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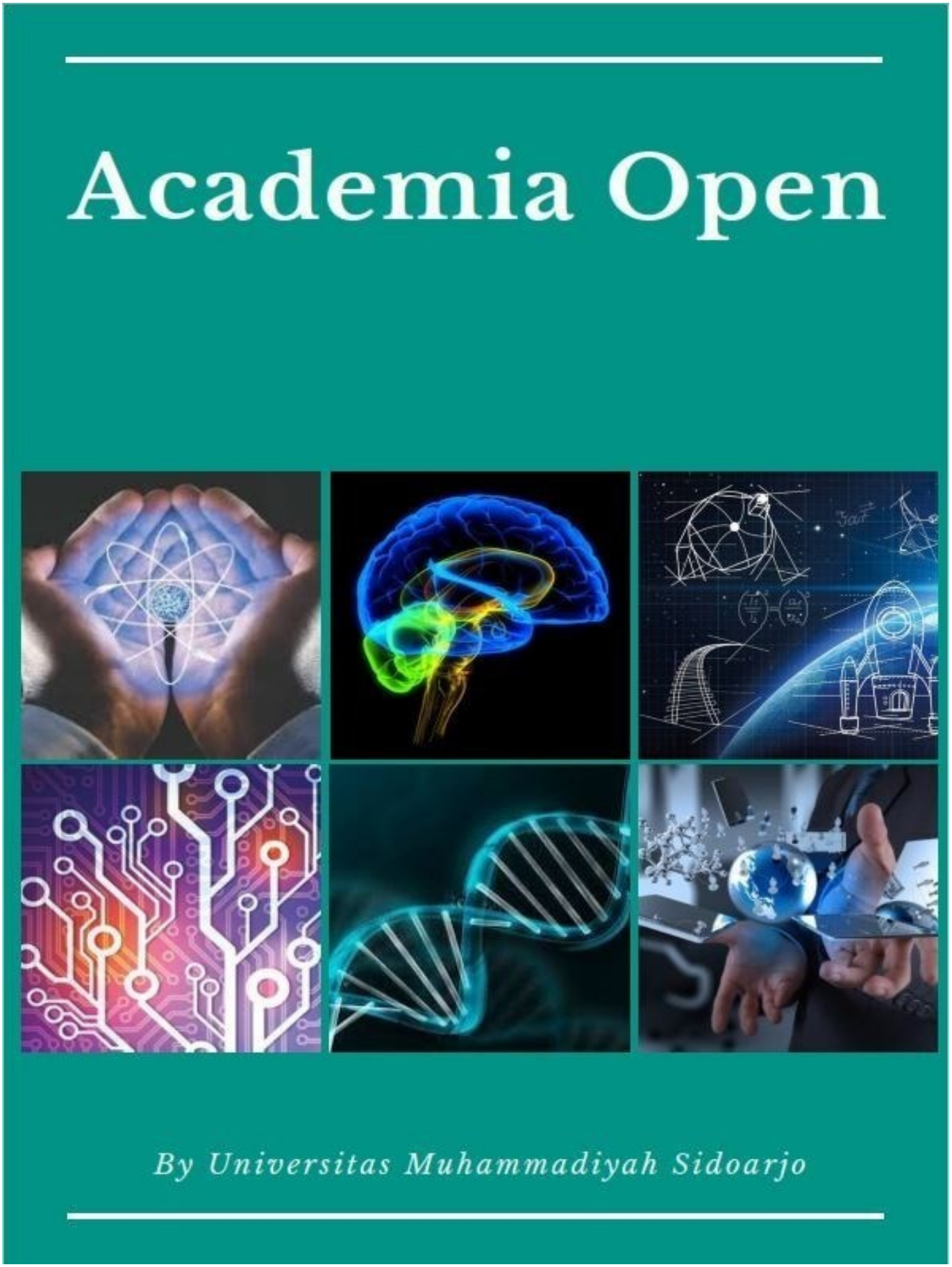

