epsilon Constraint Method. The extended epsilon constraint method is for solving multi-objective problems. Despite having many advantages over other methods, such as the weighting method, it should be considered in some cases: (1) calculating the range of objective functions in the efficient set, (2) ensuring the efficiency of the obtained answer, and (3) increasing time. Solve the problem if there are more than two-objective functions. To overcome the weaknesses of the epsilon constraint method, the amplified epsilon constraint method uses the lexicographic method to calculate the values of the final result table for each objective function. It converts the constraints related to the subobjective functions to the equation by auxiliary variables. In lexicography optimization, objective functions are ranked by the decision maker based on importance. In this method, first, the objective function is optimized with priority with La as a single objective.

In this method, it is assumed that $f_1(x)$ is the objective function with the highest priority, and its optimal answer is equal to f_1^*. To optimize the second objective function by adding the constraint $f_1(x) = f_1^*$, the optimal solution of the first objective function is maintained, and the value f_2^* is calculated to optimize the objective function with the next priority. The epsilon method model of the enhanced

Table 2: Nine spectra of fuzzy numbers.

Description	Equivalent fuzzy priorities	Reverse fuzzy preferences
Equal importance	(1, 1, 1)	(1/1, 1/1, 1/1)
Identical to relatively important	(1, 2, 3)	(1/3, 1/2, 1/1)
Relatively more important	(2, 3, 4)	(1/4, 1/3, 1/2)
Relatively crucial to very important	(3, 4, 5)	(1/5, 1/4, 1/3)
Very important	(4, 5, 6)	(1/6, 1/5, 1/4)
Very important to very much	(5, 6, 7)	(1/7, 1/6, 1/5)
Very important	(6, 7, 8)	(1/8, 1/7, 1/6)
Too much to be important	(7, 8, 9)	(1/9, 1/18, 1/7)
More important	(8, 9, 10)	(1/10, 1/9, 1/8)

constraint to solve the project financing model can be presented as follows:

$$\begin{gathered}\text{Min } Z_1 + \delta\left(\frac{s_2}{r_2}\right),\\ \text{s.t.: } Z_2 - s_2 = \varepsilon_2 \text{Eqs}\,(3-6),\end{gathered} \tag{15}$$

in which r_2 refers to the domain of the objective functions, ϵ_2 represents the answers obtained from each iteration, and δ is a small positive number.

4.3. The NSGA II Algorithm. One of the most efficient and well-known multi-objective optimization algorithms is the NSGA II genetic algorithm. This algorithm is one of the fastest and most powerful optimization algorithms, with less operational complexity than other methods. It has a good range in the change of objective functions and gives the designer the freedom to choose the design he wants from the optimized structures.

In NSGA II, the preservation of elitism and dispersion are considered simultaneously. The selection of a new population in each step of this method is based on the principle of dominance. Using elitism and population ranking in each step of the solution selects the best-undefeated answers and goes to the next step. If there are two maximization objective functions f_1 and f_2, then for the two answers x and y, the answer x beats the answer $y\,(x < y)$ if we have $f_1(x) \geq f_1(y)$ and $f_2(x) \geq f_2(y)$ or $f_1(x) > f_1(y)$ and $f_2(x) > f_2(y)$. Additionally, to observe the proper distribution of the density of the answers in this algorithm, a concept called congestion distance is used. To sort a population of size n based on non-defeat levels, each response is compared to all the other answers to determine if that answer is defeated. Finally, there are several solutions, neither of which overcomes the other, so these solutions form the first boundary of the invincible boundary.

These answers are passed to set F_1. The answers in the first boundary are temporarily ignored to determine the next boundaries' answers, and the above process is repeated. This time the answers are transferred to the F_2 set and take second place. This process continues for all the unanswered answers of the population.

One of the evolutionary algorithm's criteria to reach the optimal Pareto boundary is maintaining the variety and breadth of the answers in the set of obtained solutions. Arranging non-defeats is a procedure to achieve better answers, and the mechanism of diversity also seeks to maintain diversity and breadth in these answers. In this algorithm, this is done by swarming distance in this way. The smaller the swarming length of an answer, the greater the density of answers around it. For the next step, the solutions in the area with less density or, in other words, with more congestion distance are selected to increase the diversity and dispersion of the obtained answers. Using congestion spacing in NSGA II aims to create variety in population responses and indicate the density of responses alongside a specific response. The swarm interval for the ordered answers is obtained in ascending order and straightforward to set F as defined by the following equation:

$$\begin{aligned} C\ D\left(X^1\right) &= C\ D\left(X^S\right) = \infty,\\ C\ D\left(X^i\right) &= \left[\frac{Z_1\left(X^{i+1}\right) - Z_1\left(X^{i-1}\right)}{Z_1\left(X^S\right) - Z_1\left(X^1\right)}\right]\\ &\quad + \left[\frac{Z_2\left(X^{i+1}\right) - Z_2\left(X^{i-1}\right)}{Z_2\left(X^S\right) - Z_2\left(X^1\right)}\right], \quad i = 2, \ldots, S-1. \end{aligned} \tag{16}$$

In the above relation, $C\ D(X^i)$ is the amount of congestion distance for the answer X^i. After integrating the parent-child population, the undefeated sorting is performed, and steps 7 and 8, described below, are performed. Based on step 10, the swarm distance criterion is used to create a subset of the last undefeated set due to the subsequent increase in population size (Figure 3).

