Financial reforms in capital budgeting –application of goal programming approach

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Abstract

Capital Budgeting is an important aspect of finance which an executive and management utilises to optimize the investment. In every organization there are different priorities for investment. Risk and return are two vital aspects to be considered at the time of finalizing an investment option. There are organizations which pay more attention towards the return while reducing the risk whereas few organizations do not hesitate to take risk if more returns are expected from the investment. But the fact remains that there should be a proper balance between the risk and return in any investment decision.

There is a new dimension to this investment criteria, nowadays, the organizations are focusing more on applying mathematical programming models for the management systems. There are several approaches being practiced in this context. Here is a research paper where computing the maximum return for accepting or rejecting a project is decided with the help of fundamental programming model by prioritizing the goals. A new approach of computing capital budgeting is implemented with the help of goal programming. For example, Mobiru proposed the model of Goal Programming for allocating time and cost in Project Management by using the case in the project of a construction company.

The basic objective of this research paper is to present a clear picture on how quality can be brought into finance for getting more precise and better results in the field of capital budgeting. This research paper has provided a critical review of the Capital Budgeting and an attempt to re-counsel it with the ground level reality that a finance manager and management faces and which only can be justified in relation to the earning for the objectives and goals of the organization.

Introduction

Capital Budgeting is a process to determine Institution's long term investments such as new projects, purchase of new machines, and change of machinery. This is the process of analyzing investment opportunities and deciding which project to accept out of many options available. Basically, it deals with selecting or rejecting a particular project. There are many stake-holders in an organization who are concerned and effected, willing to invest their funds in any project which is ready to accept certain amount of risk involved in order to earn a good return. To choose a specific project out of various opportunities available is really very difficult and tedious work. It is not just only a single project available all the times; but there remain situations where they have to deal with the multiple projects available at one time. It is very difficult for a financial executive to choose the right project at the right time failing which there are chances of collapsing even of a fundamentally sound organization.

The financial executives and the academicians have started using the Goal Programming Approach in their decision making process, especially in Project Management. The main reason for this is that there are multiple goals and objectives in project selections viz. budget management, material costs, completion time and labour related issues. The financial executive is required to accommodate all relevant matters by optimizing the overall return from the project. Though, the management always prefer to maximize the returns and minimize the cost, but they have to accommodate the multiple aspects and views from various stake holders such as regulators, workforce and society at large by setting

different goals such as product quality, employment stability, industrial and labour relations and CSR etc. Under these circumstances, a different kind of approach is required to accommodate the interests of various stake holders and to optimize the multiple goals and objectives associated with a project. That is the reason that a new technique known as Goal Programming Approach for financial decision making is evolved.

Purpose of this Paper

The purpose of this research paper is to identify the applications of goal programming technique of capital budgeting and the methodological aspects for the management and the financial executives and to generate interest in academicians and researchers. It will motivate and will be very helpful to the financial executives and the top management to choose a right project for investment by accommodating all the goals and objectives of stake holders of an organization.

Literature Review

There have been various studies relating to the application of goal programming approach in capital budgeting, some are mentioned below:

Arthur & Lawrence (1985) developed a model to analyse the make or buy decision. Their approach has taken into account the multi-product environment, over-time levels and capital utilization effects.

Balachandern & Steuer (1982) developed an interactive model to assist a certified public accounting firm in audit staff planning. The multiple objectives included such items as maximizing profit, accommodating bookings, avoiding unnecessary audit staff increases and decreases, minimizing underutilization of staff, and achieving professional developmental goals.

Callahan (1973) illustrated one goal programming investment planning model with profit and risk or safety goals.

Charnes, Cooper, & Ijiri (1963), in the area of capital budgeting. They used the goal programming formulation to show the Balance Sheet extension of break-even analysis.

Fabiane, Neida, & Carlos (2003) applied goal programming to a Brazilian forest problem. The goal programming model was used seeking to reach the following goals :

Wood Harvest (Pine)
Wood Harvest (auraucaria),
Eva-mate Harvest,
Tourism,
Employees,
Diversity of flora, and
Diversity of Fauna

Gyu & John (2000) applied a goal programming model for project selection and resource planning. The decision model used is 0-1 goal programming model, which is validated by applying it to case study from the Woodward Governor Company.