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Goal Programming Model in Financial Planning of the International Development Bank

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Abstract

General Background: Financial institutions often face complex decision-making challenges due to the need to balance multiple, conflicting objectives such as profitability, cost control, and liquidity management. Specific Background: Traditional financial planning models struggle to accommodate these competing goals, especially in developing economies with resource constraints. Knowledge Gap: Existing studies have applied goal programming (GP) in limited industrial contexts, but its comprehensive use in the financial sector of emerging markets, such as Iraq, remains underexplored. Aims: This study aims to apply a goal programming model to optimize the financial planning of the International Development Bank for Investment and Finance (IDB) during 2016–2024, integrating multiple financial objectives under prioritized constraints. Results: The model, solved using WINQSB, achieved near-optimal solutions with minimal deviations between actual and target values across revenues, expenses, net profit, and fixed assets, confirming its effectiveness in managing competing goals. Novelty: This research introduces a weighted-preemptive hybrid goal programming framework that quantitatively aligns strategic financial objectives within constrained environments. Implications: The findings demonstrate the model's potential as a practical decision-support tool for banks, enabling sustainable financial performance and efficient resource allocation in complex, multidimensional financial systems.

Highlight :

- Shows how Goal Programming optimizes conflicting financial goals effectively.
- Demonstrates balanced achievement of revenue, cost, and profit targets in banking.
- Suggests the model's practical use for sustainable financial decision-making.

Keywords : Goal Programming, Weighted Method, Preemptive Method, Negative Deviation, Positive Deviation

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Introduction

Financial planning is one of the basic pillars of financial equilibrium and institution development, because it seeks to stipulate financial objectives on the basis of solid logical reasons, regarding the rational use of resources in a most efficient way. Given the speed of change in today's business world and the complexity of financial decisions, advanced tools will be necessary to meet these challenge. [1]) One of the prominent tools is objective programming (OGP), a part of operations research for solving multi-objective problems. Beyond a one-dimensional measure, such as 'maximize profits' it also includes other measures upon which organizations are known to focus meaning cost reduction, return on investment and cash flow for example. [2]

While evaluating goal program, its strength is in the capability to address globally competing objectives as it's not necessarily possible to satisfy all financial goals at once. Accordingly, there is the need to put a ranking and tolerances for deviation in each of these objectives. For instance, a financial institution could be trying to minimize risk and maximize profit and also meet liquidity requirements. PG is a formal model that provides an answer to these opposed needs [3].

Operational goal programming applications in financial planning, that of budgeting by multiple goals with finite resources being divided among attendant units according to organizational priority while constraints are minimized such as shortfall of total funds. It could also work in investment management and allocation of the right ratio of investments among assets (to maximize your returns and minimize risk). In addition, it can be used for the debt management to obtain an optimal loan structure for reduction of the financing cost while observing acceptable leverage bounds. [4]

Therefore, Goal Programming helps to balance scarce resources and strategic organizational goals, strengthening competence and competitiveness.

Research Problem:

Institutions face challenges in balancing multiple conflicting financial objectives, such as profit maximization ,cost reduction, and liquidity maintenance, which limits financial planning efficiency.

Research Objective:

The research aims to employ Goal Programming as a quantitative model to improve financial planning, achieving a balance between different financial objectives under resource constraints.

Literature Review:

Teg Alam [5]: Developed and applied a Goal Programming model to assess financial planning based on the annual financial report of SABIC, aiding in comprehensive budget optimization.

Ihda Hasbiyati et al.[6]: Proposed a preemptive GP model for production planning, demonstrating effective multi-objective optimization under priority-based decision-making using LINGO software.

N. Nyor [7]: Applied GP to financial management in a Nigerian industrial goods firm, achieving two out of five formulated objectives with a minimum revenue, expense, and asset requirement of 10.61 billion Naira annually.

Lakshmi et al.[8]: Addressed disproportionate and conflicting objectives in financial planning using GP in an Indian distribution company case study, validating results via LINGO.

