IJASRM International Journal of Advanced Scientific Research and Management, Vol. 3 Issue 12, Dec 2018.
www.ijasrm.com
ISSN 2455-6378

A Goal Programming Approach for an Effective Financial Budget of an Indian State

Sasank Mouli Kommerce[1], Dr. Raghunath Reddy[2] and Dr V S Triveni[3]

[1,2] Department of OR&SQC, Rayalaseema University, Kurnool, A.P, India.

[3] Department of Mathematics, GCET, Hyderabad, India

Abstract

For a welfare country, the effective financial budget planning is always a challenging task. Though the goals of any financial budget are about the welfare of the country, yet the priorities may change from year to year, to fulfill the economic growth of the developing countries like India. In financial budgeting, the economical priorities of the democratic countries like India depend on the ethics or the promises given by the ruling political party. Besides that, the administrator has to consider various goals in obtaining a satisfactory solution to the financial budget. In this research paper, a State from India is considered and various goals were taken in to thoughtfulness. Multi-decision making problems can be solved by goal programming. The strength of the goal programming model is that it can solve multiple objectives simultaneously and can obtain an optimal solution that satisfies all the objectives and constraints. The objectives change frequently. The goal programming model stated in this research paper can indicatively overcome the changes happening from time to time and can be successful in constructing the effective financial budget.

Keywords—*Goal programming, Goal priorities, Effective Financial budget, Indian state economy.*

1. Introduction

India is a developing country with mixed economy. India is the third largest economy by nominal gross domestic product (GDP) and ranks fourth in power purchasing parity (PPP). The country ranks 141st **[12]** in per capita GDP (nominal) with $1723**[12]** and 123rd**[12]** in per capita GDP (PPP) with $6,616**[11]**. After 1991 economic liberalization, India achieved 6%-7% **[13]** average GDP growth annually. In the fiscal year 2015 and 2017 India's economy became the world's fastest growing major economy surpassing China. India topped the World Bank's growth outlook for the first time in fiscal year 2015–16, during which the economy grew 7.6% **[13]**. Growth is expected to have declined slightly to 7.1%**[13]** for the 2016–17 fiscal year. According to the IMF, India's growth is expected to re-bounce to 7.2% **[13]** in the 2017–18 and 7.7%**[13]** in 2018–19 fiscal years.

In India, there are three types of sectors based on economy and GDP. They are **a**. Agriculture (primary sector) **b.** Industry (secondary sector) and **c.** Services (tertiary sector). In the agriculture sector, India holds world's second position in the agricultural production [13]. The agriculture contribution to the GDP is declining since from 1951, yet it is still the major sector of the Indian economy. Industry sector is having a steady share in the Indian economy and becoming the fastest growing e-commerce markets. In the service sector, India's contribution is increasing very rapidly from 2001. Information technology services (IT), business process out source (BPO) services and software services are the major exports of India in the service sectors.

Rapid increase in the contributions from the three sectors results in the growth of Indian economy. The development in Agriculture and allied services, industry and minerals, infrastructure, transportation, taking up of new irrigation projects, tourism, creating the farming jobs, providing health coverage, rural development, technical education, urban development, housing, water supply, sanitation, energy, labor and employment etc.. Leads to notable increase of Indian economy and per capita GDP. The development in the above said sectors can be achieved by the effective

planning of the financial budget and also meeting the challenges of the practical world at the same time.

In 1955, Charnes, Cooper and Ferguson have first used goal programming. Later in 1972, SM Lee has developed goal programming for decision analysis. From then, many research scholars have developed goal programming models and solved many problems in different fields. Thomas W Lin et al [1993][9] have developed a goal programming applications in financial management. S Safari et al. [2012][8] have designed a mathematical model for allocating budget to university research and educational goals: A case study in Shahed University. Y Chen Tang et al. [2012][10] Multi criteria decision-making based on goal programming and fuzzy analytic hierarchy process. L Zamfirescu Et al. [2013][3] used goal programming as a decision model for performance-based budgeting. Ali Bonyadi Naeini [2014][1] have compared two goal programming models for budget allocation problem. Bushra AbdulHalim et al. [2015][2] have developed bank financial statement management using a goal programming model. Lam W S et al. [2017][4] have developed a strategic decision making in portfolio management with goal programming model. Lam W S [2017][5] has analysed on the bank financial management with goal programming model. Sasank Mouli kommerce et al. [2017][6] have developed agricultural land apportionment through goal programming, Sasank Mouli kommerce et al. [2018][7] have developed human resource planning through goal programming in a software industry. For the first time, our research group has developed a mathematical model for the effective financial budget of a state in India through goal programming.