Hawkins & Adams (1974) gave an illustration of goal programming applied to capital budgeting, which directly incorporated the existence of multiple conflicting goals. Their example model included net present value, sales and man-hour employment goals.

Hollis (1979) presented a single-period, multicounty goal programming model for centralized corporate planning utilizing a cash-pooling center, with emphasis on short term investing and financing.

Hong (1981) used a goal programming model including on goals of local finance mix of the firm, earnings per share, average rate of return, limit on debt financing and legal or other restrictions.

Jagetia & Nelson (1976) gave one example of a goal programming formulation for hospital budgeting with goals of profit and number of patient days.

Keown & Taylor (1978) presented a general capital budgeting goal programming model for the firm. Their example has the following goals : net present value, overall sales growth, profit, market share, public service image, product innovation, limitation of risky ventures, limitation of the degree of reliability on general economy, management depth and budget expense.

Klock & Lee (1974) suggested a goal programming model for property liability insurance with profit, current asset returns, and legal bounded goals.

Kumar & Philippatos (1979) applied goal programming to the investment decision of dual-purpose funds. An empirical demonstration is provided to show that dual purpose funds managers can improve their investment selection and subsequent performance by the use of goal programming methodology.
Kombluth (1986) extended that research to show how a "preference" variance could be introduced into an accounting scheme using goal programming. The preference variance measures the proportion of the total variance that could or should be attributed to changes in management preference.
Lawrance, Koch, & Burbridge (1976) illustrated an acquisition investment problem in terms of the following constraints: maximum budget, minimum total earnings and the minimum cash flow. These have the following goals and priorities: present worth of firm's goal level of internal rate of return on all acquisition investments, present worth of firm's future revenue growth potential, amount of debt financing for acquisition investments, and amount of assets-to-liability ratio for all acquisition investments.
Lee and Kim (2000) suggest in their study an improved information system project selection methodology, which reflects interdependencies among evaluation criteria and candidate projects, by using network process within 0-1 goal programming model.
Liang (2009) focuses on developing a two-phase fuzzy mathematical programming approach for solving the multi-objective project management decision problems in a fuzzy environment. The model designed minimizes simultaneously total project costs, total completion time and cashing costs with reference to direct costs, indirect costs, contractual penalty, costs, duration of activities, and the constraints of available budget.
In a sequence of papers, **Muhlemann, Lockell, & Gear (1978), Muhlemann & Lockett (1980) and Harrington and Fischer (1980)** examined the problem of multi objective project selection. They developed a stochastic integer programme with recourse that includes as the objective function weighted linear combinations of deviations from set values for two goals.
Mubiru (2010) proposed a goal programming model for allocating time and cost in project management. A construction company case was utilized to illustrate his model.
Masood, Donald, & Dona (2001) developed a project selection model for which service institutions that incorporated research and development, investment plans, capital budgeting etc. The decision model used is 0-1 goal programming model, which is validated by applying it to a real project selection data.
Mukherjee & Bera (1995) examined the project selection decision by using the technique of goal programming. The model was applied to Indian Coal Mining Industry. The model identifies five goals :
Capital Investment Goal
Cost of Production Goal
Profit Goal
Manpower Goal
Demand Goal
O' Leary and O'Leary (1981) developed a goal programming model for the cash management problem. Their model extended the basic single-objective cash management formulations to include multiple objectives.
Sheshai, Harwood, & Hennanson (1977) assumed a piecewise linear variable cost function and a step function for fixed cost. They used zero-one integer programming to compute break-even point for a two-product example with a no-priority goal situation.
Sealey (1977), (1978), developed a goal programming bank financial planning model with the following goals: profit, capital adequacy ratio. This model also has the following constraints: capacity adequacy, diversification, required reserves and balance sheet.
Trennepohl (1975) showed an application of goal programming to bank asset management with the following goals in the same priorities: meet Federal Banking Regulations, achieve adequate safety in the bank's investments, achieve adequate liquidity in the bank's assets, achieve certain characteristics of the loan portfolio, achieve certain characteristics of the securities portfolio and obtain a certain level of earnings from the investments.

