CHAPTER 4

CAPITAL BUDGETING DECISION-MAKING

4.1 INTRODUCTION

In view of the importance of justification of FMS, a detailed discussion and literature survey of various models are presented in this chapter. Investment decisions are about how the available resources of firm – particularly money – shall be allocated for which programs, to which projects, in what amounts, and under what conditions. In recent years, the thrust of investment research has swung away from being merely descriptive of what is or was done and has moved toward what should be done within the firm in order to attain certain goals. Thus investment analysis has become goal-oriented.

An industrial project, or capital investment project, may be defined as any candidate project that involves the outlay of cash in exchange for an anticipated return flow of future benefits. It is the distinctive feature of the economic analysis of the projects [Bussey, 1985].

Investment decisions may be tactical or strategic. A tactical investment decision generally involves a relatively small amount of funds and does not constitute a major departure from what the firm has been doing in the past. Strategic investment decisions involve large sums of money and may also result in a major departure from what the company has been doing in the past.

4.2 DEFINITIONS

Capital Budgeting is a many-aided activity that includes searching for new and more profitable investment proposals. Investigating engineering and marketing
considerations to predict the consequences of accepting the investment, and making economic analysis to determine the profit potential of each investment proposal (Bierman, and Smidt, 1984).

"Capital Budgeting, an integral part of Strategic Management process, is the decision area in financial management that establishes goals and criteria for investing resources in long-term projects". (Clark, et al, 1985).

4.3 TRADITIONAL METHODS

Once the firm's management has established its goals and priorities for capital expenditures, it must address the question of evaluating proposed expenditures in some systematic manner. Since in all organizations the amount of funds available for capital expenditures is limited, management is faced with the dual problem of establishing some basic criteria for the acceptance, rejection or postponement of proposed investments, and then ranking the projects that meet the criteria for acceptance in order of their value to the firm. Six traditional methods used to evaluate capital investments are briefly outlined in the following paragraphs:

**Payback:** This method involves determining the number of years necessary to recover the cost of a project and comparing the recovery period with the maximum payback period acceptable to management.

**Return On Investment:** This name has been given to a variety of methods that divide yearly cash inflows of net income (either before or after taxes) by the project’s cost of book value.

**Equivalent Annual Charge:** This method requires discounting all expected after-tax cash inflows to present value and taking the difference between the sum of the
discounted cash inflows and outflows. This difference is called the project’s “Net Present Value”.

**Net Present Value (NPV):** This method requires discounting all expected after-tax cash inflows to present value and taking the difference between the sum of the discounted cash inflows and outflows. This difference is called the project’s NPV.

**Profitability Index (PI) or Benefit-Cost Ratio (B/C):** This method involves dividing the present value of the cash inflows by the present value of the cash outflows. The quotient provides an index for measuring “Return per Dollar of Investment”.

**Internal Rate of Return (IRR):** This method involves determining the discount rate that will exactly equate the present value of the cash flows so that the net present value will be zero. That discount rate is called the project’s “Internal Rate of Return”.

### 4.4 RANKING INCONSISTENCY

Whenever two or more investment projects must be compared, with the goal being to accept some and reject others (for reasons such as mutual exclusivity, economic or technical dependence, capital rationing or project indivisibility) the firm needs a rational methodology for making the comparison and deciding which projects should be selected and which should be rejected, so as to select an optimal investment portfolio. The Method of Ranking is one approach available. In this methodology, all candidate projects are ranked in decreasing order according to their individual IRRs, ROIs, NPVs or B/C ratios. Projects are then accepted in that order until the capital budget (firm’s available funds) is exhausted.

The ranking methodology characterized a number of difficulties. First it is often observed in a given set of candidate projects that the preference ranking by using the
IRR criterion is different from the ranking obtained when NPV is the criterion used. Selection is descending order of merit, therefore, results in a different set of projects being accepted under the IRR criterion than those that would be accepted under the NPV criterion. An analogous phenomenon occurs when benefit-cost ratio is used as ranking criterion. This leads to Ranking-Error Problem or Ranking Inconsistency (Bussey, 1985; Lorie & Savage, 1955).

4.5 CAPITAL RATIONING

Projects are also competitive in the sense that they vie for the scarce resources of a firm. Cash Rationing refers to such a situation wherein the effects of competition arising from a cash shortage precluding investment in all of those lucrative projects available to the firm are taken into account. Other constraints such as the shortage of managerial talent, skilled labor, space and raw materials could also result in different forms of rationing [De La Mare, 1982].