Step 1: create the initial population P_0 of size N with random answers and set $t = 0$.

Step 2: if the stop condition is not met, return to P_t.

Step 3: using the binary selection operator, select N parents from the population P_t.

Step 4: create a population Q_t of size N by applying the intersection and jump operators to the population P_t.

Step 5: set $R_t = P_t \cup Q_t$.

Step 6: use the invincible ranking method to determine the Pareto F_i sets in R_t population.

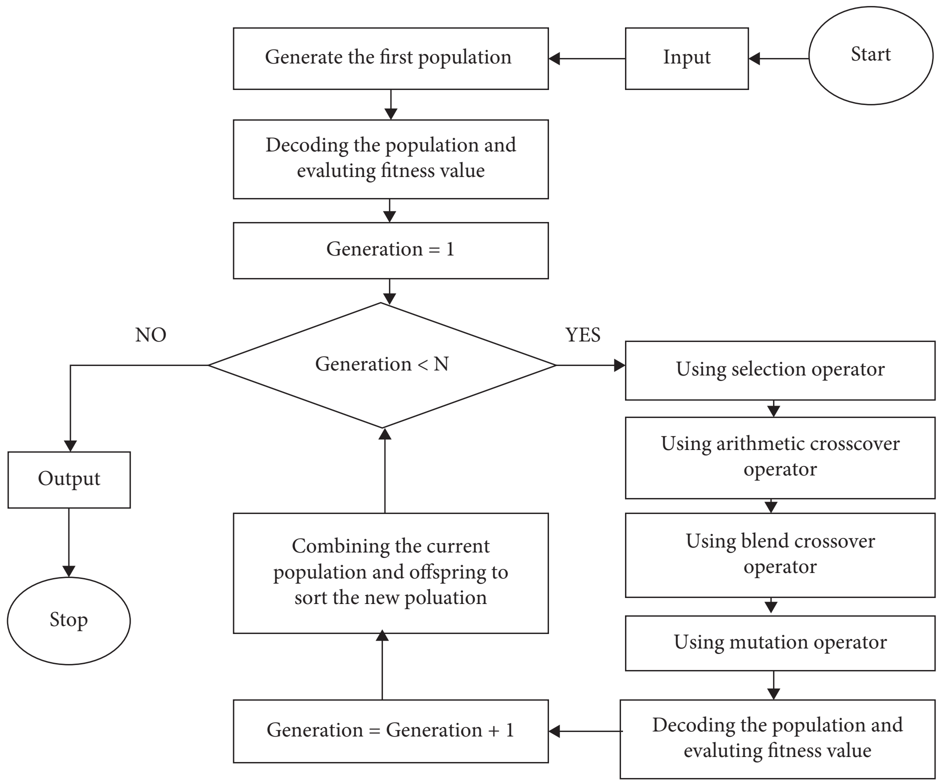

Figure 3: NSGA II algorithm pseudocode.

Step 7: set $P_{t+1} = \varnothing$ and $i = 1$.

Step 8: until $|P_{t+1}| + |F_i| < N$:

(A) Add the answers to the set F_i to the population P_{t+1}.

(B) Put $i = i + 1$.

Step 9: arrange F_i set answers in descending order of congestion.

Step 10: size $N - |P_{t+1}|$ transfer from the first answers F_i to the population P_{t+1}.

Step 11: set $t = t + 1$ and return to step 2.

To increase the efficiency of the NSGA II algorithm in optimizing target functions, it is necessary to adjust the algorithm's basic parameters using the Taguchi method. Therefore, nine experiments are designed by the Taguchi method. The NSGA II algorithm is performed based on the levels presented in Table 3. The average S/N ratio diagram for selecting the optimal level of NSGA II algorithm parameters is shown in Figure 4.

According to Figure 4, it can be found that the highest point in the mean chart of the S/N ratio is the selection of the desired level to set the parameter of the meta-heuristic algorithm. Therefore, to increase the efficiency of the NSGA II algorithm, Npop parameter is 200, Max it parameter is 200, and P_c and P_m parameters are 0.08 and 0.9, respectively.

Due to the use of two different methods in solving the mathematical model, it is necessary to define indicators to compare the results obtained from the two methods. In the following, the indicators for comparing the methods of solving the two-objective model of sustainable financing of international projects are discussed.