Practices in Capital Budgeting

At present the financial executives have been applying various undernoted techniques to choose one project out of various options available to the organisation. The most common practice among all is by applying the Net Present Value technique of Capital Budgeting. With the help of this technique, the financial executives decide upon accepting or rejecting a particular project. However, there are also various techniques available to a finance manager for choosing a particular project. Here, we will discuss in brief the various techniques of capital budgeting.

Capital Budgeting Tools

Net Present Value (NPV)
Pay Back Period
Internal Rate of Return (IRR)
Average Rate of Return (ARR)
Profitability Index (PI)

Net Present Value (NPV)

Every technique of Capital Budgeting is involved with cash outflows and cash inflows. This is the latest and modern method of evaluating capital investment proposal. In this method, the time value of money is calculated by taking into account the present value of future cash inflows and deducting from this the net cash outflows. It helps in finding out the exact amount of return from a project. In simple terms, the net present of all inflows and outflows of cash during the entire life of the project is calculated separately for each year by discounting all the inflows by the organization's cost of capital. Some organizations consider NPV as the best way of choosing a particular project for investment. The thumb rule for this approach is to find out whether the NPV is positive or negative. If it is positive, accept the proposal for investment otherwise reject it out rightly.

Pay Back Period

In this method the finance executives focus on the duration or the period by which the organization will get back their full cost of the initial cash outflows or the capital expenditure incurred for a particular project. This method is based on the premise of capital expenditure pays itself back over a number of years. Here, the organisation sets a certain target period during which they must receive their money invested in the project back. If a particular project depicts the payback period less than the period set out by the organization, then it is accepted otherwise rejected then and there only. If there is an option of more than one project available to the organisation, then the project with less payback period will be preferred but this is not the sole criteria of choosing any project. The return of the project is also calculated for consideration. However, in practice it depends upon organization to organization to choose a project having more payback period as per the organizations capability to bear the burden.

Internal Rate of Return (IRR)

The IRR technique is considered as the best technique by majority of the finance executives. As per this technique the company fixes a rate for the project and if the rate of return on investment is more than this rate, then they go for the project. In simple terms, the rate at which the sum of discounted cash inflows equals the sum of discounted cash outflows is known as the internal rate of return. For computing this internal rate, the present value of the cash inflows is equated with the present value of cash outflows then the interest rate is calculated. This interest rate is applied with the benchmark rate/the expected rate of the organization. The assumption under this technique is that intermediate cash inflows generated by a particular project are reinvested at the rate of internal return. If this rate is more than or equals to what company has anticipated, then they select the project otherwise it is rejected.

Average/Accounting Rate of Return (ARR)

This technique computes the average of averages i.e. average income/average investment. This method is popularly known as Accounting Rate of Return as the accounting statements are used under this technique to measure the profitability level of the projects. Various proposals available with the organisation are ranked in order to their earnings. The project of higher rate of return is selected. The decision rule using this technique is same as that of IRR. The Average Rate of Return should be more than

the rate set by the company and for mutually exclusive projects, the one having more ARR should be preferred. However, this technique leads to a lot of vague figures as such the ARR is considered quite obsolete and not being taken serious and practiced by most of the finance executives nowadays.

Profitability Index (PI)

This method is upgraded version of the Net Present Value technique of Capital Budgeting and also known as the Benefit Cost Ratio. It computes the ratio between present values of each cash inflows to cash outflows. If the PI is greater or equal to 1 then, the project is accepted otherwise rejected. If there are more than one project available with the organisation (mutually exclusive project) they should go for the project having greater PI.

In all the methods discussed above in brief, the present value is computed at a discount rate. This discount rate is also known as hurdle rate in accounting circle. The NPV of a project depends a lot on this discount rate decided by the company. The discount rate is computed as per the prevailing market conditions perceived by the financial executives and the top management. This discount rate should also take into account and measure the risk involved and the volatility of the market. The hurdle rate is sometimes referred to as cost of capital or cost of debt or cost of equity. A finance executive applies various methods for computing this rate as the CAPM or APT and WACC. The choosing of right rate is very important for any organisation failing which they will have to incur huge loss. Therefore, it is very important to choose the right rate at the time of selecting any project.

