International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.07, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

A ZERO-ONE GOAL PROGRAMMING MODEL TO RESOLVE THE CAPITAL BUDGETING DEALS WITH A WIDE RANGE OF PUBLIC SECTOR AREAS

C.ASHOK KUMAR
HOD., Dept. Of Mathematics, P.G.Centre-Kollapur,Palamuru University,Nagarkurnool(Dist.),Telangana State – India.

K.VIJAY KUMAR
Dept. of Mathematics, Samskruthi college of Engineering & Technology,Hyderabad,Telengana State – India.

ABSTRACT

This paper presents a capital budgeting deals with a public sector. The model could aid in capital budgeting in Telangana state government universities, penal systems, and water resource planning (MCH). The goal programming is capable of handling decision problems with single and multiple goals (constraints). The basic concept of goal programming involves incorporating all goals in one model which can be solved simultaneously. In this paper a case study is demonstrated local government capital budgeting and which is very easy to apply throughout the public sector areas.

KEY WORDS: Capital Budgeting, A zero-one goal programming, Public Sector, Limited Budget.

INTRODUCTION

In today's complex organizational environment, the decision maker is regarded as one who attempts to achieve a set of objectives to the fullest possible extent in an

environment of conflicting interests, incomplete information, and unlimited resources. The goal programming is capable of handling decision problems with single and multiple goals. The goal programming has been developed by CHARNES and COOPER (1955) on executive compensation, there has been substantial research into applying goal programming to finance and accounting problems.

This paper presents a goal programming formulation for capital budgeting in the public sector presents a unique challenge to the administrator. The conflicting goals he or she must consider cannot be expressed in Rupees or in other measures that permit simple summation and comparison. The rising costs and the increased public concern for efficiency in government have made the satisfaction of budget constraints a goal in itself.

There is little agreement on public sector goals. Each community's goals and priorities vary, depending upon its needs and values. In any case, it is obvious that one must recognize the multiplicity and complexity of the community' outputs and goals, whether defined in terms of services or community satisfaction. The capital budgeting in the public sector means satisfying as many conflicting goals as possible by distributing the Rupees of a limited budget among a set of indivisible projects.

DATA OF THE PROBLEM

The example shows the capital budgeting in Telangana state government universities, penal systems, and water resources planning (MCH) examining 19 investment proposals. Total investment in the projects is limited both by a ceiling on total expenditures and by specific allowable increases in annual operating expenses. Major goals include law enforcement, fire protection, community intellectual development, housing, recreation, clean streets, and satisfaction of political and social pressures. Costs and technical coefficients associated with each goal are presented in the Table-1.

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.07, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Table-1

Investment Proposal	Cost	Incremental Annual Operating Expenses	Estimated Reduction in Major Crimes/ 1000pop	Estimated Reduction in Annual Juvenile Arrests/1000 Juveniles	Estimated reduction in Major Fires Annually	Estimated Reduction in Rs value of Property Lost to Fires Annually/ 1000 people	No. of Books Loaned Out/10 People	Reduction % Dropout prior to H.S. Graduation	Increase in Persons Expressing satisfaction with Street Cleanliness Appearances -5% Sample Survey	No. of Days ×Citizens Use of Recreational Facilities	Low Cost Housing Units Provided