Internal capital rationing occurs (a) when management decides to limit the total amount of funds available for capital expenditures to a fixed amount in a given period or (b) when management sets a cut off rate for investments that is higher than the firm's imputed cost of money. That is, when it is a Marginal Investment Rate (MIR) or a Marginal Attractive Rate of either case, the effect of internal capital rationing is to cause the rejection of some projects from the candidate set that would otherwise be acceptable from a profitability standpoint if sufficient capital were available.

External capital rationing occurs when the firm cannot obtain funds from the capital market in sufficient amounts at a price the firm considers economical. In actuality, the unlimited availability of funds as postulated in a Free Capital Market simply does not exist, and the firm must compete for available funds.
Apart from “Ranking Inconsistency”, the second problem associated with ranking methodology is that of project indivisibility. The acceptance of, say, a single large project under a capital budget constraint may exclude the acceptance of several smaller projects that potentially have more aggregate value to the firm. If, as Lorie and Savage (1955) point out, the majority of investment projects have investment requirements that are “small” in relation to the total capital budget, then the problems created by project indivisibility can be safely disregarded with only minor consequences. If there are several indivisible investments that are “large” in comparison to the total budget, however then indivisibility becomes a serious problem in the ranking methodology since the acceptance of a single large investment can exclude the acceptance of several smaller ones that, taken together, provide better profitability for the firm.

4.7 MULTIPLE OBJECTIVES IN CAPITAL BUDGETING

The solution of the capital budgeting problem has suffered, in the past, because traditional methods were incapable of handling more than a single objective. However, real world problems almost invariably have multiple objectives.

Lee and Lerro (1974) identified 8 distinguishable objectives (goals) for a project selection problem:

(i) Capital expenditures constrained by budget allocations.

(ii) Interperiod transfer of funds.

(iii) Accepting certain projects in preference to others.

(iv) Maximizing NPV of this firm.
(v) Keeping a fixed percentage of growth rate.

(vi) Maximizing cash flow in a particular year.

(vii) Providing minimum liquidity for each year.

(viii) Increasing foreign investment.

Lee and Lerro’s article (1974) examines eight decisional permutations of a capital budgeting problem. Such an approach permits management to examine the solutions and consider “what-if” questions “beforehand”.

4.8 MATHEMATICAL PROGRAMMING MODELS

The decision-making process becomes more complex as the number of alternatives increases, as these alternatives become independent, and as the number of constraints on the decision-maker increases. Mathematical Programming Models can be utilized to facilitate the evaluation of decision alternatives. Mathematical programming models are quantitative models, which are descriptive representations of a real problem setting using mathematical equations. These models are, therefore, “abstractions” of the real system; that is, they try to capture only the most critical elements and relationships that exist in the real system, otherwise, it would be as difficult, time consuming, and costly to analyze the model as the real.

There are two major categories of equations that are used in mathematical programming models:

i. The objective function describes the goal or objective the decision-maker desires to achieve.
ii. Constraint equations describe any limitations on resources, restrictions imposed by the environment within which the system functions, or managerial policies that the firm desires to observe.

The basic approach of these models is to optimize the objective function while simultaneously satisfying all the constraint equations that limit the activities of the decision-maker. In formulating both the objective function and the constraint equations, two types of variables are used:

i. Input Parameters are values specified by the decision-maker to describe characteristics of the system.

ii. Decision Variables will be determined by the model as a part of achieving the optimal solution.

Charnes, Cooper and Miller (Solomon (Ed.), 1959) and Weingartner (1963) were the pioneers who concentrated on Lorie-Savage problem (1955) of capital rationing and its resolution. These authors demonstrated that Lorie-Savage's generalized multipliers do not exist for all types of capital rationing problems, that an optimal solution is not guaranteed using the multipliers, and the transformed problem using the approach may not be equivalent to the original problem. Charnes, Cooper and Miller formulated a linear programming model to assist the firm in allocating funds among competing projects considering both operating decisions and financial planning. Weingartner's outstanding work formulates the capital rationing problem first as a Linear Programming model and then as an Integer Programming model. His work also provided valuable insights concerning the shadow prices and dual variables for the Integer Programming formulation. Since these pioneering works, there have been many advances in the area of mathematical programming applied to the capital budgeting problem. The major extensions have either sought to integrate other
financial decision areas with the capital budgeting decision; relaxed the single goal assumption of LP and IP, or have attempted to handle the capital rationing problem under conditions of risk (Bernhard, 1969).