4.4. Comparison Indicators of Solution Methods. Each of the mentioned methods in solving the problem produces different efficient answers. Therefore, to compare efficient solutions, various indicators should be used. In this section, four indicators are introduced to compare efficient answers.

(i) Non-uniformity of Pareto front (NPF): this shows the number of undefeated answers in the Pareto set obtained for each problem. The higher the number of points, the more efficient the algorithm.

(ii) Maximum spread index (MSI): this measure shows how many of the answers of a Pareto set are distributed in the answer space, which is calculated from equation (17). The larger the value of this criterion, the more appropriate the diversity of Pareto set answers.

$$\text{MSI} = \sqrt{\sum_{k=1}^{K} \left(f_k^{\max} - f_k^{\min} \right)^2}, \quad (17)$$

in which $f_j^{\max}$ and $f_j^{\min}$ show the largest and lowest values of the objective function in terms of the objective function k among the efficient answers.

Table 3: Parametric adjustment of meta-heuristic algorithms by the Taguchi method.

Parameter	Level 1	Level 2	Level 3
N pop	100	150	200
Max it	150	200	300
P_c	0.03	0.05	0.08
P_m	0.7	0.8	0.9

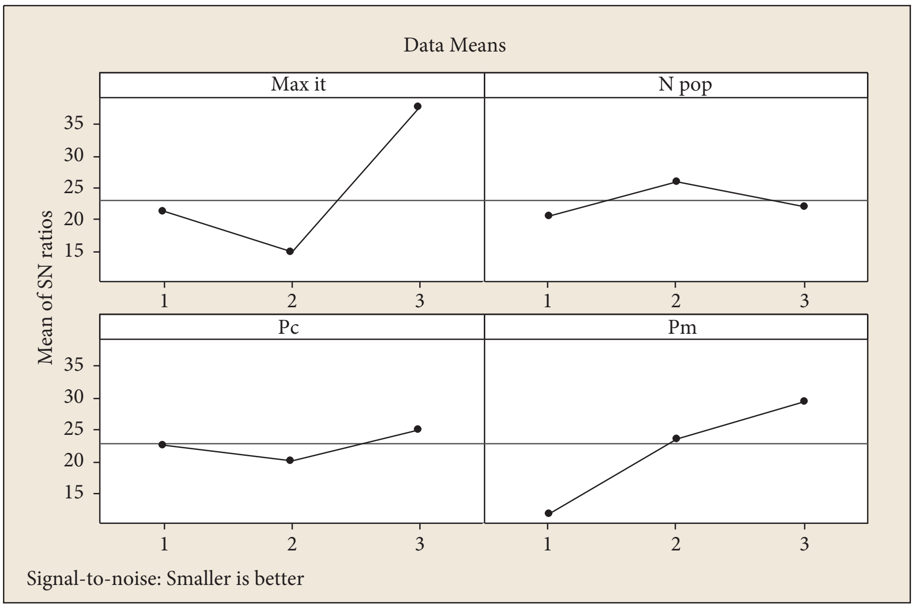

Figure 4: Mean diagram of S/N ratio in NSGA II algorithm.

(iii) Spacing: this indicates the extent to which the answers are evenly spaced, calculated from equation (18). In this regard, the value of d_i can be calculated from equation (19). An algorithm that is less than this criterion will be more desirable.

$$\mathrm{SM} = \frac{\sum_{i=1}^{K-1}\left|\overline{d} - d_i\right|}{(K-1)\overline{d}}, \tag{18}$$

$$d_i = \min_{j=1,\ldots,n\ j\neq i}\left(\sum_{k=1}^{K}\left|f_k^i - f_k^j\right|\right), \quad \forall i = 1,\ldots,n. \tag{19}$$

(iv) CPU time: an algorithm with less computation time would be more desirable.

5. Results and Discussion

After designing the mathematical model and presenting the conceptual model in this section, the results of financing some sustainable projects in Iran that have faced budget deficits have been analyzed. Therefore, Tables 4 and 5 show the list of international projects in Iran and the set of practical risks in financing each project, respectively.

Based on the information gathered and the assumptions of the problem, 12 international projects, eight types of financing risks, and three types of financial risks have been considered for each project. Based on this, first, using fuzzy hierarchical analysis method, the weight of project financing risk is determined based on the conceptual model of Figure 1. Table 6 shows the comparison matrix of the fuzzy dimensions of the project risks concerning the main objective.

After aggregating experts' opinions, the final pairwise comparison matrix between project risks is formed in Table 7. Moreover, based on the steps expressed in the fuzzy hierarchy analysis method, the magnitude of the indicators can be shown concerning the model's primary purpose, as shown in Table 8.

By determining the magnitude of each of the indicators and other analyses of pairwise comparisons of each project financing risk concerning the project financing source, the weight of each indicator for the primary purpose and origin of financing can be determined. Table 9 shows a summary of the results.