The main objective of this research paper is to allot the budget effectively to all the available sectors by the approach of goal programming. In India, the newly formed State Andhra Pradesh is taken as a model for the financial budget planning. The model state Andhra Pradesh is facing many economic challenges after getting divided from united Andhra Pradesh. In the new state, the capital city, the infrastructure, urban development, rural development, industries, general education, water supply, sanitation and many more are to be established and developed. The effective financial budget plays a key role in the state economy, thereby to the Indian economy. A GP model is developed with certain goals proposed by the administrator in the problem.

2. Data of the Problem

The required data of the receipts of Andhra Pradesh is collected from 'www.apfinance.gov.in'. Basically, there are two kinds of receipts. **a.** Revenue receipts **b**. Capital receipts. Revenue receipts consist of share of central taxes, state tax revenue, non tax revenue, grants-in-aid. Capital receipts consist of open market loans, floating debts, loans from the government of India, deposits transactions and advances. The opening balance for the financial year 2017-2018 is -447.8452 cr. The total receipts for the financial year 2017-2018 is **1,56,987.5651**[11]**.** The basic estimate of the receipts for the year 2017-2018 is given in **Table I**. The basic estimate of the receipts for the financial year 2016-2017 is also included for ready reference. The budget allotment for the available twenty one sectors of the state for the financial year 2016-2017 is also shown in the **Table II.** The administrator is having some of the goals and constraints for the current financial year 2017-2018, basing on the previous financial year 2016-2017 budgets.

Table I: Data of Revenue receipts and Capital receipts

Particulars	**Basic Estimate (2016-2017) in cr**	**Basic Estimate (2017-2018) in cr**
I Opening Balance	**-414.8518**	**-447.8452**
II Revenue receipts	**1,07,708.8837**	**1,25,495.8198**
1. Share of central taxes	26,263.8800	29,138.82
2. Tax revenue	49,282.3237	53,716.9998
3. Non tax revenue	4,500.00	5,092.00
4. Grants-in-aid	27,662.68	37,548.00
III Capital Receipts	**25,022.3492**	**31,491.7453**
5. Open Market loans	21,528.04	26,819.60
6. Floating debt(gross)	1,500.00	1,500.00
7. Loans from the GOI	983.94	0.00
8. Other loans	1,000.00	1,700.00
9. Deposits transactions etc. (Net)	-327.3758	1,032.1452
10. Loans and advances	337.7450	440.0001
Total receipts **(II+III)**	**132731.2329**	**156987.5651**
IV Available Balance (II+III-I)	**132316.3811**	**156539.7199**

IJASRM International Journal of Advanced Scientific Research and Management, Vol. 3 Issue 12, Dec 2018.
www.ijasrm.com
ISSN 2455-6378

Table II: Sector-wise Allocation (2016-2017)