4.9 THE INDIAN SCENARIO

A few Indian manufacturing firms (users of MTs) with foreign technical and financial tie-ups have adopted Advanced Manufacturing Technologies (AMTs), specifically flexible manufacturing systems, whose introduction is mainly related to the firms' capacity expansion plans. Generally, very few firms appreciate the positive impacts of all the four major components of manufacturing strategy, viz., cost, quality, flexibility and delivery. Several studies abroad have indicated that the apparent lack of investment in AMTs is the result of outmoded management accounting systems and inappropriate financial appraisal methods. The project evaluation and selection phase of the capital budgeting process has been studied extensively because of its perceived importance to a firm (Lefley, 1994; Chetty, 1991).

Baldin (1991) has called for re-examining capital budgeting systems of firms in the light of their competitive strategies and goals for long-run innovation. Firms have to respond by changing their methods of evaluating technological investments, by divesting assets, by shifting the locus of investment decisions, and by changing managerial incentives. He has quoted a statement of the CEO of Allen-Bradley: "The old financial models have failed manufacturing companies. Return on investment, internal rate of return and other such abstractions.....gave little consideration to strategic opportunities and threats presented by technological advance". Hayes and Garvin (1982) have suggested that the wider use of traditional methods of investment appraisal, such as Discounted Cash Flow (DCF), have contributed to the slowing
down of capital investments in the USA, a factor that may also apply to India. They have bluntly stated that the willingness of managers to view the future through the reversed telescope of DCF analysis was seriously shortchanging the futures of companies in the USA.

Mukherjee and Henderson (1987) have summarized four limitations of DCF models used for analysis of capital investments:

a. Inability to capture the role of organisational structure and behaviour in corporate decision making,

b. Failure to incorporate management behaviour towards risk.

c. Difficulties in application due especially to unrealistic assumptions about data availability, and,

d. Inability to incorporate strategic considerations in decisions made by firms.

This brings the justification of AMTs to the centre-stage of planning in manufacturing firms. It has been emphasized that financial justification is the major roadblock to the adoption of industrial automation in the developed countries such as USA and UK (Farhoomand et al., 1990, Primrose and Leonard, 1986 a & b, Lefley, 1994).

The major facilitating factors in the process of AMT justification have been summarized below (Meredith and Suresh, 1986; Zairi, 1992):

a. The induction of AMTs is seen as part of an overall competitive strategy. The main areas of competitiveness include quality and flexibility. AMTs are therefore considered to be a part of a general commitment to sustain competitiveness.

b. At the economic level, the identification of various cost savings facilitates AMT justification.
c. The lack of cash flow problems and the level of demand for existing products make the process of AMT justification less problematic.

d. Investment is the responsibility of a parent company and therefore, the problem of AMT justification does not affect its business units.

e. In some cases, government grants facilitate the justification process and positively encourage AMT implementation.

Typical justification processes focus on direct labour and material savings and make no attempt to document tangible savings potential in such areas as inventory reduction, space reduction, higher quality, reduced accounts receivable, reduced requirement for material handling, etc. Also often neglected are the intangibles. While it may be difficult to quantify these, it is equally invalid to assume that they do not exist at all. Intangibles such as greater flexibility and shorter throughput or lead time may eventually justify the technology by themselves (Kaplan, 1986). In fact, the ultimate intangible may be the recognition that, in some cases, failure to make appropriate short-term investments in a particular technology will place the long-term survival of the entire company in jeopardy (Tippett, 1989).

A survey conducted in India has indicated that industries are not coming forward to introduce AMTs, partly because of the very high level of investment required (Datta et al., 1992). Some of the main reasons attributed to Indian managers for the slow introduction of AMTs in the Indian manufacturing sector are (Chetty, 1991; Tulpule and Datta, 1990; Kulkarni and Sinha, 1992):

* their risk-averse attitudes;
* their apprehension about the long-term benefits of AMTs;
* their assumptions of static markets and industrial activities;
their adherence to traditional financial appraisal methods; and

* their inability to identify the strategic role of manufacturing.

The lack of appreciation of the beneficial effects of AMTs by the Indian manufacturing industry can also decelerate the pace of technological progress in the IMT (Wogart et al., 1993).