X_1 New Model High school	Rs 45,00,000	Rs10,00,000	0.3	10.3	0.0	0.0	0.50	3.90	0.1	15,000	0.0
X_2 Renovate Old Municipal High School	15,00,000	5,00,000	0.1	4.1	0.0	0.0	0.30	1.05	0.0	12,000	0.0
X_3 New Police St.	25,00,000	6,00,000	6.4	1.2	0.0	0.0	0.0	0.00	0.1	0.0	0.0
X_4 Renovate Old Police St.	7,00,000	3,00,000	2.0	0.6	0.0	0.0	0.0	0.00	0.0	0.0	0.0
X_5 Public Gardens	4,00,000	1,00,000	0.1	1.6	0.0	0.0	0.0	0.00	1.0	20,000	0.0
X_6 Lumbini Park	3,00,000	1,00,000	0.1	1.4	0.0	0.0	0.0	0.00	1.0	15,000	0.0
X_7 New Library(University)	20,00,000	5,00,000	0.0	0.1	0.0	0.0	3.75	0.20	0.1	0.0	0.0
X_8 Expand Old Library(City)	9,00,000	3,00,000	0.0	0.1	0.0	0.0	1.90	0.10	0.0	0.0	0.0
X_9 Book Mobile	3,00,000	2,50,000	0.0	0.1	0.0	0.0	0.75	0.05	0.0	0.0	0.0
X_{10} YMCA	15,00,000	3,50,000	0.3	8.5	0.0	0.0	0.0	0.00	0.2	75,000	0.0
X_{11} Ice Rink	5,00,000	1,50,000	0.1	3.9	0.0	0.0	0.0	0.00	0.1	25,000	0.0
X_{12} Swimming Pool (MCH)	6,00,000	1,50,000	0.1	4.2	0.0	0.0	0.0	0.00	0.1	25,000	0.0
X_{13} Subsidized Urban Renewal Low cost Housing	30,00,000	3,00,000	0.5	1.2	6.3	12,000	0.0	0.00	3.1	5,000	2,000
X_{14} Subsidized Urban Renewal- Low cost Housing	20,00,000	3,00,000	0.4	1.0	5.3	10,000	0.0	0.00	2.6	3,000	1,300
X_{15} Subsidized Senior Citizen Housing	15,00,000	3,00,000	0.2	0.3	2.4	5,200	0.0	0.00	1.4	2,000	700
X_{16} Additional Fire station & Equipment	25,00,000	6,00,000	0.0	0.0	14.6	36,000	0.0	0.00	0.0	0.0	0.0
X_{17} New Fire Equip. For Existing Fire station	15,00,000	4,50,000	0.0	0.0	9.4	20,000	0.0	0.00	0.0	0.0	0.0
X_{18} Trash Truck Model A	2,50,000	1,00,000	0.0	0.0	0.0	0.0	0.0	0.00	6.9	0.0	0.0
X_{19} Trash Truck Model B	3,50,000	1,00,000	0.0	0.0	0.0	0.0	0.0	0.00	4.3	0.0	0.0

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.07, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

INTEGER GOAL PROGRAMMING MODEL

Goal programming is a mathematical programming approach in which the objective function is expressed in terms of deviations from the stated goals. The deviation variables are scalar weighted and/or ordinally ranked. Goal programming differs from linear programming in that it does not require translating multiple and conflicting goals (which may be measured in incommensurable units) into a unidimensional objective criterion. It allows these goals to be measured in unlike units and to be treated in both a sequential and/or simultaneous manner. It is a realistic tool that allows the public administrator to represent the particular community's policies and desires in incommensurable units and to solve problems using hierarchical optimization. Profit or utility measurements simply do not apply in the public sector. Arbitrary conversion of unlike units into a unidimensional objective function yields meaningless results. Goal programming solves this problem through hierarchical optimization procedure in which weights are implicitly assigned by creating preemptive priorities. This avoids the direct conversion or assignment of weights to goals which is necessary in linear programming.

Problem Constraints:

The model has been demonstrated to the indivisibility requirements for the decision variables; several of the projects (X_1 & X_2, X_3 & X_4, X_7 & X_8, X_{16} & X_{17}, and X_{18} & X_{19}) are mutually exclusive, as they perform similar functions. Also, project X_{11} is not possible financially unless project X_{10} is also accepted. This leads to the following set of system constraints:

$$X_1 + X_2 + d_1^- - d_1^+ = 1.0 \quad \text{.....(1.}a\text{)}$$

$$X_3 + X_4 + d_2^- - d_2^+ = 1.0 \quad \text{.....(1.}b\text{)}$$

$$X_7 + X_8 + d_3^- - d_3^+ = 1.0 \quad \text{.....(1.}c\text{)}$$

$$X_{16} + X_{17} + d_4^- - d_4^+ = 1.0 \quad \text{.....(1.}d\text{)}$$

$$X_{18} + X_{19} + d_5^- - d_5^+ = 1.0 \quad \text{.....(1.e)}$$

$$X_{11} - X_{10} + d_6^- - d_6^+ = 0.0 \quad \text{.....(1.f)}$$

Where X_i = projects 'i' expressed as a zero-one value, d_g^+ = the positive deviational or slack variable from the g^{th} goal or constraint; and d_g^- = the negative deviational or slack variable from the g^{th} goal or constraint. The deviational variables are introduced to change the goal equations into equalities.