Based on the results of Table 9, it can be stated that Iran's economic conditions are the riskiest in financing projects, followed by sanctions on Iran, limited resources, and political and international conflicts. By determining the weight of financing risks regarding the financing sources of international projects, the two-objective model presented by the epsilon constraint method and the NSGA II algorithm is solved. The set of efficient answers obtained is shown in Table 10. The best value of the first objective function is

Table 4: List of international projects.

No.	Project name	Project site	Amount	Foreign investor	Results and achievements
1	Arkan Khan Petro Refinery Production Project	Mako Free Zone	$ 500.000	Private and foreign sector investor (Turkish)	Thirty jobs were created, which is expected to increase its production capacity to 150 tons per month.
2	International Student Small Satellite Project (SSS)	Iran Space Research Institute	$ 3.2 million	Asia-Pacific Space Cooperation Organization and Bihang University, China	Creating a satellite system of three satellites in a solar orbit is a 500- to 700-kilometer rotation, with the larger satellite at the center and the cube satellites equipped with their propulsion subsystem at a maximum distance of 500 kilometers around it to communicate with the satellites.
3	Multi-Mission Small Satellite System (SMMS) Project	Iran Space Agency	$ 12 million	Beihang University of China	Harmonization of space for peaceful purposes, sharing of space infrastructure between several countries, encouraging the use of space for economic development, enhancing the space capabilities of member countries, and establishing a space data corridor.
4	Technical cooperation project	Iran	$ 1 million	International Atomic Energy Agency	The agency's technical cooperation projects cover 30 areas where health, nutrition and agriculture, and safety and security are the highest priorities for cooperation between the agency and the member states, respectively.
5	Mercury planet transit project	Kashan University	$ 2 million	Middle East Iota	To make the scientific activities related to the Mercury transit astronomical event more purposeful, it was carried out by the Iranian Space Agency, the Middle East Iota, and the Kashan University Observatory with the support of the Iranian Astronomical Society.
6	Vienna Hospital Construction Project	Kermanshah (Vienna Hospital)	$ 120 million	Chinese investors	—
7	Zagros Ceramic Tile Project	Kermanshah	$ 100 million	China	It will employ 1,500 people, of which 1,400 will be from Kermanshah and 100 from China.
8	Ferroalloy plant project	Kermanshah	$ 10 million	China	With the completion of this project, 210 people will be directly employed, and 400 people will be indirectly employed in Kermanshah.
9	Foreign investment town project	Tabriz	$ 10 million	Turkish company	Employment of 500 people.
10	International project of Gas Engineering and Development Company	Iran Gas Engineering and Development Company	$ 6 million		The results lead to a more accurate definition of improvement plans in line with the sustainable development of project management capabilities.
11	Melting plant project and development plans of Sungun copper mine	East Azerbaijan Province (Varzeqan)	$ 13 million	Chinese company	With the implementation of these projects, the copper production chain in Varzeqan city will be completed. It will be the beginning of starting a significant job creation in the region that will lead to economic development and prosperity in the town.
12	Tabriz-Bazargan freeway project	East Azerbaijan Province	One billion and 249 million and 734 thousand dollars	Bergiz Insaat Company in Turkey	The implementation of this marvellous plan can play a significant role in the economic prosperity and development of the country and the northwest.

Table 5: Set of project financing risks.

No.	Risk	Symbol
1	Iran sanction	$C1$
2	Available historical records	$C2$
3	Resource constraints	$C3$
4	Economic conditions of Iran	$C4$
5	Political and international conflicts	$C5$
6	Election	$C6$
7	Lack of investment in the design phase	$C7$
8	World economic conditions	$C8$

Table 6: Fuzzy dimension comparison matrix.