4.10 TECHNOLOGY JUSTIFICATION METHODS: A Review

Survey articles that have appeared in recent years (Lefley, 1994; Proctor and Canada, 1992; Son, 1992; Parsaei et al., 1990; Swamidass, 1990; Wallace and Thuesen, 1987; Meredith and Suresh, 1986) vouch for the growing awareness and importance of justification methodologies for AMTs in the manufacturing sector.

Naik and Chakravarthy (1992) have identified the following major categories of technology justification methods:

* Purely quantitative or financial techniques.

* Purely subjective or judgmental techniques.

* Financial techniques with modified hurdle rates to account for the qualitative or strategic aspects.

* Hierarchical evaluation approach where strategic aspects are considered first and financial criteria are applied next; and vice versa.

* Optimization approach involving analytical formulations with numerical solutions, and different mathematical programming techniques such as integer, mixed-integer, goal and dynamic programming.

* Simulation models using simulation languages or packages.
* Decision support and expert systems that help select the best financial or scoring technique in a given situation.

* Integrated approaches where the strategic, tactical and operational decision factors have been aggregated into measures of manufacturing system value.

Meredith and Suresh (1986) have provided a taxonomy of technology justification approaches which is shown in Figure 4.1. They have identified three major groups based on economic, analytic and strategic justification approaches. Swamidass (1990) has also provided a similar classification on the acquisition of new manufacturing technology. This classification has laid due emphasis on the planning process employed and the strategic value of flexibility.

Figure 4.1: Justification methods
Some of the recent articles on justification of AMTs are briefly indicated below:

* Park and Son (1988) have provided an economic evaluation model incorporating productivity, quality and flexibility factors into a linear programming formulation so as to measure long-term manufacturing performance.

* Krinsky and Miltenberg (1989), in a financially oriented approach, have identified Net Present Value (NPV) as a major decision-input in technology justification of AMTs.

* Suresh (1991) has employed a mixed-integer goal programming technique for evaluating flexible automation investments. It incorporates replacement schedules and production plans besides flexibility.

* Demmel and Askin (1992) have provided a multiple objective decision model using composite programming for the evaluation of AMTs.

* Lederer and Singhal (1994) have developed a model for considering financial and technology decisions simultaneously. Equity and debt values have been included in the analysis, providing a new impetus to justification methodologies.

* Peronne (1994) has developed a fuzzy multiple criteria decision model for the development of a fuzzy integrated index that combines both the qualitative and quantitative, but uncertain, issues.

* Dynamic programming has also been utilized for flexible automation systems evaluation (Lotfi and Suresh, 1994).

There is an upsurge of research activity in the use of multi-attribute decision models, particularly the weighted scoring model and the Analytic Hierarchy Process - both at
the national level (Ramanujam and Saaty, 1981; Sharif and Sunderarajan, 1983; Sivarama Prasad and Sonaschhara, 1990; Madu and Madu 1993) and at the firm level (Wabalickis, 1987; Boucher and MacStravic, 1991; Liberatore et al., 1992; Azhar and Leung, 1993). The growing complexity of modelling in this area of research has been instrumental in evolving decision support systems to help planners in dealing with such ill-structured problems pertaining to technology justification processes (Suresh, 1990; Kassicieh et al., 1993; Tabucanon et al., 1994; Aly and Subramaniam, 1993).

The current trends of research point to the formulation of integrated models, as the justification problems become more complex with the identification of seemingly unconnected factors ranging from the commitment of top management (Randhawa and Bedworth, 1985) and managers' perceptions towards automation (Farhoomand et al., 1990) to the strategic issues (Boaden and Dale, 1990) and production criteria such as quality, flexibility, etc. (Chen and Adam, 1991). In this context, Suresh and Kaparthi (1992) have developed a procedure that combines a general mixed integer goal programming formulation with AHP to utilize both optimization and evaluation capabilities. The procedure takes into account a wide range of factors categorized under strategic and tactical elements. A similar attempt has been made by Myint and Tabucanon (1994) who effectively combined the GP and AHP methodologies for the machine selection problem in an FMS environment. As a possible extension to these works on combining AHP and GP methodologies, an integrated AHP-GP model has been formulated. It formally treats the priorities in the decision hierarchy of AHP as penalty weights of the goal constraints. This model has been applied for justifying the choice of AMTs in the case of a medium-scale automotive components-manufacturing firm.