Capital Budget Goal

Assuming a maximum total limit on expenditures of Rs7,50,00,000 the capital budgeting goal becomes

$$\begin{aligned} &Rs45{,}00{,}000X_1 + Rs15{,}00{,}000X_2 + Rs25{,}00{,}000X_3 + Rs7{,}00{,}000X_4 \\ &+ Rs4{,}00{,}000X_5 + Rs3{,}00{,}000X_6 + Rs20{,}00{,}000X_7 + Rs9{,}00{,}000X_8 \\ &+ Rs3{,}00{,}000X_9 + Rs15{,}00{,}000X_{10} + Rs5{,}00{,}000X_{11} + Rs6{,}00{,}000X_{12} \\ &+ Rs30{,}00{,}000X_{13} + Rs20{,}00{,}000X_{14} + Rs15{,}00{,}000X_{15} + Rs25{,}00{,}000X_{16} + \\ &Rs15{,}00{,}000X_{17} + Rs2{,}50{,}000X_{18} + Rs3{,}50{,}000X_{19} + d_7^- - d_7^+ = Rs7{,}50{,}00{,}000 \quad \text{.....(2)} \end{aligned}$$

Annual Operating Expenses Goal

The annual operating expenses caused by new project acceptance to Rs 2, 20, 00,000. This goal can be formulated as follows:

$$\begin{aligned} &Rs10{,}00{,}000X_1 + Rs5{,}00{,}000X_2 + Rs6{,}00{,}000X_3 + Rs3{,}00{,}000X_4 + Rs1{,}00{,}000X_5 \\ &+ Rs1{,}00{,}000X_6 + Rs5{,}00{,}000X_7 + Rs3{,}00{,}000X_8 + Rs2{,}50{,}000X_9 \\ &+ Rs3{,}50{,}000X_{10} + Rs1{,}50{,}000X_{11} + Rs1{,}50{,}000X_{12} + Rs3{,}00{,}000X_{13} \\ &+ Rs3{,}00{,}000X_{14} + Rs3{,}00{,}000X_{15} + Rs6{,}00{,}000X_{16} + Rs4{,}50{,}000X_{17} \\ &+ Rs1{,}00{,}000X_{18} + Rs1{,}00{,}000X_{19} + d_8^- - d_8^+ = Rs2{,}20{,}00{,}000 \quad \text{.....(3)} \end{aligned}$$

Political-Social Goal

To satisfy political and social forces, city planners feel it necessary to accept a minimum of three projects among projects X_1, X_2, X_3, X_4, X_{15}, X_{16} and X_{17}. These involve police, fire, and school improvements and subsidized housing for senior citizens. This goal can be written as follows.

$$X_1 + X_2 + X_3 + X_4 + X_{15} + X_{16} + X_{17} + d_9^- - d_9^+ = 3 \quad \text{.....(4)}$$

Law Enforcement Goal.

To quantify the objective of law enforcement as both a desired reduction in major crimes and a reduction in juvenile delinquency as measured by juvenile arrests. Therefore, if the community's specific goal is a reduction of 2.6 major crimes per 1,000 inhabitants per year in addition to a reduction of 12.0 juvenile arrests per 1,000 juveniles per year, these goals can be formulated as follows:

$$0.3X_1 + 0.1X_2 + 6.4X_3 + 2.0X_4 + 0.1X_5 + 0.1X_6 + 0.3X_{10} + 0.1X_{11} + 0.1X_{12} + 0.5X_{13} + 0.4X_{14} + 0.2X_{15} + d_{10}^- - d_{10}^+ = 2.6 \quad \text{.....(5.a)}$$

And

$$10.3X_1 + 4.1X_2 + 1.2X_3 + 0.6X_4 + 1.6X_5 + 1.4X_6 + 0.1X_7 + 0.1X_8 + 0.1X_9 + 8.5X_{10} + 3.9X_{11} + 4.2X_{12} + 1.2X_{13} + 1.0X_{14} + 0.3X_{15} + d_{11}^- - d_{11}^+ = 12.0 \quad \text{.....(5.b)}$$

Fire Protection Goal

The fire protection is another major municipal goal. Specifically, city officials wish to reduce fires by 11.0 major fires annually per 1,000 inhabitants, in addition to cutting the annual Rupee value of property lost to fires per 1,000 inhabitants by Rs 30, 00,000. This goal can be formulated as:

$$6.3X_{13} + 5.3X_{14} + 2.4X_{15} + 14.6X_{16} + 9.4X_{17} + d_{12}^- - d_{12}^+ = 11.0 \quad \text{.....(6.a)}$$

$$Rs12{,}000X_{13} + Rs10{,}000X_{14} + Rs5{,}200X_{15} + Rs36{,}000X_{16} + Rs20{,}000X_{17} + d_{13}^{-} - d_{13}^{+} = Rs30{,}00{,}000 \quad \ldots\ldots(6.b)$$