	$C1$	$C2$	$C3$	$C4$	$C5$	$C6$	$C7$	$C8$
$C1$	(1, 1, 1)	(1, 2, 3) (1, 1, 1) (1, 2, 3)	(2, 3, 4) (1, 2, 3) (2, 3, 4)	(1, 2, 3) (2, 3, 4) (2, 3, 4)	(5, 6, 7) (7, 8, 9) (2, 3, 4)	(4, 5, 6) (7, 8, 9) (6, 7, 8)	(1, 2, 3) (3, 4, 5) (2, 3, 4)	(1, 2, 3) (6, 7, 8) (3, 4, 5)
$C2$	(1/3, 1/2, 1) (1, 1, 1) (1/3, 1/2, 1)	(1, 1, 1)	(2, 3, 4) (1, 1, 1) (1, 2, 3)	(1, 1, 1) (2, 3, 4) (1, 1, 1)	(2, 3, 4) (1, 1, 1) (1, 2, 3)	(1, 2, 3) (1, 1, 1) (1, 2, 3)	(2, 3, 4) (1, 2, 3) (2, 3, 4)	(1, 2, 3) (1, 1, 1) (2, 3, 4)
$C3$	(1/4, 1/3, 1/2) (1/3, 1/2, 1) (1/4, 1/3, 1/2)	(1/4, 1/3, 1/2) (1, 1, 1) (1/3, 1/2, 1)	(1, 1, 1)	(1, 1, 1) (3, 4, 5) (1, 2, 3)	(1, 2, 3) (6, 7, 8) (3, 4, 5)	(1, 2, 3) (1, 1, 1) (1, 2, 3)	(4, 5, 6) (7, 8, 9) (6, 7, 8)	(2, 3, 4) (2, 3, 4) (3, 4, 5)
$C4$	(1/3, 1/2, 1) (1/4, 1/3, 1/2) (1/4, 1/3, 1/2)	(1, 1, 1) (1/4, 1/3, 1/2) (1, 1, 1)	(1, 1, 1) (1/5, 1/4, 1/3) (1/3, 1/2, 1)	(1, 1, 1)	(5, 6, 7) (7, 8, 9) (2, 3, 4)	(4, 5, 6) (7, 8, 9) (6, 7, 8)	(5, 6, 7) (4, 5, 6) (7, 8, 9)	(7, 8, 9) (4, 5, 6) (7, 8, 9)
$C5$	(1/7, 1/6, 1/5) (1/9, 1/8, 1/7) (1/4, 1/3, 1/2)	(1/4, 1/3, 1/2) (1, 1, 1) (1/3, 1/2, 1)	(1/3, 1/2, 1) (1/8, 1/7, 1/6) (1/5, 1/4, 1/3)	(1/7, 1/6, 1/5) (1/9, 1/8, 1/7) (1/4, 1/3, 1/2)	(1, 1, 1)	(5, 6, 7) (5, 6, 7) (4, 5, 6)	(4, 5, 6) (7, 8, 9) (3, 4, 5)	(7, 8, 9) (8, 9, 10) (5, 6, 7)
$C6$	(1/6, 1/5, 1/4) (1/9, 1/8, 1/7) (1/6, 1/7, 1/8)	(1/3, 1/2, 1) (1, 1, 1) (1/3, 1/2, 1)	(1/3, 1/2, 1) (1, 1, 1) (1/3, 1/2, 1)	(1/6, 1/5, 1/4) (1/9, 1/8, 1/7) (1/6, 1/7, 1/8)	(1/7, 1/6, 1/5) (1/7, 1/6, 1/5) (1/6, 1/5, 1/4)	(1, 1, 1)	(2, 3, 4) (1, 1, 1) (1, 2, 3)	(1, 2, 3) (1, 1, 1) (1, 2, 3)
$C7$	(1/3, 1/2, 1) (1/5, 1/4, 1/3) (1/4, 1/3, 1/2)	(1/4, 1/3, 1/2) (1/3, 1/2, 1) (1/4, 1/3, 1/2)	(1/6, 1/5, 1/4) (1/9, 1/8, 1/7) (1/6, 1/7, 1/8)	(1/7, 1/6, 1/5) (1/6, 1/5, 1/4) (1/9, 1/8, 1/7)	(1/6, 1/5, 1/4) (1/9, 1/8, 1/7) (1/5, 1/4, 1/3)	(1/4, 1/3, 1/2) (1, 1, 1) (1/3, 1/2, 1)	(1, 1, 1)	(1, 2, 3) (1, 2, 3) (3, 4, 5)
$C8$	(1/3, 1/2, 1) (1/6, 1/7, 1/8) (1/5, 1/4, 1/3)	(1/3, 1/2, 1) (1, 1, 1) (1/4, 1/3, 1/2)	(1/4, 1/3, 1/2) (1/4, 1/3, 1/2) (1/5, 1/4, 1/3)	(1/9, 1/8, 1/7) (1/6, 1/5, 1/4) (1/9, 1/8, 1/7)	(1/9, 1/8, 1/7) (1/10, 1/9, 1/8) (1/7, 1/6, 1/5)	(1/3, 1/2, 1) (1, 1, 1) (1/3, 1/2, 1)	(1/3, 1/2, 1) (1/3, 1/2, 1) (1/5, 1/4, 1/3)	(1, 1, 1)

75190.120 thousand dollars, and the best deal of the second objective function is 2665292.075 rusks per thousand dollars.

According to the results of Table 10, it can be seen that with the reduction of financing restructuring of international projects, the cost of financing sources will increase. Hence, the Pareto front is obtained from solving the two-objective financing model in the form of equation (5).

As shown in Figure 5, to reduce the risk of sustainable financing of international projects, the way of financing projects should be changed, which can lead to an increase in the total cost of financing projects. On the other hand, it can be seen that the NSGA II algorithm has obtained 32 efficient answers (a combination of how projects are financed). Each of the answers has advantages over the other answers obtained. The epsilon constraint method also brought 11 efficient answers. In Table 11, other comparison indicators of solution methods, including different efficiency solutions, are analyzed.

