CHAPTER-III
CHAPTER - III
REVIEW OF LITERATURE

3.0 INTRODUCTION:

Productivity management has been the subject of intensive study right from the inception of scientific management. The field of productivity management has grown over the years. Contributions have come from multiple disciplines.

In the competitive era of today's world productivity management is gaining paramount importance right from the day an organisation is conceived - whether smaller or large, profit or non-profit, manufacturing or services. The principle of productivity management have not remained within the theoretical boundaries of text books and journals, but such principles have cut across different types of organisations and have been translated into action, although organisations do differ in achieving their ultimate outcomes. Strategies and tactics adopted and emphasis placed in managing the multifaceted affairs of productivity do vary from place to place and time to time. The literature relating to productivity management is really very vast in terms of models and techniques. Out of the large number of reported researches, most researches are oriented towards manufacturing organisations. However, there are some application oriented studies which can provide experiential learning from real life complex organisational situations. In the following section, a review of productivity management models is presented. The content and context of the present research are then outlined.
3.1 INCONGRUENT DYNAMICS IN PERCEIVING PRODUCTIVITY:

Mohanty (1983, 1992) has amply researched on the differing perceptions of productivity. He has mentioned that economists, politicians, industrial engineers, trade union leaders, accounting professionals, organisational development specialists, industrialists, managers and entrepreneurs have used various concepts for their own independent requirements. Further he studied the different incongruent characteristics and has organised them into the following clusters for better understanding:

(i) EXPECTATIONAL INCONGRUENCY:

According to the behavioural roles played by different stakeholders in an organisation say for example, entrepreneurs, managers, workers, customers, suppliers, Government policy makers etc. the expectations from the organisational outcomes are different and have different meanings for productivity management. Entrepreneurs are primarily interested for the maximisation of the profits over their total investments. Managers make attempts to maximise the outputs through efficient utilisation of various resources. Workers, on the other hand, aspire to maximise the net earnings, while demanding for the improvement of the quality of work life and to enjoy more leisure time. Customers look for higher product reliability at lowest possible price. Government policy makers generally look for the expansion of organisations to promote employment opportunities, to regulate inflationary tendencies in the economy, to enforce safety inflationary tendencies in the economy, to enforce safety conditions, and to safeguard the security of work forces. If a real expectational analysis is carried out, one can come to the
conclusion that the behavioural roles displayed by the various stake holders bring disharmony in the productivity management systems because of non-compatible and conflicting demands on the organisation.

(II) DEFINITIONAL INCONGRUENCY:

Mohanty (1983) has outlined variety of definitions of productivity. Each definition has its own interpretation of productivity. Economists, accountants, behavioural scientists, engineers, managers, etc., define productivity relating to their own field of specialisation, but even within the same discipline, there are varying interpretations. For example, Kendrick (1965) has classified productivity in economic terms such as:

(a) Partial Productivity Ratio of gross or net output to a single factor input. This may be further classified by the type of input, e.g.:

* labour productivity
* capital productivity
* material productivity
* energy productivity

Recently, information productivity has also been added.

(b) Total Factor Productivity is a ratio of gross or net output to total labour and capital input expressed in monetary equivalents.
(c) Total Productivity is a ratio of gross or net output to total inputs including labour, capital, material, energy and others all expressed in monetary equivalents.

Mohanty (1983) has logically concluded by saying that every organisation in its evolution passes through different phases such as growth, stability, decline, or redevelopment over time. In each phase, specific activities are undertaken, the input-output relationships undergo changes and problems and constraints become different and priorities undergo revisions. For example, the developmental stage is characterised by unstability because of risks involved in the adoption of new methods and procedures. During this period, some productivity criteria are evolved. Subsequently, such productivity criteria adopted are influenced by whether the organisation faces decline, or whether an attempt is made to redevelop. Generally, short-term productivity measures become more appropriate for managerial actions rather than long-term measures; because in short-range decisions, the cause-effect relationships are more certain and predictable, and there is less argument about which of the specific variables should be valued or controlled over the limited time horizon.