(in crores)				
S. no	**Sector**	**R.E 2016-2017**		
		Non-Plan	**Plan**	**Total (a_i)**
A	**Economic Services**	**17599.59**	**26832.95**	**44432.54**
	% to total	21.44	52.96	33.47
1	Agricultural and Allied services	5751.42	2739.72	8491.14
	% to total	7.01	5.41	6.40
2	Rural Development	3478.85	12486.08	15964.93
	% to total	4.24	24.65	12.03
3	Irrigation and Flood control	624.03	7495.67	8119.70
	% to total	0.76	14.80	6.12
4	Energy	3715.94	385.13	4101.07
	% to total	4.53	0.76	3.09
5	Industry and Minerals	135.77	911.68	1047.46
	% to total	0.17	1.80	0.79
6	Transport	1173.89	2181.94	3355.83
	% to total	1.43	4.31	2.53
7	Science & Tech. Environment	5.92	25.22	31.14
	% to total	0.01	0.05	0.02
8	General Eco Services	2713.76	607.51	3321.27
	% to total	3.31	1.20	2.50
B	**Social Services**	**24129.63**	**22335.05**	**46464.69**
	% to total	29.39	44.09	35.00
9	General Education	16004.52	2859.76	18864.27
	% to total	19.49	5.64	14.21
10	Sports & Youth Services	29.48	393.56	423.05
	% to total	0.04	0.78	0.32
11	Technical Education	756.97	67.51	824.48
	% to total	0.91	0.13	0.62
12	Art & Culture	23.97	16.71	40.68
	% to total	0.03	0.03	0.03
13	Medical	3040.52	2723.64	5764.16
	% to total	3.70	5.38	4.34
14	Water, Supply, Sanitation	224.41	978.99	1203.40
	% to total	0.27	1.93	0.91
15	Housing	132.88	1000.00	1132.88
	% to total	0.16	1.97	0.85
16	Urban Development	1693.86	5066.89	6660.76
	% to total	1.94	10.00	5.02
17	I&PR	69.15	74.17	143.32
	% to total	0.08	0.15	0.11
18	Welfare	1828.01	7.86.58	9214.59
	% to total	2.23	14.58	6.94
19	Labor Employment	340.99	87.77	428.76
	% to total	0.42	0.17	0.32
20	Social, Security & Welfare	84.81	1679.47	1764.34
	% to total	0.10	3.31	1.33
C	**General Services**	**40372.00**	**1495.00**	**41867.00**
	% to total	49.17	2.95	31.53
21	General Services	40372.00	1495.00	41867.00
	% to total	49.17	2.95	31.53
Grand Total (**A+B+C**)		**82101.22**	**50663.00**	**132764.23**

3. Goal Programming Model

3.1) Priority Structure for Financial Budget Goals

The administrator of the model State has many conflicting goals. He has some goals in connection to the budget allotment of the previous financial year 2016-2017. Here are the following goals in ordinal ranking of importance:

P_1 = Ongoing budget plan should be supported by the ongoing revenue and a maximum excess of 1% of the total available balance is allowed.

P_2 = Agriculture &Allied services and Irrigation & Flood control sectors, together should be given more importance than any other sector.

P_3 = Urban development should be given more percentage of total receipts than the last year's percentage and the increase should be maximum

P_4 = The total amount allotted to the social services should be more than the other services.

P_5 = Amounts to the Arts & culture, I & PR and Science & Tech, Environment sectors should be allotted with lesser amounts than the previous budget.

P_6 = The total percentage of the budget allotted to the general services in 2017-2018 should be less than the percentage of the total budget of the previous year 2016-2017.

P_7 = The percentages in the budget to the energy, transport, tech education, labor employment, social security & welfare sectors should be less than the previous allotted percentages.

P_8 = The total amount allotted to agriculture & allied services should less be than the irrigation & flood control.

3.2) The Goal Constraints are developed as follows

Let the budget allotted to the sectors Agricultural and Allied services, rural development, irrigation & flood control, energy, industry & minerals, transport, science tech. environment, general eco services, general education, sports & youth services, technical education, art culture, medical, water supply, sanitation, housing, urban development, I&PR, welfare, labor employment, social security & welfare and general services be x_1, x_2 ……. x_{21} Rs in cr. $\boldsymbol{d_i^-}$ and $\boldsymbol{d_i^+}$ represents the under achievement and over achievement of the goal constraints.

G1: Restriction on the total budget

The first goal to achieve is to plan the total budget within the available total balance (after deducting the opening negative balance) of Rs 156539.7199/- cr and can cross by 1% (Rs 1565.397199/- cr) of the total available balance i.e., Rs 158105.1171/- .

