CHAPTER 5

EVALUATION OF BENEFITS &
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5.1 SELECTION OF CARDINAL MEASURES.

5.1.1 Evaluation of benefits and related costs of the selected project has to be done in relation to several alternative objectives of the economic decision. In the evaluation of benefits of a computerised system often a conflict may arise in selection of a single cardinal measure due to complexities of technological progress, magnitude of economies of scale in computing and relative benefits derived from selection of the configuration in comparison to the other. Selection of a single objective out of a number of alternatives available, may simplify this complex problem.

The benefits offered by a computerised system could be measured in terms of response time, throughput performance and capacity. When the objective is to measure the performance of a typical set of tasks, it could be related to measure the performance per economic unit (in terms of money, time etc) for a typical set of tasks. While in certain cases, it might be convenient to measure the benefits of the complete system, in general, it was advantageous to relate the benefit evaluation to a particular set of tasks. Similarly evaluation of the average cost of computation was related to the volume of computation at the available rate of output.

5.2 EFFECT OF TECHNOLOGICAL & ECONOMIC EFFICIENCY OF SYSTEM ON COSTS.

5.2.1 The cost evaluation is related to the input of the system whose main elements are the programming cost and the
computers time cost. These cost elements would depend on the
technological efficiency of the system as well as the economic
efficiency. A technologically efficient combination could
produce as much output using at least one input less, without
using any additional input, as compared to a technologically
less efficient system. On the other hand, an economically
efficient system would be the cheapest amongst all the tech-
nologically efficient combinations. Applying the economic
theory, the least possible cost curve for the given volume of
output for different technologically efficient system would
take a U shaped form as shown in Fig. 5.21. The isoquant
(equal quality output curve) is typically downwards sloping
and convex at the origin. This is characteristic of substi-
tutability of inputs in computers. The isoquant lines $K_1$, $K_2$
$\ldots\ldots K_4$ are a result of the combinations of inputs as
economically efficient, producing least cost amongst the
technologically efficient combinations. The optimum combina-
tion will obviously lie at the point where isoquant line is
tangent to the isoquant.

5.22 The cost curve arrived on the basis of economic theory
thus implies that as a computer system became more and more
effective its cost increases, not in a linear fashion, but
following a hyperbolic law. Thus a system twice as effective
than twice the earlier system. The change in computer

\[1\] This implies that isoquant touches but does not intersect
the isoquant. If isoquant is smooth at the point of contact
the two will have same slope; but if tangency occurs at a
link, the isoquant slope is not even defined.
technology has, however, reversed this trend of economy to a certain extent. The trend visible now was asserted by Herbert R. Gorsch way back in 1940 itself, stating that for computer equipment average cost decreases substantially as size increases. This assertion, which was subsequently known as Gorsch's law could be generally stated as:

\[ C = \frac{K}{E} \quad \text{or} \quad E = \left( \frac{1}{K} \right) C^2 \]

where

- \( C \) = Cost of computer
- \( E \) = Benefit achieved

and \( K \) = Empirical constant

Thus the law asserted that the cost-benefit ratio of the system gave the cost per unit of benefit of the system. That is

\[ \frac{C}{E} = \frac{K}{E} = \frac{K}{K} = 1 \]

Application of economic theory related to the average cost of computation to output as shown in Fig. 5.22-a. But when the results were measured based on different measures of benefits, it was considered advantageous to use cost as independent variable as shown in fig. 5.22-b.

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2/ Herbert R. Gorsch — assertion in 1940, not published but cited subsequently in a number of articles among them by Coleman [23-cit. pp.].
5.3 PROCEDURES OF BENEFIT AND COST ASSESSMENT.

5.31 Once the benefits and costs have been assessed in terms of standard measure, it should be possible to reach the economic zone of operation of the project where the rate of return on the increments will exceed the minimum attractive rate of return. Such an economic analysis should be possible only when the evaluation of the benefits and costs of the project has been carried out in common measure, say in terms of money value. The selected cardinal measures of datamation have therefore, to be converted to their equivalent money value.

5.32 The zone of economic operation of project would lie between the limits of maximum benefit cost ratio and the maximum difference between the benefits and costs of the project (Fig.5.32).

5.33 To arrive at the economic zone of operation, therefore the benefits and costs should be measured accordingly. The standard of measure adopted should be capable of uniform application for assessment of direct as well as the indirect Benefits and Costs. The judgement used in applying the weights to gains and losses of various functions should be pragmatic and over simplification will have to be avoided as that might lead to inaccurate results. This would be achieved through a process based on post decision approach as applied in case of income assessment or through a process of explicit value judgement.