(III) VALUATIONAL INCONGRUENCY:

Apart from the differences existing between different type of organisations, there are also differences in ways of working within the same organisation. Such methods and procedures adopted may effect final outcomes. Some of the important issues according to Mohanty (1992) that complicates in defining productivity are:

* how to deal with different types of inputs and outputs
how to recognise qualitative changes in inputs

how to keep input and output measurement unbiased and independent.

how to aggregate the diversified outputs of the organisation.

Further, there exists confusion in measuring indirect costs and intangible outputs and there have been controversies over the base-period selection to be used for comparison in future years. Rao (1993) describes how to generate and use the optimal base period values pertaining to the inputs and outputs of a measuring system. But he admits that the design and development of an accurate and appropriate base period data depends largely on a more realistic set of constraints.

3.2 MACRO AND MICRO LEVEL PRODUCTIVITY MANAGEMENT:

(I) MACRO LEVEL PRODUCTIVITY MANAGEMENT:

At international level, productivity measurement models are directed towards developing measures or indices for comparison of the growth and competitive position of competing countries in domestic and international markets. Most research at macro level is contributed by economists; prominent among these are Rostas (1955), Shelton and Chandler (1963), The Bureau of Labour Statistics (1960) and Bergson (1968). At national level, productivity measurement models have been used to develop economic indicators that enable a country to plant its resources on a rational basis. Thus, planning of national resources includes the allocation of man power, materials and money resources to various sectors of the national economy. A labour productivity index has been the chief measure used to compare the
performance of various sectors of industry. Contributions have been made in this area by the Bureau of Labour Statistic (1960), Kendrick (1961), Denison (1967) and Fabricant (1940).

(II) MICRO LEVEL PRODUCTIVITY MANAGEMENT:

At sectoral level, the main emphasis has been on the development of measures which assist sectoral performance comparison, planning of man power requirements and the prediction of growth patterns. Measurement models vary with the type of sector. For example, separate models have been proposed for manufacturing, service and agricultural sectors. Some major contributions here are by Mill (1932), Magdoff (1939), The Bureau of Labour Statistics (1960), Kendrick and Creamer (1965) Fuchs (1969), Hall and Knapp (1961), Legris (1971), Tomazinis (1955), Dacy (1964), Yoshihare et al (1977), Baker (1972) & Gray (1992). These works have general relevance and are applicable to manufacturing, commercial banking, Warehouse operation, transportation services, defence, etc.

Many researchers have made contribution towards organisational productivity measurement. The main emphasis in this area has been to develop measures which will enable companies to plan their resources efficiently, to measure trends in productivity improvements and sometimes to compare themselves with other companies in the same sector. Unlike the international, national and sectoral levels, at the organisational levels; accountants, managers and engineers have also developed measures and models of productivity measurement, in addition to the economists. Therefore, there is more variety of models reported at organisational level. Some of the pioneering contributors are Kendrick (1961), Mundel (1976), Mali (1978),
Sink (1985) has advocated that the following set of measures only can reflect the overall performance of an organisation. He has also defined the following measures like,

(i) Productivity
(ii) Effectiveness
(iii) Efficiency
(iv) Quality
(v) Profitability
(vi) Quality of work life
(vii) Innovation

Peter and Waterman (1982) have also outlined many criteria for judging organisational excellence. Mail (1978) and Sumanth (1984) have shown that productivity is any way related to other two very important performance measures namely:

\[
\text{EFFECTIVENESS and EFFICIENCY as } \\
\text{Productivity = Function (Effectiveness) / Function (Efficiency)}
\]
Therefore, controlling and improving productivity indirectly achieves higher and better performance over for other important performance measures. Besides, productivity is relatively easier to measure, monitor and control unlike other performances like effectiveness, quality of work life, innovation, etc. Still, it has been observed that most of the organisations even today do not have any formal Productivity Management programme.