Wijayanti [9]: Applied GP to optimize asset-liability management in textile and garment companies in Indonesia, analyzing financial statements and providing recommendations for goal achievement.

Gaspars [10]: Introduced a new GP-based method for solving uncertainty problems through hybrid multi-criteria decision-making models.

Mohseny et al.[11]: Proposed a two-phase approach combining DEA and GP for portfolio selection, showing superior performance under uncertainty using Tehran Stock Exchange data.

Goal Programming Definitions:

- Goal Programming[12]: A mathematical model comprising linear or nonlinear functions and continuous or discrete variables, in which all functions are transformed into goals.

- Negative Deviation[13]: The amount by which an actual value is below the aspiration level.

- Positive Deviation[14]: The amount by which an actual value exceeds the aspiration level.

Weighted Method: Assigns each goal a numeric value denoting its relative importance, aggregating all goals into a single objective function to minimize total deviation while honoring the assigned weights [15].

Mathematical Model:

$$Min\ Z = \sum_{i=1}^{m} w_i^- d_i^- + w_i^+ d_i^+$$

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Subject to

$$\sum_{j=1}^{n} a_{ij}X_{ij} + d_i^- d_i^+ \quad , i = 1, \dots, m$$

$$X_{ij}, d_i^-, d_i^+ \geq 0, w_i > 0 \quad , i = 1, \dots, m, \quad j = 1, \dots, n$$

Where w_i^- and w_i^+ Represent the weights allocated in the goal programming model to evaluate the significance of negative and positive deviations d_i^+, d_i^- , respectively. These variables indicate the degree of under achievement or over achievement of the target, enabling the model to maintain a flexible balance among competing goals based on the decision-maker's priorities..

Preemptive Method: Solves multi-criteria GP problems by ranking goals by importance, fully satisfying higher-priority goals before addressing lower-priority ones.

Mathematical Model:

$$Min\ Z = \sum_{i=1}^{n} \rho_i (d_i^- + d_i^+)$$

Subject to

$$\sum_{j=1}^{m} a_{ij}X_j + d_i^- - d_i^+ = b_i \quad , i = 1, \dots, n$$

$$X_j, d_i^-, d_i^+ \geq 0 \quad , i = 1, \dots, n, \quad j = 1, \dots, m$$

Methods

The model represents a mathematical formulation of a real-world phenomenon. The general linear GP model with P goals and q constraints was applied using composite weights and preemptive strategies.

$$Min\ Z = \sum_{i=1}^{p} M_i R(dev^- + dev^+)$$

Subject to

$$\sum_{j=1}^{q} a_j * X_i + (dev_i^- + dev_i^+) = B_i \quad , i = 1, \dots, P$$

$$X_i, dev_i^-, dev_i^+ \geq 0$$

Where:

1. Z represents the objective function aimed at minimizing the total deviations from all the goals to be achieved.
2. M_i denotes the relative weight assigned to the deviation variables.
3. R indicates the priority level for each goal, ordered as $(R_1 > R_2 > \cdots > R_q)$
4. dev^- is the negative deviation variable, which should be less than the allowable target.
5. dev^+ is the positive deviation variable, which should be greater than the allowable target.
6. a_j is the technical coefficient of the decision variables in the constraints.
7. X_i represents the decision variables.
8. B_i denotes the resources available for the constraints.

Case Study:

International Development Bank for Investment and Finance (IDB), a private Iraqi bank established in 2011, known for comprehensive banking services and an extensive branch network domestically and abroad.

Data Source:

Financial data collected from IDB's annual reports for the period 2016–2024.

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Target Values:

- Increase revenue by at least 0.290878 billion annually.
- Keep expenses below 0.238279 billion annually.
- Increase net profit by at least 0.342094 billion annually.
- Increase fixed assets by at least 1.069823 billion annually.
- Reduce loans by at least 0.684292 billion annually.
- Increase common shares by at least 0.337092 billion annually.
- Increase administrative financial statement values by at least 0.337092 billion annually.