Table 11 illustrates that the epsilon constraint method has estimated the lowest financing cost of projects by creating various efficient solutions. In comparison, the NSGA II algorithm has reduced the risk of financing sustainable projects by creating more efficient solutions than the epsilon constraint method. Also, the NSGA II algorithm obtains the most expansion indices more efficiently than the epsilon constraint method. It has solved the designed two-objective model in a shorter time. Therefore, due to the high efficiency of each technique in specific indicators, it is necessary to prioritize the solution methods using the TOPSIS method. Based on this, Table 12 has been designed by considering six indicators (averages of the first and second objective functions, number of efficient answers, maximum expansion, metric distance, and computational time) and two

Table 7: Fuzzy dimension comparison matrix based on the sum of experts' opinions.

	C1	C2	C3	C4	C5	C6	C7	C8
C1	(1, 1, 1)	(1, 1.59, 2.08)	(1.59, 2.62, 3.63)	(1.59, 2.62, 3.63)	(4.12, 5.24, 6.32)	(5.52, 6.54, 7.56)	(1.82, 2.88, 3.91)	(2.62, 3.83, 4.93)
C2	(0.48, 0.63, 1)	(1, 1, 1)	(1.26, 1.82, 2.28)	(1.26, 1.44, 1.59)	(1.26, 1.82, 2.29)	(1.00, 1.59, 2.08)	(1.59, 2.62, 3.63)	(1.26, 1.82, 2.29)
C3	(0.28, 0.38, 0.63)	(0.44, 0.55, 0.79)	(1, 1, 1)	(1.44, 2.00, 2.47)	(2.62, 3.83, 4.93)	(1.00, 1.59, 2.08)	(5.52, 6.54, 7.56)	(2.29, 3.30, 4.31)
C4	(0.28, 0.38, 0.63)	(0.63, 0.69, 0.79)	(0.41, 0.50, 0.69)	(1, 1, 1)	(4.12, 5.24, 6.32)	(5.52, 6.54, 7.56)	(5.19, 6.21, 7.23)	(5.81, 6.84, 7.86)
C5	(0.16, 0.19, 0.24)	(0.44, 0.55, 0.79)	(0.20, 0.26, 0.38)	(0.16, 0.19, 0.24)	(1, 1, 1)	(4.64, 5.65, 6.65)	(4.38, 5.43, 4.46)	(6.54, 7.56, 8.57)
C6	(0.13, 0.15, 0.18)	(0.48, 0.63, 1.00)	(0.48, 0.63, 1.00)	(0.13, 0.15, 0.18)	(0.15, 0.18, 0.22)	(1, 1, 1)	(1.26, 1.82, 2.29)	(1.00, 1.59, 2.08)
C7	(0.26, 0.35, 0.55)	(0.28, 0.38, 0.63)	(0.13, 0.15, 0.18)	(0.14, 0.16, 0.19)	(0.15, 0.18, 0.23)	(0.44, 0.55, 0.79)	(1, 1, 1)	(1.44, 2.52, 3.56)
C8	(0.20, 0.26, 0.38)	(0.44, 0.55, 0.79)	(0.23, 0.30, 0.44)	(0.13, 0.15, 0.17)	(0.12, 0.13, 0.15)	(0.48, 0.63, 1.00)	(0.28, 0.40, 0.69)	(1, 1, 1)

Table 8: The degree of magnitude of the indicators in relation to the main goal.

	V1	V2	V3	V4	V5	V6	V7	V8
V1	—	0.128	0.592	1	0.614	0	0	0
V2	1	—	1	1	1	0.183	0	0
V3	1	0.457	—	1	1	0	0	0
V4	0.951	0	0.478	—	0.479	0	0	0
V5	1	0.289	0.879	1	—	0	0	0
V6	1	1	1	1	1	—	0	0.327
V7	1	1	1	1	1	1	—	1
V8	0.951	0	1	1	0.479	1	0	—

Table 9: Final weight of financing risks.

	Towards the primary purpose	A1	A2	A3
W1	0.327	0.571	0.000	0.429
W2	0	0.538	0.000	0.462
W3	0.164	0.563	0.438	0.000
W4	0.343	0.000	0.600	0.400
W5	0.164	0.000	0.417	0.583
W6	0	0.312	0.000	0.688
W7	0	0.429	0.000	0.571
W8	0	0.111	0.889	0.000

Table 10: A set of answers obtained from solving the financing model.