In the following paragraphs, the various aspects of productivity management are discussed.

3.2.1 PRODUCTIVITY MANAGEMENT CYCLE:

Sumanth (1984), has outlined that the Productivity Management cycle consists of the following four phases:
(a) Productivity measurement and evaluation
(b) Productivity planning
(c) Productivity improvement through interventions and control.
(d) Measuring and evaluating the impact of these interventions.

Fig 3.1 depicts such a cycle. At any given point of time, an organisation may be involved in any one of the above four phases. It may be preferable for an organisation who wishes to launch the formal productivity management programme for the first time in its life, however, to begin with the productivity measurement phase.
FIG. 3.1 PRODUCTIVITY MANAGEMENT CYCLE
Following this particular cycle the literature on productivity management can be classified into two classes. One of the classes is related to the productivity measurement and evaluation and the other is related to the productivity planning and improvement. A large number of models are reported in the areas of productivity measurement and evaluation. Relatively very few models are reported in the areas of productivity planning and improvement. Following is the brief review of the models reported in literature in each class.

3.2.2. A REVIEW OF PRODUCTIVITY MEASUREMENT AND EVALUATION MODELS:

As stated above, among the numerous models reported in the literature, the major ones are basically productivity measurement and evaluation models. The prominent among them are Kendrick and Creamer (1965), Craig and Harris (1973), Hines (1976), Mundel (1976), Gold (1976), Taylor and Davis (1977), Aggarwal (1979), Roll and Sachish (1980), American productivity center (1981), Sumanth (1979), Riggs (1983), Sink (1985). A detailed review of these measurement models has been reported already by Mohanty (1992). He has classified and compared all the available models according to the following criteria:

(1) Type of Index used:
   - Partial Productivity Measure (PPM)
   - Total Factor Productivity Measure (TFPM)
   - Total Productivity Measure (TPM)

(2) Type of Output used:
(a) Gross Output:
- Deflated against price variation
- Weighted output concept
- Type of output considered

(b) Net Output:
- Value added concept
- Income originating concept
- Others

(3) Type of input used:

(a) Labour Input
- Man-hours
- Weighted concept (SKILL, QUALITY OF LABOUR)
- Total expenditure
- Others

(b) Capital Input
- Annual cost method
- Leasing method
- Book value method

(c) Material Input
Special features of the models:

These models basically measure the productivity in some form of ratio or the other and can also evaluate these from one period to another. Generally, these models do establish some basis for providing for improving productive performance.

3.2.3 A REVIEW OF PRODUCTIVITY PLANNING AND IMPROVEMENT MODELS:

The models reported under productivity planning and improvement categories may further be classified into two broad classes, namely (I) Descriptive Models and (II) Quantitative Models.

(I) REVIEW OF DESCRIPTIVE MODELS

Although there are a number of descriptive models reported for productivity improvement. The most referred models do belong to Sumanth (1984), Goodwin (1968), Sutermeister (1976), Cotton (1976), Aggarwal (1979), Schermerhorn (1984), Sink (1985), Edosomwan (1986) and Armstrong (1991), etc. Goodwin (1968) emphasised that improvement must be managed in a deliberate manner and he called it improvement management. He has presented a conceptual framework consisting of the Art (Philosophy, Human consideration like participation, Communications, etc.), the Science (Tools and Techniques generally related to Industrial Engineering, like Method Study, Plant Layout and Materials Handling, Value Engineering, etc.). In his descriptive model, he has emphasised that people are the most important asset and their attitudes and motivational drives are the major factors in any successful business.
Sutermeister (1976) has explained the inter-relationship between factors affecting worker productivity. His model is a series of concentric circles around productivity. The factors influencing productivity are arranged in such a way that the one closer to the center have more direct affect on productivity than the one further from center. He identifies two major categories of factors influencing workmen productivity namely, Technological development and Employee motivation.