Problems in Current Tools of Capital Budgeting

There are many problems being faced by the practioners in the application of current techniques of Capital Budgeting. The major problem is that an organization using more than one parameter in selecting a project ultimately ends up in getting itself confused instead of getting a proper solution. The various techniques of capital budgeting mentioned above is that all focus on the different aspects of a project. As such, the financial executives have to select and go as per only one technique of capital budgeting. While doing this, they have to sacrifice the results derived from some other tool of capital budgeting. The techniques applied by the finance executive deals only with limited parameters. That is, it only computes the whole project as per the given rate of an organization's expectation and some additional measures or criteria or they fix a higher or lower limit, then the available tools of capital budgeting are not able to provide the solution of the goals of the organization. For example, if there are two different shares of companies which an organization intends to buy but both the shares are associated with different amount of risk as well as returns attached with it. Suppose, the objective of a company is to attain a minimum amount of return cannot satisfy their goal as it has restricted itself from taking the risk beyond a minimum amount of risk as well as returns from it. In such a scenario, there would be several combinations possible for choosing these shares. Here, the methods suggested for above mentioned scenario will definitely not satisfy the goals of the company.

Further, there is much beyond just risk and return concepts associated with the project of an organization. Nowadays some projects are undertaken for improving the brand image of an organization. As such, in this case the method mentioned above will not be able to satisfy the required objective while selecting the best project which will satisfy the overall criteria according to priority of the organisation. The available techniques of capital budgeting will create a lot of conflicts at the time of choosing a project. These methods are supposed to be handled with a lot of care and precautions as NPV and IRR sometime depict different opinions about a project which may ultimately result in confusion for a finance manager. There are also problems, if an organization intends to attach some more criteria in selecting a right project. There may be several other objectives an organization intends to achieve, to be incorporated while selecting a project which cannot be computed with the prevailing techniques of capital budgeting. As such, the new approach of goal programming has been derived to provide solution to all the problems discussed above.

Development of New approach Goal Programming

The Goal Programming Approach of Capital Budgeting is an advanced linear programming technique used for providing a solution for the problems related to multi criteria decision making system. Each of these criteria measures is provided a goal or target value which is expected from the project.

Unwanted deviations from the process of target values are minimized or maximized in an achievement function. This can be a vector or a weighted sum dependent on the goal programming variant used by the financial executive.

Steps Involved in Goal Programming Approach

Step 1 : Identify the goals and constraints that may create hurdles in achieving the goals.

Step 2 : Determine the priority level of each goal with P1 is very important, P2 is next most important and so on.

Step 3 : Define the decision variables.

Step 4 : Formulate the constraints using LP procedure.

Step 5 : Develop goal equation for each goal with right hand side specifying the target goal. Deviation Variables d 1 + d 1 – are included in each goal equation to reflect possible deviations from the Target values i.e. above or below.

Step 6 : Write the objective function in terms of minimizing or maximizing a prioritized function of the Deviation variables.

Goal Programming Approach for Capital Budgeting

We can accommodate and solve the problems related to various goals and objectives desired by the stake-holders of an organization. The way we can develop this model is by first set various goals and objectives for selecting a project out of various options available with the organization. We can divide our discussions in two parts i.e. the first one dealing with clubbing of all the capital budgeting tools through goal programming and second one by dealing with new parameters to select a project using goal programming approach. Let's discuss each part of this model in brief.

Inclusion of New parameters into Goal Programming Model

We can understand this model with the help of an example. Suppose, the process of selecting projects in an organization is based upon certain parameters such as, the risk associated with the project, returns expected from it, Pay Back Period of the project and the extent of social service presumed to be performed through this project. Here, we have four goals and objectives expected to be fulfilled from a particular project. We will now have to accord our priority to the goals decided by an organization, after consultation with all the stake-holders. Now, let's presume that the risk is on the top of priorities fixed by this organisation, then the returns from this project, third is Pay Back Period and the last one is related to the level of social work expected from this project.

Suppose, the organisation has six projects in hand to select from, then we can choose the best one by applying various combinations. In Goal Programming, the goals with higher priority are expressed as priority level 1 goal, i.e. risk, and the secondary goal as priority level 2 goal i.e. returns and so on. This type of prioritizing procedure is known as pre-emptive priorities because the decision maker will not sacrifice any portion of target of the priority level 1 for priority level 2. In goal programming with pre-emptive priorities, trade-offs between higher and lower level goals are never permitted.