5.4 PROFITABILITY OF AUTOMATIC DATA PROCESSING.

5.41 Computer installation involves locking up substantial capital. This can not be done purely to achieve a status symbol. Commitment of such an investment will be dictated by
investment criteria as in case of other types of capital expenditure. It has to be studied whether the work for which computer is being planned to be installed can be done more economically by some alternative means. Existing methods are not for consideration when there is scope for their improvement. Profitability of automation in data processing should be assessed at various stages viz.

(a) Before a decision is made to install a computer for the first time.

This decision will involve an analysis of justification of the proposal and a study of the type of equipment to be installed.

(b) After the equipment has been installed and taken into the use.

The project has to be reviewed from year to year or more frequently if required, to see the results of actual achievements against estimates. Deviation if any should be explained.

5.32 The nature of work entrusted for computerisation has a great significance in profitability analysis. It will therefore be convenient to categorise the work where optimum results are obtained without computerisation, and those where it is not possible to obtain optimum results without the help of the computer. Often the computer might be loaded with additional work to utilise its full capacity and such work should not be lost sight off in assessing the profitability criteria.

5.5 ESTIMATION OF BENEFITS.

5.51 In addition to direct economic benefits, it might be
worth while examening other benefits of computerisation. The primary benefits are:

(a) Improvement in accuracy and form of presentation of data. Human intervention at different stages in a mechanised process is prone to bringing in errors while an electronic data processing working on input data is least interfered with human elements once the programme has been fed after due verification. In such system errors due to human elements is completely eliminated.

(b) Speed in obtaining statistical statements is improved considerably. Accuracy of such statements can be accepted with greater confidence due to integrated nature of computerised data processing system.

(c) Computerised system offers a greater degree of control on data processing. System can be designed to meet specific requirements as deemed necessary and processed data produced in an easy to interpret format.

(d) Additional statistics can be obtained when desired. Data can be analysed in the form desired, and produced to meet specific requirements of subsidiaries.

(e) It is possible to carry out both microscopic as well as macroscopic analysis of data with the help of computers. This facility offers a wide range of choices for the operators to concentrate.

5.52 The planning for the computerisation would normally envisaged four clear cut stages through which the system will be fully operational. These would be:

Stage 1- The conduct of preliminary studies.
Stage 2- The conclusion of details study which finally decide
the mode of the project on economically grounds.

Stage 3 - Evaluation of the project, involving the decision on the precise equipments to be obtained and evalua
tion of its costs.

Stage 4 - Installation and usage of the equipments.

5.63 During the preliminary stages saving potential is considered as one of the main criteria for automation in data processing. The estimates of savings should bring out clearly the use of capital investment as well as the effect of upheaves inherent in the introduction of automatic data processing. In such estimates a caution is necessary to avoid over statement of expected savings. The effective rate of return on the whole period of the equipment should not fall below a predetermined level of rate of return on capital investment. When optimum results are possible through means other than computerisation it will be worth while considering the following:

(a) The life expectancy of computer installation -
A high rate of technological development in the field of computers has considerably reduced the life expectancy of computers due to frequency of obsolescence, if life expectancy is taken to be too long parts and sub assemblies may not be available in later years. The suitable trained maintenance staff may not be available to look after obsolete equipment. Computer installation takes time. The costs start earlier than actual installation. The feasibility study phase adds up to the life expectancy and it will be advisable to reckon this period in calculation of costs while estimating the life expectancy. Under these conditions a
computer life of seven years is considered a good estimate.

(b) Identification of jobs -

It should be decided in advance, as to what works is to be entrusted to computer. If a detailed analysis is not carried out on this, then jobs which could be done more economically by other means would be entrusted to computer. This would entail going in for a more expensive computer than required. At the same time more remunerative jobs will have to pay for the less remunerative ones.

5.59 The future growth of work load should also be kept in mind. The best policy would be to make a proper assessment of the work load at mid point of life expectancy of computer, leaving increased of work load in later part to be catered by over time. This will help making a more correct assessment of capacity required for computer.

(c) Running Time -

A proper assessment of hours of working is essential to have a correct appraisal of capacity utilisation. During initial stages forty hours per week is a good estimate for planning purposes. Longer hours can be worked but in the initial stages of teething trouble, mis operation might cause delays in comparison to the time when operations settled down. Contingencies like growth of work beyond estimates, or inclusion of additional jobs not included in original, specifications should also be catered for.
5.54 Optimality Evaluation.