Cotton (1976) recognises the importance of productivity planning & suggests a three step procedure (a) Develop an effective planning process & structure in the organisation. (b) Prepare productivity goals and permeate the planning process with specific objectives based on these goals. (c) Establish productivity surveillance, assistance & co-ordination in a manner tailored to the organisation's need. Cotton points out that there is bound to be a point when the productivity level reaches a peak and then starts to decline or saturates unless action is deliberately taken to maintain the growth rate.

Aggarwal (1979) has proposed a step by step descriptive procedure to productivity improvement in companies, based on 27 published case studies. The procedure can be summarised as:

(a) Identify and prioritise the objectives of the organisation;

(b) Delineate criteria for outputs within organisational limitations;

(c) Prepare action plan;

(d) Eliminate known barrier to productivity;
(e) Develop productivity measure and decide base period;
(f) Execute action plan and start measurement and reporting;
(g) Motivate workers and supervisors to achieve higher productivity;
(h) Maintain momentum of productivity efforts;
(i) Keep auditing the organisational climate.

Schermerhorn (1984) visualises the productivity planning - as problem solving and listed of a series of steps as follows:

(a) Define your objective
(b) Determine where you stand relative to the objective
(c) Develop your premises regarding future conditions
(d) Identify and choose among alternative courses of action
(e) Implement the plan & evaluate results.

Sink (1985) has suggested A practical Eight Steps Productivity Management Programme Planning Process. It can be summarised as:

(1) Strategic and tactical planning awareness for the organisation and affected groups;
(2) Internal strategic audit (looking within);
(3) External strategic audit (looking around);
(4) Planning premises, assumptions, importance;
(5) Strategic planning - 2 to 5 years goals and objectives for productivity programme;

(6) Prioritisation and consensus of performance objectives in key result areas of productivity programme;

(7) Identification, prioritisation and consensus of strategical, tactical and operational action programme;

(8) Programme Planning and resource allocation;

(9) Programme evaluation, review and maintenance.

Edosomwan (1986) came out with another conceptual framework for Productivity Planning as an extension of Sink's model (1985) above. He stated that comprehensive productivity planning is the process by which all factors affecting the organisation are considered in formulating its goals and objectives, assessing its capabilities and capacities, designing alternatives courses of action for the purpose of achieving these goals and objectives, initiating necessary actions for their implementation and evaluating the effectiveness of the plan. Comprehensive Productivity Planning has dimensions such as TIME (short, medium, long range) ORGANISATIONAL IDENTIFICATION (production, planning, personal planning, etc.) ORIENTATION (internal, external) and SCOPE OF THE PLAN (all factors considered or few factors considered). This approach also seems logical but primarily is descriptive in nature and is yet to be tested intensively for its strength.

Armstrong (1991) through a quantitative critique of 28 studies concludes that formal planning is valuable for firms but he agrees with Greenley (1986) that it is important to define better the
conditions under which formal planning is useful. He lays importance to study what planning techniques are useful and how the techniques should be matched to the situation, because many concerns persist regarding the shortcomings of planning practice. Madu (1994) has discussed in his paper how total productivity management (TPM) could be applied to improve the effectiveness of a maintenance float system. He has suggested that Analytic hierarchy process (AHP) could be applied with simulation meta models to obtain an "optimal" solution to the system.

Development of quantitative models for productivity planning and improvement are of recent origin.

These are described and reviewed in the next section.