Results and Discussion

The International Development Bank for Investment and Finance was selected as the case study in this research. Financial statement data, including revenues, expenses, net profit, fixed assets, loans, and common stock, were obtained from the bank's annual report, as detailed in Table (1) below.

Table (1): Summary of the Financial Data of the International Development Bank for Investment and Finance from 2016 to 2024

Total	common Stock	Loans Granted	Fixed Assets	Net Profit	Expenses	Revenues	goal / Year
1,034,291,184	15,700,000	284,373,898	654,596,192	15,709,050	22,229,056	41,682,988	2016
1,000,916,301	12,075,000	261,757,805	650,770,424	12,085,942	24,630,008	39,597,122	2017
1,004,796,610	7,275,000	276,761,143	660,960,008	7,280,953	21,753,042	30,766,464	2018
1,153,313,359	4,925,000	329,151,441	768,378,726	4,922,510	19,919,835	26,015,847	2019
1,521,399,747	12,950,000	359,645,948	1,069,745,295	12,945,353	25,029,084	41,084,067	2020
2,189,103,300	16,425,000	569,407,325	1,507,855,376	16,419,809	29,330,891	49,664,899	2021
865,882,761	12,550,000	840,790,447	1,798, 952,163	12,542,314	52,288 606	68, 746,840	2022
1,266,437,975	50,490,000	971,464,605	2,568, 694,698	50,486,330	65,951,026	128,046,014	2023
4,440,010,799	66,440,000	1,095,281,606	2,966,109,228	66,454,722	81,676,543	164,048,700	2024
14,476,152,036	198,830,000	4,988,634,218	8,278,415,249	198,846,983	290,519,485	520,906,101	Total

Table (2) provides a summary of the financial data of the International Development Bank for Investment and Finance with scaled values and their weights for the years 2016 to 2024 in Iraqi billion dinars. The scaling of values is intended to enable analysis using smaller numbers.

Table (2): Scaled Values of the Summarized Financial Statements of the International Development Bank for Investment and Finance from 2016 to 2024 (in billion IQD)

Total	common Stock	Loans Granted	Fixed Assets	Net Profit	Expenses	Revenues	goal / Year
1.034291	0.015700	0.284374	0.654596	0.015709	0.022229	0.041683	2016
1.000916	0.012075	0.261758	0.65077	0.012086	0.02463	0.039597	2017
1.004797	0.007275	0.276761	0.66096	0.007281	0.021753	0.030766	2018
1.153313	0.004925	0.329151	0.768379	0.004923	0.01992	0.026016	2019
1.521400	0.01295	0.359646	1.069745	0.012945	0.025029	0.041084	2020
2.189103	0.016425	0.569407	1.507855	0.01642	0.029331	0.049665	2021
0.865883	0.012550	0.840790	1.798952	0.012542	0.052289	0.068747	2022
1.266438	0.050490	0.971465	2.568695	0.050486	0.065951	0.128046	2023
4.440011	0.066440	1.095282	2.966109	0.066455	0.081677	0.164049	2024
14.47615	0.19883	4.988634	8.278415	0.198847	0.290519	0.520906	Total

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Decision Variables:

X_1 :Financial statement quantities for the year 2016

X_2 :Financial statement quantities for the year 2017

X_3 :Financial statement quantities for the year 2018

X_4 :Financial statement quantities for the year 2019

X_5 :Financial statement quantities for the year 2020

X_6 :Financial statement quantities for the year 2021

X_7 :Financial statement quantities for the year 2022

X_8 :Financial statement quantities for the year 2023

X_9 :Financial statement quantities for the year 2024

goals constraints:

$$0.041683X_1 + 0.039597X_2 + 0.030766X_3 + 0.026016X_4 + 0.041084X_5 + 0.049665X_6$$
$$+0.068747X_7 + 0.128046X_8 + 0.164049X_9 \geq 0.290878 \qquad Revenue\ constrain$$