Benefits secured by optimisation of results not achievable by any other means except computerisation, or increase were it is not possible to carry out the work by other methods due to exorbitant costs involved, should be realistically estimated. To this end estimated cost of computerisation scheme should be prepared compared with a cost of existing work being done by other methods if any. In case the computerisation scheme appears to be more expensive in comparison to other method, there will be negative saving on present value calculations. Justification of expected results therefore will have to be decided against the increase cost of processing. Acceptance of undesirable degree of approximation, which is inherent in a manual system will not be prudent decision in these areas.

5.55 Capacity Utilisation.

During initial stages when a computer has been newly installed and not fully utilised there is a tendency to undertake any suitable work to engage its idle capacity. But as the volume of work increases there is a pressing demand on computer time and capacity by work which will be more profitable for computer. The capacity engaged by less profitable work is not available, therefore additional work will have to be transferred to other computer or alternative methods. It is therefore not advisable to transfer work of perpetual nature and not profitable to computer to engage its idle capacity. On the other hand it might be advantageous to computerise adhoc work of nonrecurring nature to engage the idle capacity. If cost of other methods is more than cost of computerisation, the net benefits obtained
from such ad hoc transfers should be taken on the credit side of computerisation.

5.6 ESTIMATION OF COSTS.

5.61 Cost estimation of computerisation will fall into two broad areas:

- relative cost of other competing schemes.

5.62 The cost assessment will have to be done on accordance with the stages of development of the system. These can be broadly grouped into the following:

- During stages 1 & 2 assessment should be -
  a) For existing system and
  b) For most economical alternative to the present system - excluding a.d.p.
  c) The proposed a.d.p. system.


While evaluating for the actual equipment to be procured a cost assessment of the existing system and non a.d.p. alternative to the existing system should be carried out. In a non a.d.p. alternative offers a competitive position with a.d.p., it should be costed, taking into consideration the additional equipment intern of accounting machines purchased card machine, staff training and cost of planning and introduction of alternative system.

5.64 Choice of Alternative.

It will be worth while having a cost assessment of buying v/s renting for a scheme not lasting more than five years at stage 3. Assessment at stage 1 & 2 will normally be based on purchase of equipment unless it is quite clear that the work is not expected to last for sufficient long period.
5.65 Cost estimation is always done against the time base. In case of a.d.p. where equipment life is estimated a seven years, the schedule of cost may have to be spanned through a period of ten years. This will cater three years for time spent in stage 1 & 2 of the preparatory phase till the equipment is actually installed and becomes operational, giving useful life of seven years.

5.66 The cost schedule should cover all areas where effect of a.d.p. is left. It should be so drawn to make it possible to compare the cost of work with a.d.p. and without it.

5.67 Nature of computer and its software itself may create some cost differences. The programming delay also have a cost attached to it. Time spent in operations and maintenance of computers will also have its associated cost. All these cost are not easy to quantify and it is a natural tendency to attach arbitrary weights to them. It may possible to quantify the cost in a large number of cases. Help of past experience and statistical data of similar situation should be taken where possible. If weights have to be attached at all care should be taken to see that they are not out of proportion to the significance attached.

5.671 Present Value.

Once the system has become functional it will be a good practice to assign the annual cost of its maintenance and operation and thus estimate its annual expenditure. The annual expenditure should be compared with present value of the system. The present value will take into consideration the factors like spare capacity, scope for expansion, reliance that can be placed on
suppliers promises for delivery of hard ware and soft ware etc. Thus it is a comparison with the present value of the system which will give the real cost of operation. A system having low annual expenditure with low present value is definitely high cost item in comparison to one having irregular comparative difference between its annual expenditure and present value.

5.672 Operational Cost.

The real cost of a.d.p. appears only during its service life, in actual operations. Once the equipment is installed, the current position should be always compared with annual estimates and the deviation if any should be analysed and rectification action taken in time. It is possible that the figures of the original calculation might have altered due to the fact that:

- There has been a change in the area of work planned.
- Significant changes have occurred in original salary and wages due to inflationary pressure.
- There have been significant change in the work load assigned to the system.

Under such situations the cost estimates should be revised showing the actual costs increased each year till date and the estimated cost for the remaining period of service life of the system.

