1. INTRODUCTION, THE PROBLEM AND SURVEY OF RELEVANT LITERATURE

1.1 INTRODUCTION AND THE PROBLEM

A system, in any functional area of management, is often a complex structure consisting of series connected complicated subsystems. The property of the systems guaranteeing fulfilment of the required task in the required time which is termed as the "system reliability" can therefore be traced, at the micro-level, to the various subsystems constituting it because the system will fail functioning if any of its subsystem fails. A system designer cannot be oblivious to this aspect of reliability. Any one or a combination of the following ways will augment the reliability of a system:

a) Over-designing the system,

b) Using alternate back-up components (stand-by units) comprising the system and

c) Introducing better maintenance facilities.

To increase the probability of the systems continuity by above mentioned ways, however, will entail increased costs.

Designing of a system with an eye only on its continuity qualification are to neglect the other major objectives and limitations of system designing, namely survival and growth under resource limitations. In the long run, it is the profitability of the system which measures the survival and growth of the system that holds sway. In business, and often elsewhere, a reliable but financially not viable system is not a favourable reflection of the system designer.

If, therefore, to study the viablility of the system, one has to take into account both the reliability and the profitability of the system, the obvious question that arises next: What are the profitability criteria that may be considered in this connection ? One may mention three such criteria [33] :

i) Discounted Net Cash Inflow (DNCI): In recent years, the time discounted rate of return has come to be recognised as one of the most meaningful tool for financial decision making with respect to future commitments and projects. It is being increasingly used not only to screen and rank proposed capital expenditures but also employed in make or buy decisions, in lease or own judgements, and in mergers and acquisitions. The essence of this method is to find the earnings rate at which the present value of the earnings equals the amount of the investment. For the planning horizon $[0, t]$ the discounted net cash inflow (DNCI) from the system is given by,

$$\int_0^t \exp(-\bar{r}\tau)\, P(\tau)\, R(\tau)\, d\tau$$

where, τ = discount factor,

$P(t)$ = Instantaneous expected rate of net cash inflow (or net operating benefits) per unit time from the system at time t. The net cash inflow equals the sales revenue derived from operating the system, less the operating expenses, plus depreciation at time t.

$R(t)$ = Reliability of the system at time t which in turn is function of the number of standby units used in each subsystem of the system and the planning horizon $[0, t]$.

ii) Net Present Value of Investment (NPVI): It is the difference between the net present value of benefits and present value of all outflows. If the net present value is positive, the conclusion is favourable to go ahead with the project, but if it is negative the project is rejected. For the project with initial investment the net presant value of investment (NPVI) is given by,

$$\left[\int_0^t \exp(-\bar{r}\tau)\, P(\tau)\, R(\tau)\, d\tau - \text{Initial Investment.} \right]$$

iii) Profitability Index (PI): In order to compare the proposals, in terms of relative profitability , the size of the cash flows to investment must be related. This is done by dividing the present value of inflows by the amount of investment to give a ratio that is called the 'profitability index' or 'desirability ratio' or 'benefit to cost' ratio. The profitability index is an effective tool for making the projects. Profitability Index

(PI) for a project is given by

$$\left[\int_0^t \exp(-\bar{r}\,\tau)\, P(\tau)\, R(\tau)\, d\tau \,/\, \text{Initial Investment} \right]$$

Considering the decision variable to be the number of redundant units for each stage of the system under study, the system designer will try to optimize the different performance indices of the system subject to its resource limitations and then to analyse and compare the behaviour of optimal solutions as obtained from optimizing different performance indices subject to same set of resource restrictions.

Optimal allocation of redundant units to a series system with repairable subsystems is investigated here for maximizing separately the system reliability and profitability criteria as mentioned subject to multiple linear resource restrictions and restrictions on maintenance facilities using mathematical programming techniques.