Epsilon restriction (EP)			NSGA II algorithm					
No.	Z1	Z2	No.	Z1	Z2	No.	Z1	Z2
1	75190.120	3104970.730	1	77488.56	3053879	17	88389.01	2809067
2	76574.280	3061002.860.	2	77924.38	3027474	18	90687.55	2742120
3	78445.340	3017035.000	3	78501.25	3022165	19	91259.74	2734122
4	80316.400	2973067.130	4	78664.65	3018854	20	91358.57	2726665
5	82178.450	2929099.270	5	78747.21	3004553	21	91328.60	2726657
6	84058.510	2885131.400	6	79025.61	3000289	22	91358.92	2726649
7	85929.570	2841163.540	7	81339.62	2968256	23	91415.01	2725034
8	87800.630	2797195.140	8	82179.14	2951147	24	91882.48	2713281
9	89671.680	2753227.810	9	82377.4	2946201	25	91882.48	2713280
10	91542.740	2709259.540	10	84627.01	2903703	26	92136.37	2706698
11	93903.360	2665292.270	11	85568.61	2879211	27	92387.54	2700476
12	—	—	12	85590.53	2887847	28	92387.67	2700463
13	—	—	13	87363.82	2836211	29	92380.23	2700422
14	—	—	14	87240.21	2836099	30	92387.89	2700231
15	—	—	15	87361.81	2836075	31	92401.60	2700000
16	—	—	16	87377.66	2828770	33	92402.44	2699965

options (epsilon constraint method and NSGA II algorithm).

Table 12 demonstrates that the NSGA II algorithm is the superior solution method due to the high value of weight utility (0.5636) compared to the epsilon constraint method (0.4364). Therefore, according to the results obtained from solving the two-objective model and selecting the NSGA II algorithm due to its high weight, the amount of funding from different sources for each project is shown in Table 13.

According to the results of Table 13, the domestic capital market can provide 54.89% of the deficit budget of the country's international projects. Also, 44.81% of the project deficit budget can be financed from a foreign bank loan source, and only 0.2% of the budget can be funded through the company's internal resources. Therefore, the risk of financing from the domestic capital market and the cost of funding it are very appropriate. Figure 6 shows how projects are financed from different financial sources.

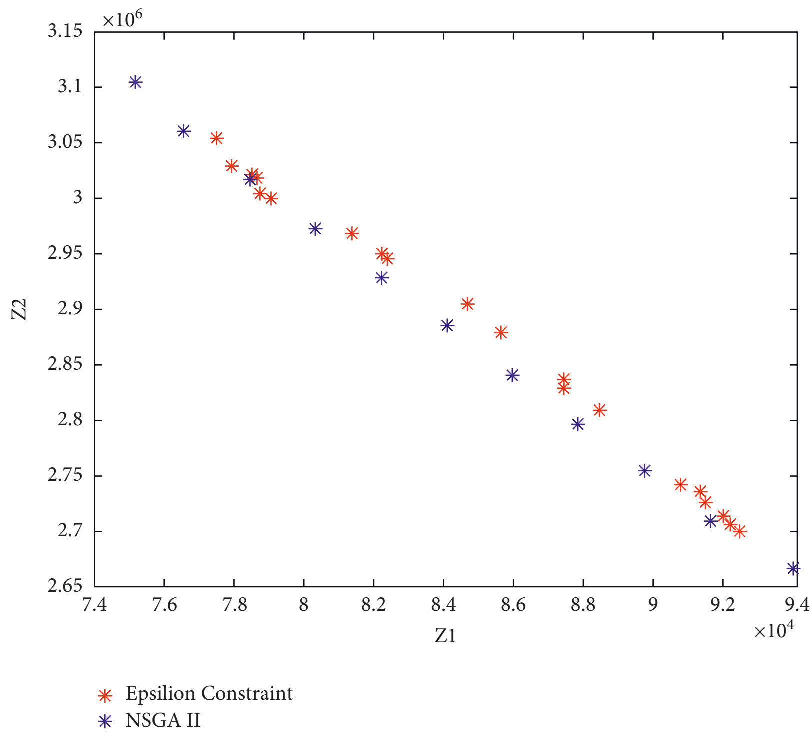

Figure 5: Pareto front obtained from solving the mathematical model of sustainable financing.

Table 11: Comparison indicators of problem solving methods.

Indicator	EP	NSGA II
Mean of $Z1$	84147.28	87111.600
Mean of $Z2$	2885131.40	2828651.86
NPF	11	32
MSI	354227.73	440076.70
SM	0.002	1.071
CPU time	20.34	15.76

Table 12: Weighting coefficients of comparison indicators of solution methods.

Indicator	EP	NSGA II	Weighting coefficients
Mean of $Z1$	84147.28	87111.600	0.02
Mean of $Z2$	2885131.40	2828651.86	0.02
NPF	11	32	0.02
MSI	354227.73	440076.70	0.02
SM	0.002	1.071	0.1
CPU time	20.34	15.76	0.1
WE	0.4364	0.5636	-

Table 13: Amount of financing performed using NSGA II algorithm.