IJASRM International Journal of Advanced Scientific Research and Management, Vol. 3 Issue 12, Dec 2018.
www.ijasrm.com
ISSN 2455-6378

$$\sum_{i=1}^{21} x_i + d_1^- - d_1^+ = 158105.1171 \quad \ldots\ldots \quad (1)$$

Where x_i = Rs in Crore for the i^{th} sector

G2: The budget should be farmer oriented

Agriculture &Allied services(x_1) and Irrigation & Flood control sectors(x_2), together should be given more importance than any other sectors of the government by allotting more than 13.83% of the total available balance.

$$x_1 + x_3 + d_2^- - d_2^+ = 21865.93769 \ldots\ldots \quad (2)$$

G3: Urban development

The model State is a newly formed state and it needs to develop its capital city and towns. The administrator has given the third priority to the urban development. The percentage of allotment to the total budget should be more than the last year's percentage and more than half the percentage allotted to the agriculture and irrigation sectors.

$$x_{16} + d_3^- - d_3^+ = 10932.96885 \quad \ldots\ldots \quad (3)$$

G4: Priority Goal on Social Services

The total amount allotted to the social services should be more than the other services. The total allotment to the twelve sectors under the social services should occupy more than 30% of the total available balance.

$$\sum_{i=9}^{20} x_i + d_4^- - d_4^+ = 47431.53513 \quad \ldots\ldots \quad (4)$$

G5: Restrictions on Arts & culture, I & PR and Science & Tech, Environment sectors

The budget allotted to the Arts & culture, I & PR and Science & Tech, Environment sectors should be allotted with lesser amounts than the previous budget.

$$x_{12} + d_5^- - d_5^+ = 100 \quad \ldots \quad (5)$$
$$x_{17} + d_6^- - d_6^+ = 200 \quad \ldots \quad (6)$$
$$x_7 + d_7^- - d_7^+ = 50 \quad \ldots \quad (7)$$

G6: Restrictions on General Services

The total percentage of the budget allotted to the general services in 2017-2018 should be less than the percentage of the total budget of the previous year 2016-2017.

$$x_{21} + d_8^- - d_8^+ = 49850.54342 \quad \ldots \quad (8)$$

G7: Restrictions on some other sectors

The percentages in the budget to energy, transport, tech education, labor employment, social security & welfare sectors should be less than the previous budget percentages.

$$x_4 + d_9^- - d_9^+ = 4885.448118 \ldots\ldots\ldots\ldots (9)$$
$$x_6 + d_{10}^- - d_{10}^+ = 4000.059463 \quad \ldots\ldots\ldots (10)$$
$$x_{11} + d_{11}^- - d_{11}^+ = 980.251726 \quad \ldots\ldots\ldots (11)$$
$$x_{19} + d_{12}^- - d_{12}^+ = 505.9363747 \quad \ldots\ldots\ldots (12)$$
$$x_{20} + d_{13}^- - d_{13}^+ = 2102.798057 \quad \ldots\ldots\ldots (13)$$

G8: Restriction on Agriculture & allied services

The total amount allotted to agriculture & allied services should less be than the irrigation & flood control.

$$x_3 + d_{14}^- - d_{14}^+ = 10932.96885 \quad \ldots\ldots\ldots (14)$$

3.3) Constraints

Let the budget allotted in the year 2016-2017 for the existing twenty one sectors be a_i. The budget amount should be allotted to each and every sector for the welfare of the State. The following constraints are also included by the administrator in order to get the allotments to all the available sectors after the fulfilment of the prescribed goal constraints.

$$\sum_{i=1}^{21} x_i \geq a_i \quad \ldots\ldots \quad (15)$$

3.4) The Objective Function

The objective of the model is to minimize deviations from a set of goals by assigning appropriate priority factors. After reviewing the priority structure of goals and the model constraints formulated above, we can derive the following objective function:

$$\text{Min } Z = P_1 d_1^- + P_2 d_2^+ + P_3 d_3^+ + P_4 d_4^+ + P_5 (d_5^- + d_6^- + d_7^-) + P_6 d_8^- + P_7 (d_9^- + d_{10}^- + d_{11}^- + d_{12}^- + d_{13}^-) + P_8 d_{14}^+$$

4. Results

This Goal Programming model for the financial budget is solved by Lingo 17.0 software. The GP is developed with twenty one decision variables, fourteen goal constraints, twenty one constraints, twenty eight deviational variables and eight primitive priority goals. The effective financial budget for a model State to the financial year 2017-2018 is shown in the **Table III**. Further, the division of the funds allotted to the each sector can be divided into planned and non-planed categories depending on the demands and requirements of the each sector. The priorities, goal attainments and the values attained by the decision variables are shown in **Table IV.**

IJASRM International Journal of Advanced Scientific Research and Management, Vol. 3 Issue 12, Dec 2018.
www.ijasrm.com
ISSN 2455-6378