$$0.022229X_1 + 0.02463X_2 + 0.021753X_3 + 0.01992X_4 + 0.025029X_5 + 0.029331X_6$$
$$+0.052289X_7 + 0.065951X_8 + 0.081677X_9 \leq 0.238279 \qquad Expenses\ constrain$$

$$0.015709X_1 + 0.012086X_2 + 0.007281X_3 + 0.004923X_4 + 0.012945X_5 + 0.01642X_6$$
$$+0.012542X_7 + 0.050486X_8 + 0.066455X_9 \geq 0.342094 \qquad Net\ Profit\ constrain$$

$$0.654596X_1 + 0.65077X_2 + 0.66096X_3 + 0.768379X_4 + 1.069745X_5 + 1.507855X_6$$
$$+1.798952X_7 + 2.568695X_8 + 2.966109X_9 \geq 1.069823 \qquad Fixed\ Assets\ constrain$$

$$0.284374X_1 + 0.261758X_2 + 0.276761X_3 + 0.329151X_4 + 0.359646X_5 + 0.569407X_6$$
$$+0.840790X_7 + 0.971465X_8 + 1.095282X_9 \leq 0.684292 \qquad Loans\ Granted\ constrain$$

$$0.015700X_1 + 0.012075X_2 + 0.007275X_3 + 0.004925X_4 + 0.01295X_5 + 0.016425X_6$$
$$+0.012550X_7 + 0.050490X_8 + 0.066440X_9 \geq 0.337092 \qquad common\ Stock\ constrain$$

$$1.034291X_1 + 1.000916X_2 + 1.004797X_3 + 1.153313X_4 + 1.521400X_5 + 2.189103X_6$$
$$+0.865883X_7 + 1.266438X_8 + 4.440011X_9 \geq 1.608461 \qquad Financial\ Management\ constrain$$

$$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9 \geq 0 \qquad Non-negativity\ constraint$$

Objective Function:

The objective function will combine both the priority method and the weighting method. The priorities are ranked as follows: first, maximizing revenues; second, minimizing expenses; third, maximizing profitability; fourth, maximizing fixed assets; fifth, minimizing loans granted by the bank; sixth, maximizing the share of common stock; and seventh, maximizing the ratio of managerial financial statements. As for the weights, these are imposed by the bank and represent the targets it aims to achieve.

$$Min\ Z = 2d_1^- + d_2^+ + d_3^- + 2d_4^- + 2d_5^+ + 5d_6^- + d_7^-$$

$\underline{S.T:}$

$$0.041683X_1 + 0.039597X_2 + 0.030766X_3 + 0.026016X_4 + 0.041084X_5 + 0.049665X_6$$
$$+0.068747X_7 + 0.128046X_8 + 0.164049X_9 + d_1^- - d_1^+ = 0.290878$$

$$0.022229X_1 + 0.02463X_2 + 0.021753X_3 + 0.01992X_4 + 0.025029X_5 + 0.029331X_6$$
$$+0.052289X_7 + 0.065951X_8 + 0.081677X_9 + d_2^- - d_2^+ = 0.238279$$

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$$0.015709X_1 + 0.012086X_2 + 0.007281X_3 + 0.004923X_4 + 0.012945X_5 + 0.01642X_6$$
$$+0.012542X_7 + 0.050486X_8 + 0.066455X_9 + d_3^- - d_3^+ = 0.342094$$

$$0.654596X_1 + 0.65077X_2 + 0.66096X_3 + 0.768379X_4 + 1.069745X_5 + 1.507855X_6$$
$$+1.798952X_7 + 2.568695X_8 + 2.966109X_9 + d_4^- - d_4^+ = 1.069823$$

$$0.284374X_1 + 0.261758X_2 + 0.276761X_3 + 0.329151X_4 + 0.359646X_5 + 0.569407X_6$$
$$+0.840790X_7 + 0.971465X_8 + 1.095282X_9 + d_5^- - d_5^+ = 0.684292$$
$$0.015700X_1 + 0.012075X_2 + 0.007275X_3 + 0.004925X_4 + 0.01295X_5 + 0.016425X_6$$
$$+0.012550X_7 + 0.050490X_8 + 0.066440X_9 + d_6^- - d_6^+ = 0.337092$$