5.68 Staffing.

Staffing pattern of a.d.p. system is another area of significant cost. The automation in data processing involves significant changes in staffing pattern from a manual system. The change has to be brought in gradually. Some of the old staff may have to be retrained for new jobs, while some new
build up may take place. The staffing pattern has to be planned and estimated for the whole period of change over from the old system to the new, right up to stage 3 of the installation of new system. All the staff affected by the change over should be included for costing of staffing pattern. The scheduled draw should be able to provide a clear comparison between the previous system to the a.d.p. system. The repercussion that the introduction of a.d.p. may have on the staffing pattern of either department/sections should not be over looked. The whole field of operation, including the unessential paper work, typing etc. should be examined to ensure that no relevant cost affected by introduction of a.d.p. is ever looked.

5.69 Social Costs.

Computers and automatic data processing methods, while easing many of the burdens involved in the information system produces disruption on many workers, particularly the older ones might find it difficult to ever find a suitable job again. According to Prof. Daniel Bell - Automation is creating new salariat instead of proletariat, as automatic process reduced the number of industrial worker required in production. Due to automate production in chemical industry in U.S.A., the output rose by 50% in seven year period, while number of blue collar workers increased only by 15%. On the other hand supervisory, clerical and sales personnel increased by 50%. With lesser dependence on labour, plants can be located in suburbs and as more and more workers live along the radial fringes of spreading cities, the distribution between urban and sub urban will disappear. The rythem of life will change as well.
6.692 In automated production, machinery rather than labour wages become the major cost. When labour is cheap, it becomes uneconomical to keep an enormously expensive machinery idle. Expansion of shift operation is the outcome. This produces a change in the rhythm of life of workers. Sleeping, eating, social and sexual life becomes skewed. A change in friendship pattern occurs. Home and sex life becomes disjointed. As income rises and hours of leisure increased, demands for entertainments increased. Increased quantum of entertainment services like hotels, vacation resorts, restaurants etc. places greater demands for outdoor workers on week ends and evenings. All these produces a change in life pattern of members of the community.

6.693 According to Freud, work was the chief means of binding an individual to reality. Automation is not only the displacing the worker but it has the potentiality of displacing the work itself by machine. The capacity of the homo faber (man the maker) to use his intelligence for inventing and using tools is at stake. Automation requires a worker who can think of plant as a whole. His worth will be measured not in terms of his best way but on the basis of his planning, organising and continuously smooth functioning of the system. It is the team, and not the individual worker who will assume new importance. The social engineer will play his role and come into its own. All this leads to a social cost to the community as a whole which may not be easy to estimate in monetary terms.

5.7 ASSESSING THE EFFECT OF MANAGEMENT.

5.71 Normally the user manager of a computerised system is changed with the delegated authority to carry out specific
functional tasks. He has the responsibility for marshalling the resources necessary to accomplish the task in the most effective and efficient manner. The actual process through which he may develop the attitude towards the computer based information would be fairly complex dependent on a large number of situational variables, viz. management style, task responsibilities, EDP organisational capabilities and EDP planning and control systems. However, if he is able to get the desired information readily from the computerised system, then his positive attitude towards the system would be reinforced, otherwise the need for extended search for information might cause frustration and thus develop a negative attitude towards the system.

5.72 Even the benefits derived from using the information of a computer based system, in carrying out the assigned task would affect the attitude formation. The initial impact of internal pricing of computer services would produce a constraining effect on the use of computer based system. But in the long run, as the cost of using computer based system is communicated to the user manager, he develops a more balanced approach in the use of resources by bringing together the benefits and cost consequences of the system and thus develops an understanding as to how best to carryout the delegated decision tasks.

5.73 Considerable research effort has been spent in developing a system to measure these attitudes of management and relate them to the effect of internal pricing of the system. Porter has developed a subtractive approach to measure the level of dissatisfaction which has been effectively used to measure the

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perceived needs deficiency of a number of user manager in firms using computerised data system. The model used in discriminating the user attitude in relation to the set of situational variables has led to determine the ceiling on variance that the variation of user manager attitude will produce on the internal pricing system of computerised service.

5.74 An effective internal pricing system should indicate to the user, the cost consequences of their decision which in turn will motivate them to utilise their resources effectively and efficiently. The effectiveness of this internal costing system could thus offer a measure of control exercised over the employment of computer-related resources by the user management. This effectiveness of the internal pricing system has thus been perceived to be a fair system of performance evaluation of the system. Its relative maturity has been used as a measure of calibrating the system in the stage Hypothesis of Nolan R.I. to develop the four stages of S.D.P. evolution.