Recreation Facilities Goals

The city planners also wish to increase the community's recreational facilities by 75,000 citizen-day use units. This would involve development of recreational facilities such as parks, ice rinks, and swimming pools, renovation of the old Municipal High school and its athletic facilities or building of a new model high school, as well as urban renewal projects that include recreational facilities. This goal can be quantified as follows:

$$15{,}000X_1 + 12{,}000X_2 + 20{,}000X_5 + 15{,}000X_6 + 75{,}000X_{10} + 25{,}000X_{11} + 25{,}000X_{12} + 5{,}000X_{13} + 3{,}000X_{14} + 2{,}000X_{15} + d_{14}^{-} - d_{14}^{+} = 75{,}000 \quad \ldots\ldots(7)$$

Community Intellectual Development Goal

The city also wishes to provide for community intellectual development by making possible an increase of 1.25 in the number of library books loaned per ten inhabitants, in addition to reducing the high school dropout ratio by 1.25%. This goal is quantified as:

$$0.50X_1 + 0.30X_2 + 3.75X_7 + 1.90X_8 + 0.75X_9 + d_{15}^{-} - d_{15}^{+} = 1.25 \quad \ldots\ldots(8.a)$$

And

$$3.90X_1 + 1.05X_2 + 0.20X_7 + 0.10X_8 + 0.05X_9 + d_{16}^{-} - d_{16}^{+} = 1.25 \quad \ldots\ldots(8.b)$$

Public Housing Goal

City planners wish to increase by 2,000 the number of low-cost housing units provided by the municipality:

$$2{,}000X_{13} + 1{,}300X_{14} + 700X_{15} + d_{17}^{-} - d_{17}^{+} = 2{,}000 \quad \text{.....(9)}$$

These units would replace current substandard housing by creating planned neighborhoods with small parks, wide well lighted streets, and easy access to public transportation.

City Cleanliness Goal

The city also wishes to achieve an increase of 7.5% in the number of people expressing

Satisfaction with the cleanliness and appearance of the city streets, based upon a 5% random sample survey. This can be represented as follows:

$$0.1X_1 + 0.1X_3 + 1.0X_5 + 1.0X_6 + 0.1X_7 + 0.2X_{10} + 0.1X_{11} + 3.1X_{13}$$
$$+ 2.6X_{14} + 1.4X_{15} + 6.9X_{18} + 4.3X_{19} + d_{18}^{-} - d_{18}^{+} = 7.5 \quad \text{.....(10)}$$

To satisfy this goal it would be necessary to accept projects dealing with urban renewal and more efficient trash collection.

Objective Function

Based on the desires of residents the priorities were established for each goal. The first priority goal is the system constraints involving mutually exclusive and contingent projects. The second priority goal is the capital budgeting. The third priority goal is the annual operating expenses. The fourth priority goal is the political-social. The fifth priority goal is the law enforcement, within this priority level the crime reduction and juvenile arrests goals are weighted equally. The sixth priority is the fire protection goals of reducing major fires and property losses. The seventh priority goal is the recreation facilities. The eighth priority goal is the community intellectual development, with the

library book usage and high school dropout reduction goals equally weighted. The ninth priority goal is the public housing goal and the tenth priority goal is the city cleanness. The priority designations resulted in the following function:

$$\text{Minimize } Z = P_1\sum_{i=1}^{6} d_1^{+} + P_2 d_7^{+} + P_3 d_8^{+} + P_4 d_9^{-} + P_5(d_{10}^{-} + d_{11}^{-}) + P_6(2000 d_{12}^{-} + d_{13}^{-}) + P_7 d_{14}^{-} + P_8(d_{15}^{-} + d_{16}^{-}) + P_9 d_{17}^{-} + P_{10} d_{18}^{-}.$$

RESULT AND ANALYSIS

The solution will be obtained by using QM for WINDOWS package may interpret as follows:

The zero-one goal programming model yielded the following results:

$X_2 = 1.0$ $X_4 = 1.0$ $X_5 = 1.0$ $X_6 = 1.0$ $X_9 = 1.0$

$X_{12} = 1.0$ $X_{14} = 1.0$ $X_{17} = 1.0$ All other $X_i = 0.0$

The first seven goals (P_1 through P_7) are completely attained, while Priorities 8 through 10 were attained partially which is shown in the following table-2:

Table-2

Goals	Achieved / Not Achieved
The system constraints involving mutually exclusive and contingent projects	Achieved
The capital budgeting	Achieved
The annual operating expenses	Achieved
The political-social	Achieved
The law enforcement	Achieved
The fire protection goals of reducing major fires and property losses	Achieved
The recreation facilities	Achieved
The community intellectual development	Not Achieved
The public housing goal	Not Achieved
The city cleanness	Not Achieved

CONCLUSION

In this paper we have presented that how the capital budget deals in public sector areas with a sample data. From the data of the problem we presented that how a zero-one goal programming model to resolve the existing problem of facility allocation with multiple conflicting objectives.

REFERENCES

1. **Awerbuch S and Wallance W A [1976]:** *Policy Evaluation for Community Development. Decision Tools for Local Government,* **New York, Praeger Publishers.**
2. **BEUTHE M, L. EECKHOUDT, AND G. SCANNELLA [2000]:** A Practical Multi-criteria Methodology for Assessing Risky Public Investments **Socio-Economic Planning Sciences, 34(2), 121-139.**
3. **Collette Y & Siarry P [2003]:** *Multiobjective optimization: principles and case studies,* **springer, Berlin.**
4. **Eckstein O [1958]:** *Water Resource Development: The Economics of a Project Evaluation.* **Cambridge, Harvard University Press.**
5. **Fan Zhi-Ping et al. [2006]:** *A goal programming approach to group decision making based on multiplicative preference relations and fuzzy preference relations,* **European Journal of Operational Research, 174(1), 311-321.**
6. **FERNANDO GARCÍA, FRANCISCO GUIJARRO ,AND ISMAEL MOYA [2010]:** A goal programming approach to estimating performance weights for ranking firms.
7. **GANG KOU & YIPENG [2009]:** A bibliography Analysis of multi criteria decision making in computer science A journal of Communications in computer & information science. **July 68-71.**
8. **Gregory R S [2002]:** *Incorporating value trade-offs into community based environmental risk decisions*. **Environmental Values. 11,461-488.**
9. **Heroux R L & Wallance W A [1973]:** *Financial Analysis and the new Community Development Process,* **New York, Praeger Publishers.**

10. **Ignizio J P [1976]:** *An Approach to the Capital Budgeting Problem with Multiple Objectives,* **Engineering Economist, 259-72.**
11. **Krutilla J & Eckstein O [1958]:** *Multiple Purpose River Development: Studies in Applied Economic Analysis,* **Baltimore, Johns Hopkins University Press.**
12. **Laidlaw C D [1972]:** *Linear Programming for Urban Development Plan Evaluation,* **New York, Praeger Publishers.**
13. **Lee S M & Sevebeck W R [1971]:** *An Aggregative Model for Municipal Economic Planning,* **Policy Science, 99-115.**
14. **M E NJA AND VDOFIA G.A.[2009]:** Formulation of the mixed-integer Goal programming model for flour producing companies, Asian Journal on mathematics & statistics volume 2, Issue-3, 55-64.
15. **OZERNOY W [1992]:** Choosing the best multiple criteria decision-making method, INFOR, Canadian Journal of Operational Research **30, 159-171.**
16. **Stuart D G [1970]:** *Urban Improvement Programming Models,* **Socio-Economic Planning Sciences, 217-37.**
17. **Weingartner H [1963]:** *Mathematical Programming & the Analysis of Capital Budgeting Problems,* **Englewood Cliffs, N.J., Prentice-Hall Inc.**
18. **WILLIS K & JONES D F [2008]:** Multi-objective simulation optimization through search Heuristic & relation database analysis, Decision support system 46, 277-286.
19. **YAGHOOBI M, TAMIZ M & JONES D F [2008]:** Weighted additive models for solving fuzzy Goal Programming problems. Asia Pacific Journal of Operational Research, 25, 715-733.
20. **YUN YB, NAKAYAMA H AND ARAKAWA M [2004]:** Multiple Criteria Decision Making with Generalized DEA and an Aspiration Level Method, **European Journal of Operational Research 158, 697-706.**