(II) REVIEW OF QUANTITATIVE MODELS:

Mathematical models for productivity planning and improvement are reported during the last decade. The prominent ones are due to Sumanth (1984), Mo (1985) and Hawaleshka and Mohamed (1986, 1987). The models and their strengths and limitations are discussed below:

Sumanth (1984) has developed a "Total Productivity Maximisation Model" and briefly can be presented as:

Max: $T_{php} = \frac{Q}{l}$ \hspace{1cm} (3.2)

Subject to: $l = f(Q)$ \hspace{1cm} (3.3)

$l, Q > 0$ \hspace{1cm} (3.4)

where,
\[ T_{p_{ph}} = \text{Total Productivity(Physical)} \]

\[ Q = \text{Quantity produced} \]

\[ I = \text{Total constant dollar tangible input in base period terms.} \]

\[ f = \text{functional form.} \]

Four functional forms of input, namely, Linear, Exponential, Quadratic and Cubic are considered in the analysis. The solution methodology suggested is to plot \( T_{p_{ph}} \) in certain feasible range of \( Q \) (from \( Q_{min} \) to \( Q_{max} \)) and to read the value of \( Q \) which provides the highest value of \( TP_{ph} \) from the curve. If such a value is \( Q^* \), then the company should operate at \( Q = Q^* \) and should decide input required \( I^* \) at this \( Q^* \) from the relationship. The company can plan to operate at \( Q^* \) and \( I^* \) to achieve \( TP_{ph} \) close to maximum \( TP_{ph} \).

This model does not isolate the inputs (material, labour capital and energy, etc.) and does not indicate how these inputs should be planned separately for resource allocations in order to maximise total productivity measures. The model also does not consider external (like market demand, extent of import, etc.) or internal (hiring/firing of man power, capital available, etc.) constraints.

Mo (1985) has suggested two mathematical models:

(1) Productivity maximisation model

(2) Productivity attainment model
(1) PRODUCTIVITY MAXIMISATION MODEL:

Minimise: \( Z = SX \) \hspace{1cm} (3.5)

Subject to:
\[ AX \leq b \] \hspace{1cm} (3.6)
\[ fX \geq Y_T \] \hspace{1cm} (3.7)
\[ X \geq 0 \] \hspace{1cm} (3.8)

where,

\( X = (n \times 1) \) column vector of all \( n \) inputs
\( S = (1 \times n) \) row vector of cost shares of input vector.
\( A = (m \times n) \) matrix containing all technological constraints.
\( f = (1 \times n) \) row vector containing information related to production requirement.
\( Y_T = \) demand (output) at time \( T \).

A linear program is used to solve the problem.
PRODUCTIVITY ATTAINMENT MODEL:

Productivity Attainment Model is stated in two forms, the first being similar to the one stated above with an additional constraint.

\[ SX \leq \frac{(K, Y_t)}{(1+r)}, \text{ where, } K=1/TPM_{t-1} \]  

(3.9)

representing minimum productivity growth as r% previous time period.

Another productivity attainment model is in the form of Goal programming where attempt is made to minimise deviations from goals stated in a given priority. The problem is formulated as,

Minimise \[ Z = \sum P_k (W_{ik} d_i + W_{ik} d_i) \]  

(3.10)

subject to \[ \sum a_{ij} x_i + d_i - d_i = b_i \text{ (Technical Constraint)} \]  

(3.11)

\[ \sum f_j x_i + d_{m+1} - d_{m+1} = Y_t \text{ (Production Constraint)} \]  

(3.12)

\[ \sum S_j x_i + d_{m+2} - d_{m+2} = (K, Y_t) (1+r) \text{ (Productivity Attainment Constraint)} \]  

(3.13)

\[ x_i, d_i, d_i \geq 0 \]

Where,

\( P_k \) is priority level assigned to goal \( K \)

\( W_{ik}, W_{ik} \) are numerical weights assigned to devotional variables of \( i \)th goal at given priority \( K \).
d,, d, are 've' and '+'ve' devotional variables of i\textsuperscript{th} goals;

\( a_{ij} \) is technological coefficient of \( X_i \) in \( i^{th} \) goal;

\( b \) is \( i^{th} \) goal level; and

\( K, Y_T, S_i \) and \( r \), as defined earlier.

Some of the weaknesses that can be observed in such models are that the technological coefficient and production function or production requirements are not considered explicitly as may be applied to real-life industrial situations. Moreover, these models are explained with very simple examples.