Project name	Deficit (thousand dollars)	Company internal resources ($J1$)	Domestic capital markets ($J2$)	Bank loans ($J3$)
Arkan Khan Petro Refinery Production Project	315	32.560	148.832	133.608
International Student Small Satellite Project (SSS)	1489.98	—	1460.00	27.980
Multi-Mission Small Satellite System (SMMS) Project	2975	—	2975.00	—
Technical cooperation project	240	—	240.00	—
Mercury planet transit project	480	—	480.00	—
Vienna Hospital Construction Project	39250	—	39250.00	—
Zagros Ceramic Tile Project	28750	—	23944.74	4805.252
Ferroalloy plant project	345	—	3455.000	—
Foreign investment town project	535	—	4327.573	1207.427
International project of Gas Engineering and Development Company	2580	—	2104.293	475.707
Melting plant project and development plans of Sungun copper mine	10435	3086.377	3633.947	3714.676
Tabriz-Bazargan freeway project	1002734	—	520908.79	481825.221

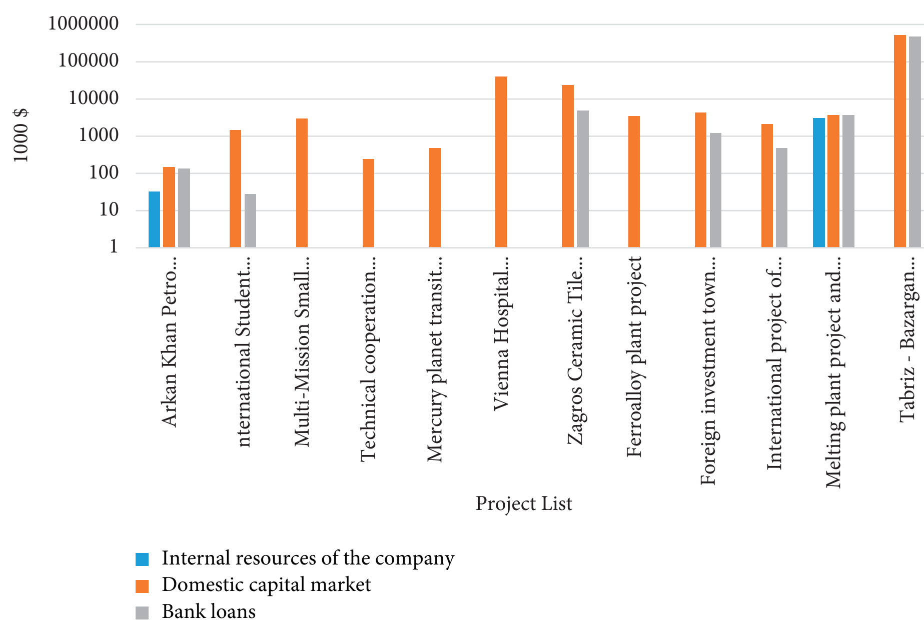

Figure 6: Amount of financing for international projects from different sources.

6. Conclusion

Based on the opinions of experts in prioritizing the risks of project financial security, it was found that Iran's economic conditions are the riskiest in financing projects because sanctions on Iran, limited resources, and political and international conflicts are the following influential factors. Based on this results, 11 different efficient answers were obtained from the epsilon constraint method, and 32 other efficient answers were obtained from the NSGA II algorithm. Examining indicators (such as mean objective functions, number of efficient answers, maximum expansion, metric distance, and computational time) shows that the NSGA II algorithm has the highest efficiency in achieving a suitable answer minimizing financing costs and financing risks.

Analyzing the results of the superior method for financing 12 international projects in Iran that are facing budget deficits illustrates that the domestic capital market can provide 54.89% of the deficit budget of the country's international projects. Also, 44.81% of the project deficit budget can be financed from a foreign bank loan source, and only 0.2% of the budget can be financed through the company's internal resources. Therefore, the risk of financing from the domestic capital market and the cost of funding it are very appropriate. Future research suggests that other meta-innovative methods achieve more desirable results than the NSGA II algorithm and discuss the uncertainty in the financing of international projects.

It is also suggested that the financing method of public-private partnership should be considered in mathematical modeling to determine the contribution of each in the financing of sustainable projects. On the other hand, other factors such as harmful environmental effects after the implementation of each project should also be considered. Finally, it is suggested to use the fuzzy neutrosophic method for weighting and prioritizing the risks of each project due to the lack of full cooperation of experts.

6.1. Managerial Implications. The high costs of financing international projects in line with the country's development, as well as the existence of financing risks due to the existence of restrictions in each country, have led to decision making in this area a major problem. On the other hand, the existence of different financing methods and the obligations of each method have made it difficult for managers to decide on the type of financing method and the amount of financing by each method. Therefore, in this article, taking into account the importance of this issue, a two-objective mathematical model was presented in which managers can choose the most suitable financing method and financing amount by having different financing options (effective answers). In this case, the managers have taken appropriate decisions to reduce financing costs and financing risk.

6.2. Limitations of the Research. This article investigated the financing of 12 international projects in Iran. In this regard, collecting information related to other international projects is impossible due to the confidentiality of data. Also, another limitation of the current research is the insufficient cooperation of managers and experts in the economic field in providing information related to the various risks of project financing.

Data Availability

The collected data are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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