Then after prioritizing of the objectives and the goals of an organisation, goal equations and constraints are developed by the financial executive. This is done just like as is done in linear programming. The difference is just that here we form equation of the priority based upon the deviations. For example, if we are talking about the level 1 goal i.e. risk, then deviations will be d1+, d1-, where :

d1+ = The amount by which the portfolio/ project risk index exceeds the target.

d2- = The amount by which the portfolio/project risk index is less than the target.

Now, after finding the deviations, these will be converted into equations. If risk associated with each of the six projects are 0.50, 0.25, 0.75, 0.60, 0.40 and 0.10 and suppose the risk index is 1000, then the goal equation will be subject to following constraints :-

$0.50A + 0.25B + 0.75C + 0.60D + 0.40E + 0.10F - d1+ + d1- = 1{,}000$

Where, A, B, C, D, E and F are various projects.

The objective function will be minimizing the deviation that exceeds the risk. Thus, our objective function would be represented as :

Minimise d1-

This is just an example to express the goal equation formulated as level one, likewise other level goals are written in each kind of equation and then total of all the equations are merged by forming a

unique equation for the whole project. To complete the formulation of the model, we must develop a goal equation for each goal. Thus, for the above mentioned example, our objective function will be as under
Minimise P1(d1) + P2(d2) + P3(d3) + P4(d4)

Where, P1, P2, P3 and P4 represent goals and objectives of the organisation at priority level 1, 2, 3 and 4 respectively. As mentioned above d implies positive and negative deviations from the goal at various levels. By solving the equation, we can easily come to a point for selecting projects and this is very helpful in solving the equations. We can easily come to a point for selecting projects and this is very helpful in Portfolio Management. These equations can be easily solved by using excel and specially developed software package.

Application of Goal ProgrammingModel

The goal programming approach of capital budgeting can be utilized effectively in many areas of financial management as mentioned below :-
Corporate Budgeting and Financial Planning
Working Capital Management
Capital Budgeting
Financing Decisions
Mergers, Acquisitions and Divestitures
Investment Planning / Portfolio Selection
Commercial Bank Management
Insurance Management and Pension Fund Management
Scheduling Financing Staff
Interest Rates and Risk
Government and Public Firms
Accounting Control

Research work on Goal Programming Applications by Basic Application Areas *

S.No.	Application Area	Author
1.	Corporate Budgeting and Financial Planning	Charnes et al (1983), Turk and Seliman (1981), Guerad and Lawrence (1987), Hindelang and Krishnamurthy (1985), Jagetia and Nelson (1976), Kvanli (1980), Kvanil and Buckley (1986), Lawrence et al (1981), Mulvey (1987), Nunamaker and Truilt (1987), Shashei et al (1977).
2.	Working Capital Management	Cos (1981), Hollis (1979),Keown and Martin (1977), O'Leary and O'Leary (1981), Phililippatos and Christofi 91984), Rakes and Franz (1985), Sartoris and Spruill (1974).
3.	Capital Budgeting	Bernhard (1980), Bhasker (1979), (1980), Bhasker and McNance (1983), Chateu (1975), Gonzales et al (1987), Hawkins and Adams (1974), Ignizio (1976), Keown and Taylor (1978), Lin (1976), Mervile and Tavis (1974), Spahr et al (1987), Thanassoulis (1985).
4.	Financing Decisions	Arther and Lawrance (1985), Ashron (1985), (1986), Jones (1979), Maimon and Porter (1987).
5.	Mergers, Acquisitions and Divestitures	Charnes et al (1988), Fowler and Schnniederjans (1987), Lawrence et al (1976).
6.	Investment Planning/ Portfolio Selection	Callahan (1973), Harrington and Fisher (1980, Kumar and Phillapattos (1979), Kumar et al (1978), Lee and Chesser (1980), Lee and Lerro (1973, (1978), Muhlemann (1978), Mulhemann and Lickett (1980), Shar and Musser (1986), Stone and Reback (1975).
7.	Commercial Bank Management	Booth and Dash (1977), Fortson and Dince (1977), Keown (1978), Lam and Karwan (1978), Lee et al (1971), Sealey (1977), Sealey (1977), (1978), Tremepohi (1975), Turshen and Nolley (1987).
8.	Insurance Management and Pension Fund Management	Drudell (1977), Gleason and Lilly (1977), Klick and Lee (1974), O'Leary and O;Leary (1987).
9.	Scheduling Financial Staff	Balachandran and Seauer (1982).
10.	Interest Rates and Risk	Booth and Ressier (1989), Boquist and Moore (1983), Gressis et al (1985), Hong (1981).
11.	Government and Public Firms	Channes et al (1988), Gueard and Buell (1984), Jackman (1973), Joiner and Drake 91983), Keown and Martin (1976), (1978), O'Leary and O'Leary (1982), O'Leary (1990), Olive (1981), Taguchi et al (1983), Trivedi (1981), Wacht and Whatford (1976), Wallenius et al (1978).
12.	Accounting Control	Kaornbluth (1985), (1986), Lee (1979), (1986).