5.75 Further research on the subject supported by Associates of Harvard Business School, has been able to establish a relationship between the maturity of internal pricing system and the user manager attitude. The internal pricing system maturity has been defined in these studies under four different criteria viz:

(i) Understandability  (ii) Controllability
(iii) Accountability  (iv) Cost-Benefit incidence.

5.76 The inter-relationship between the four stages of growth of S.D.P. and the maturity of internal pricing system as defined above has been found to follow an structure as shown in fig. 5.76.


5.77  The relationship established as a result of research shows that at the characteristic stage IV of EDP evolution, there is a high degree of understanding amongst the user manager attitudes. The quality of understandability reduces the user manager frustration without the internal pricing system and thus promotes a positive attitude towards their computer-based information system. This shift towards the positive attitude coupled with training in EDP will give the user manager effective capabilities to exercise control over the computer-based system for which they are accountable.

5.8  SELECTION OF WEIGHTS FOR BENEFIT AND COST ASSESSMENT.

5.81  It is difficult to arrive at a true assessment of reduction in cost of data collection, or the measure of benefits achieved through increases in performance affected through reduction in dead time, or improvement of labour, at the planning stage of datamation. A computerised information system has a considerably long gestation period. In such conditions applying suitable weights, based on past decisions is found to be quite beneficial in extrapolating the past for developing the future benefits and costs as applied to a base year of assessment. A past decision approach in applying weights to the measure of benefits and costs is particularly suited for those parameters, where uncertainties of market mechanisms are found inadequate due to long gestation periods as in case of datamation.

5.82  Imposition of an explicit value judgement as suggested by Foster implied scaling down of higher incomes and scaling up of lower income to equalise their influence. Applying

Fig. 5.76

Understandability

Controllability

Accountability

Cost Benefit Incidence

Stage I (Initiation)
Stage II (Contagion)
Stage III (Control)
Stage IV (Maturity)

Attitude vs. Internal Pricing System Maturity
this approach to the problem of datamation, suggested applying
weights to the benefits and costs of the system parameters in
proportion to the overall gains and losses of the system as a
whole. The overall economic welfare achieved through a system
is the sum total effect of the gains and losses of individual
components of the system, each producing its effect on the
total system in accordance with the weight ascribed to it.
5.89 If \( \alpha_1, \alpha_2, \ldots, \alpha_n \) are the weights derived from
decision makers own judgement for the welfare functions \( R_1, R_2, \ldots, R_n \) in money values, producing utility values \( U_1, U_2, \ldots, U_n \)
then the total additive economic welfare achieved from the
system would be
\[
W = \alpha_1 U_1 + \alpha_2 U_2 + \ldots + \alpha_n U_n
\]
with the application of explicit value judgement for deter-
mining the value of weights \( \alpha_1, \alpha_2, \ldots \) etc. according to
Fosters approach would be
\[
\alpha_1 = \frac{b_1}{E_1} \quad \text{and} \quad \alpha_2 = \frac{b_2}{E_2} \quad \text{etc}
\]
where \( b_1 \) is average money value benefit achieved through the
project and \( E_1, E_2, \ldots \) are the individual money value benefits
from the respective components of the system.
5.9 APPLICATION OF COST-BENEFIT ANALYSIS TO AUTOMATION.
5.91 As already stated the aim of cost-benefit analysis was
to maximise the present value of all benefits less that of all
costs incurred subject to specified constraints. The cost-
benefit analysis could thus be employed to compare the social
costs and benefits resulting from a potential policy with
those to be expected from a continuation of existing levels of effort.

5.92 Applying this principle for evaluation of a project on datamation, it was essential first to define the life of the project and then compute the costs and benefits of alternative resource policies. These costs and benefits had to be discounted back to the base year for the purpose of comparative analysis. The rating date thus achieved could then be useful for evaluation of alternative policies under examination.

5.93 Realistic estimation of project life thus played an important role in this analysis. Factors like physical life span, technological change, shifts in demand and emergence of competing system played an important role in estimation of project life. In case of project of datamation it was advisable to consider a shorter life span of project for the following reasons:

(a) Frequent changes in requirement of data base.
(b) Rapid depreciation of computers.
(c) Obsolescence of amcurrent equipment due to technological innovations.
(d) Rapid technological and conceptual changes throughout the relatively new field of information management system.

5.94 Having correctly estimated the project life through which the costs and benefits were to be measured, it was then desirable to develop a cost-benefit model for the project by clearly identifying the costs as the input to the strategic model and benefits as its output.