$$1.034291X_1 + 1.000916X_2 + 1.004797X_3 + 1.153313X_4 + 1.521400X_5 + 2.189103X_6$$
$$+0.865883X_7 + 1.266438X_8 + 4.440011X_9 + d_7^- - d_7^+ = 1.608461$$
$$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, d_1^-, d_1^+, d_2^-, d_2^+, d_3^-, d_3^+, d_4^-, d_4^+, d_5^-, d_5^+, d_6^-, d_6^+, d_7^-, d_7^+ \geq 0$$

The GP model was solved using WINQSB. The optimal solution achieved nearly all objectives with minor deviations. The analysis of positive and negative deviations indicated that revenue, expenses, net profit, and fixed assets goals were met within acceptable limits, while equity goals slightly fell short.

variable	*value*
X_9	0.6248
d_1^-	0.1884
d_2^-	0.1873
d_3^-	0.3006
d_4^+	0.7833
d_6^-	0.2956
d_7^+	1.1655
Z	2.1553

Interpretation of Results:

The results reveal that the value of Z is not equal to zero. This indicates that the optimal solution satisfies the goals P_1 و P_2 و P_3 و P_4 و P_5 و P_6 و P_7, which are revenues, expenses, net profit, fixed assets, loans granted, stock shares, and managerial financial constraints. Almost all specified goals have been achieved, with minor deviations in some cases. The positive and negative deviation from P_1 *to* P_7 are as mentioned previously. The first priority P_1 is to maximize the bank's total revenues. The results show that the negative deviation value d_1^- , equals 0.1884, and the positive deviation d_1^+ equals zero. Therefore, the goal was achieved slightly less than d_1^- . Similarly, the goal of reducing expenses (P_2) was achieved slightly below the target d_2^-, that equal 0.1873 , For the third goal, maximizing profitability (P_3), the negative deviation d_3^-= 0.3006, indicating that the net profit goal was achieved slightly below the allowable target. Additionally, the goal of maximizing fixed assets (P_4) was also achieved, Where d_4^- is zero, and d_4^+ is 0.7833. This indicates that the bank's fixed assets can be increased by 1.069823 billion annually. Since the values of 〖d_5^-*and* $d_5^+$are both zero, it can be concluded that reducing loans (P_5) has been achieved. However, the sixth objective (P_6), which is maximizing equity, has been achieved slightly less than the value of d_6^- which is 0.2956. This indicates that objective P_6 has not been fully achieved, as its target value is 0.337092 billion. Finally, the objective of maximizing the financial management ratio, P_7 , has been achieved because the value of d_7^- is zero and the value of d_7^+ is 1.1655. This indicates that the ratio of the items in the financial statement can be increased by 1.608461 billion annually.

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Conclusion

Use of Goal Programming in IDB Financial Planning was proved to be useful as regards conflicting objectives under limited resources. The model we propose here can provide a decision-making support tool to financial institutions operating in a complex environment, giving them markers for sustainable growth. The use of Goal Programming (GP) in financial planning for the institutions such as Islamic Development Bank (IDB) proves that it is powerful technique to handle conflicting goals under resource limit. Involving multiple objectives like profit maximisation, liquidity adequacy, capital structure and socio-economic development targets, Goal Programming provides a rational method of reconciling these competing goals. The model supports a sound resource allocation and prioritization, informing the institution how to reach the best targets. The study underscores the flexibility of Goal Programming in financial organizations especially where there are diverse goals and highly complex operational systems. The capability of GP in processing both quantitative and qualitative measures provides a holistic view of financial strategies that prevent short-term profit from being at the expense of long-term sustainability. Further, the model's flexibility allows for transferability to other financial institutions and not necessarily only in developed markets, since resource limitation is a serious problem among these businesses (Emerging markets).

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