(Taken from Research Paper on Goal Programming Application by Basic Application Area by Lin & O'Leary, 1993)

Clubbing Current Capital Parameters into a Goal Programming Model

The major problem with the current techniques of capital budgeting was that the Finance Executive used to get confused at the time of using more than one tool. This issue now can be easily handled and resolved by applying this model as he can now apply easily, all the techniques of capital budgeting for finding the best project out of all the projects available with the organisation. Suppose, we want to consider a project by considering NPV, IRR, Pay Back Period, ARR and Profitability Index and our priority remains as per ascending order i.e. NPV, IRR, Pay Back Period, Profitability Index and ARR. Then our objective function of Goal Programming Model will be as follows :-

Minimise P1(d1-) + P1(d2-) + P3(d3+) + P4(d4-) + P5(d5-)ere,

P1, P2, P3, P4 and P5 represent goals at priority level 1,2,3,4 and 5 respectively.

d1- = The amount by which project is having a present value of each cash inflows less cash out follows.

d2- = The amount by which the project is having IRR less than the hurdle value.

d3+ = The amount by which project is having Pay Back Period greater than the required period.

d4- = The amount by which project is having P1 less than the desired index.

d5- = The amount by which project is having ARR less than the hurdle rate or discount rate.

Now, the whole problem in finding the best project can be solved by the finance executive by using this equation under Goal Programming. We can arrive at the best project that will optimize the objective function. We have already discussed above about how to solve this equation.

Note : In the above cases, we have shown you the objective function by minimizing the deviations that reduces from attaining maximum profits. The same thing can be done to maximize the deviation that helps in achieving our goal. The whole objective function can be formulated so as to maximize the deviations accordingly.

Advantages of Goal Programming Model

The major advantage of this Goal Programming approach is that it also takes into consideration all other aspects of the projects/ investments/portfolios. Such as the extent of benefits expected from the project for public welfare, branding the project and economically soundness etc. There is yet another major benefit using this model that is it prioritises the goals as per the expectations of various stake holders who help in selecting the project, without any conflict. The prioritization is done purely on the basis of each stake holder, which helps in producing the desired results through customization. This customization will solve the major problems of the organization in selecting the projects which they used to face at the time of using IRR and NPV methods of capital budgeting.

Conclusion

Use of Goal Programming Approach over the conventional methods of capital budgeting will prove to be very useful for organizations having multiple objectives to handle at the time of selecting the best suited project out of various options available. It is quite easy to apply, once this method is understood properly. This model provides an opportunity to the finance executives and the management to prioritize the risk and return as per their requirement which helps in solving the problems being faced by them because of various compulsions in the organisation.

The Goal Programming Model appears to be an appropriate, powerful and flexible tool for decision making for a modern decision maker who is burdened with achieving multiple conflicting goals under complex environmental constraints. This approach does not attempt to maximize or minimize the objective function directly, as in the case of Linear Programming technique but focuses on accommodating the goals and objectives of all the stake holders of an organization. This new approach of capital budgeting tries to minimize the deviations observed between the desired goals and the actual results to be achieved as per the assigned priorities in an organization.

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