Table III: Proposed Sector-wise Allocation for the year 2017-2018

In crores		
S.no	**Sector**	**B.E 2017-2018 Total**
A	**Economic Services**	**61102.477**
	% to total	38.65
1	Agricultural and Allied services	8491.14
	% to total	5.37
2	Rural Development	15964.93
	% to total	10.10
3	Irrigation and Flood control	8119.7
	% to total	5.14
4	Energy	4885.448
	% to total	3.09
5	Industry and Minerals	1047.46
	% to total	0.66
6	Transport	4000.059
	% to total	2.53
7	Science & Tech, Environment	50
	% to total	0.03
8	General Eco Services	18543.74
	% to total	11.73
B	**Social Services**	**47152.0961**
	% to total	29.82
9	General Education	18864.27
	% to total	11.93
10	Sports & Youth Services	423.05
	% to total	0.27
11	Technical Education	980.2517
	% to total	0.62
12	Art & Culture	100
	% to total	0.06
13	Medical	5764.16
	% to total	3.65
14	Water, Supply & Sanitation	1203.4
	% to total	0.76
15	Housing	1132.88
	% to total	0.72
16	Urban Development	6660.76
	% to total	4.21
17	I&PR	200
	% to total	0.13
18	Welfare	9214.59
	% to total	5.83
19	Labour Employment	505.9364
	% to total	0.32
20	Social, Security & Welfare	2102.798
	% to total	1.33
C	**General Services**	**49850.54**
Grand Total		**158105.1131**

Table IV:Goal Achievement

S.No	**Priority**	**Goal Attainment**	**Deviation Variables**		
1	Priority 1 (P_1)	Fully Achieved	$d_1^- = 0.0$	$d_6^- = 0.0$	$d_{11}^- = 0.0$
2	Priority 2 (P_2)	Not Fully Achieved	$d_1^+ = 0.0$	$d_6^+ = 0.0$	$d_{11}^+ = 0.0$
3	Priority 3 (P_3)	Not Fully Achieved	$d_2^- = 5255.098$	$d_7^- = 0.0$	$d_{12}^- = 0.0$
4	Priority 4 (P_4)	Not Fully Achieved	$d_2^+ = 0.0$	$d_7^+ = 0.0$	$d_{12}^+ = 0.0$
5	Priority 5 (P_5)	Fully Achieved	$d_3^- = 4272.209$	$d_8^- = 0.0$	$d_{13}^- = 0.0$
6	Priority 6 (P_6)	Fully Achieved	$d_3^+ = 0.0$	$d_8^+ = 0.0$	$d_{13}^+ = 0.0$
7	Priority 7 (P_7)	Fully Achieved	$d_4^- = 279.439$	$d_9^- = 0.0$	$d_{14}^- = 2813.269$
8	Priority 7 (P_8)	Not Fully Achieved	$d_4^+ = 0.0$	$d_9^+ = 0.0$	$d_{14}^+ = 0.0$
9			$d_5^- = 0.0$	$d_{10}^- = 0.0$	
10			$d_5^+ = 0.0$	$d_{10}^+ = 0.0$	

5. CONCLUSION

The goal programming technique is successful in framing the budget for a model state. The priorities P_1, P_5, P_6, P_7 are fully achieved, while P_2, P_3, P_4, P_8 are not fully achieved since the deviational variables $d_2^- = 5255.098$, $d_3^- = 4272.209$, $d_4^- = 279.439$, $d_{14}^- = 2813.269$ took up the values in the solution other than zero, violating the respective priority goal constraints. The total sum of the under achievements is Rs. '12620.02' cr. The one percent excess of the opening balance (priority P_1) 156539.7199 cr is 1565.397199 cr. So, the total excess amount required by the model state to fulfill all the priorities (1565.397199 + 12620.02) cr is 14185.41 cr. The model State should go for an excess of nine percent to the available balance for the satisfaction of all the goals set by the administrator. Hence the opening balance for the financial year 2018-2019 will be Rs. -14185.41 cr.

This Goal programming application is applied in framing the effective financial budget to a model State (Andhra Pradesh, India) with twenty one sectors. This model can be extended to the financial budget of a country with any number of sectors.

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