Hawaleshka and Mohammed (1986, 1987) have proposed two mathematical models for planning and improvement of total productivity. In the first model, they have maximised TPM (Total Productivity Measure) subject to man power capacity and constraints, etc. The model can be briefly stated as:

\[
\text{Maximise TPM}_i = \frac{K}{\sum_{j=1}^{J} \sum_{k=1}^{L} X_{jk}} \sum_{k=1}^{K} Y_{k,t}^2
\]

(3.14)

Where \( y_{kt} = k^{th} \) type of Output at time t

\( x_{jt} \) = amount of input consumed during time t from group j

\( j = 1 \) for Man power

\( j = 2 \) for Capital

\( j = 3 \) for Materials & Supplies

\( j = 4 \) for Energy
j = 5 for other cost

Such that following constraints are met:

1. Productivity growth:
\[
\Sigma \Sigma x_{jit} (TPM)_{(i-1)} - Y_{it} \leq 0
\]  
(3.15)

2. Man power:
\[
(1-\alpha) X_{1it-1} \geq X_{1it} \geq (1+d) X_{1it-1}
\]  
(3.16)

3. Capacity constraints:
\[
\Sigma Y_{it} \leq C
\]  
(3.17)

4. Output growth:
\[
Y_{it} \geq Y_{it-1}
\]  
(3.18)

5. Capital consumption:
\[
X_{2it} \leq X_{2it-1} \text{ for all } 1's
\]  
(3.19)

6. Material consumption
\[
X_{2rs} \leq X_{3it} \leq X_{3it-1} \text{ for all } 1's
\]  
(3.20)

7. Energy constraints:
\[
X_{4its} \leq X_{4it} \leq X_{4it-1} \text{ for all } 1's
\]  
(3.21)

\(X_{3its}\) and \(X_{4its}\) are the standard material and energy consumption for output \(Y_i\). They have then solved this problem using Linear Fractional Programming, to find out the level of \(Y_{kt}'s\).
and $X_n$, to maximise TPM. This model considers many constraints like Man power, Capacity, Capital and Material Consumption realistically. However, it ignores a very important relationship between inputs and outputs of the organisation. It treats inputs and outputs as independent variables, which belittles the value of the model for real life problems. Moreover, they have assumed that TPM for next time period is always more than the previous period, which may not be possible due to internal or external factors.

In another model Hawaleshka and Mohamed (1986), did consider a relationship between inputs (only labour and capital) and output using a Cobb-Douglas production function but they have ignored, in that model all the internal and external constraints. They have also ignored other important input such as Material Supply and Energy in that model.

TOTAL PRODUCTIVITY OPTIMISATION MODEL:

The model proposed by Rastogi and Mohanty (1994) is based on the basic proposition that total productivity optimisation is a strategic management process requiring the appropriate selection of an optimal strategy. The selection criterion may be governed by the dynamics of the situation in which the strategies are being formulated. Normally selection of strategies will be influenced by the external environment (like market demand, market competition) and internal factors (like availability of various resources, technological constraints etc.). We envisage that an organization evolving in its milieu over a given planning horizon may require any of the following strategies (Rastogi 1992):
- Cost reduction oriented
- Technical efficiency oriented
- Management effectiveness oriented

Each strategy has its own basic governing principles and requires the understanding of various complexities and non-linearities involved with several variables, both internal and external.

The external environmental factors like total market demand, technology, competition etc., affect the organisational productivity to a great extent. Since the organisation as a system has practically no control over these environmental factors, it is only influenced by them, the best it can do is to review the opportunities and threats from the environmental factors and select the right strategy for productivity improvement for the organisation.

The authors have tried to formulate four nonlinear optimization models for the above mentioned four strategies. They have tried to demonstrate their use for a real-life continuous production process plant in order to derive some meaningful conclusions regarding total productivity optimization of this company, taking into account external factors as well as internal factors. The following sections describe these four strategies and the models, and also the implications of application of these models to the case example.
TOTAL PRODUCTIVITY OPTIMISATION : FORMULATION OF STRATEGIES

To optimise the total productivity of an organisation, it can be considered the optimisation process to pursue in four possible directions (FIG.-3.2).
FIG. 3.2 STRATEGIES FOR TOTAL PRODUCTIVITY OPTIMISATION.
(1) Maximisation of organisational overall growth.

(2) Minimisation of inputs (through cost reduction).

(3) Maximisation of technical efficiency.

(4) Maximisation of organisational effectiveness.

(I) Overall growth oriented strategy

This strategy looks for the overall significant growth by enhancing outputs as much as possible, even if it calls for additional input. This strategy may be suitable in an environment, where the market position is very comfortable, e.g. there is a growing demand for the product, socio-economic conditions are favourable and there is not much competition in the market. Whatever is produced, is easily sold, even at a slightly higher price.

(II) Cost reduction oriented strategy

This strategy directs the management to significantly decrease the gross inputs (reduce the gross input cost) of the organisation, even at the expense of marginally reducing the gross output. This strategy may be suitable where there is tough competition in the market and any increase in the price has an unfavorable response in the market; where there are many manufacturers in the market and product demand is limited; where a manufacturer has to win over a demand on the basis of lower price, but still wants to achieve reasonable profitability, even at the expense of marginally reducing total production.
(III) Technical efficiency oriented strategy

This strategy focuses upon the efforts of management to reduce the gross total inputs consumed by an organisation through improved efficiency, utilisation, allocation or deployment, without reducing the total outputs from the existing level. This strategy may be suitable in such situations, higher productivity and higher profitability can be achieved by reducing the total input costs without sacrificing the level of output.

(IV) Organisational effectiveness oriented strategy

This strategy aims at enhancing the gross total outputs of the organisation without spending extra inputs in any form. Although the gross total inputs are to be maintained at the existing level, redeployment/reallocation/substitution within a given class of input or inputs is possible. This strategy may be suitable in an environment where improved socio-economic conditions are resulting in the improved market demand, but competition in the market prohibits increase in the prices.

The effect of external environment on the selection of the most suitable strategy for optimising productivity can also be represented (in terms of two important external factors, namely, market demand and competition) as a four-window diagram, shown in FIG.3.3.

It can be seen that the selection of a suitable total productivity optimization strategy is also influenced by external or environmental factors which are generally beyond the control of management.
Internal factors

The relationship between total output and individual input parameters, which depends upon the technologies, processes and production system adopted by the organisation, the internal production function, i.e. the relationship between the gross output of the company and the various controllable input decision variables like man hours etc., can take various forms, e.g. linear, exponential or polynomial.

One popular and meaningful form of this function is the Cobb-Douglas type of production function as also suggested by Japan Productivity Center (1984) and Johansen (1972), i.e.

\[ T_o = a_0 X_1^{a_1} X_2^{a_2} \ldots \ldots \ldots \ldots X_n^{a_n} \] (3.22)

or

\[ T_o = a_o \prod X_i^{a_i} \] (3.23)

Such that,

\[ X_i \text{ min} \leq X_i \leq X_i \text{ max} \] (3.24)
FIG. 3.3 SUITABLE PRODUCTIVITY OPTIMIZATION STRATEGIES UNDER DIFFERENT ENVIRONMENTAL FACTORS

Where $T_o = \text{Total gross output (in physical or financial terms)}$

$X_i = \text{ith independent controllable input variable}$

$a_i = \text{elasticity with respect to } X_i$

$a_o = \text{constant}$

$X_i \text{ max., } X_i \text{ min} = \text{maximum and minimum values of } X_i, \text{ within which relationship is valid.}$

Moreover, there may be restrictions (upper and lower bounds) within which these input decision variables $X_i$, can be considered to be varied by the management in the next planning period. For example, number of men to be hired or fired during a certain planning period will depend also upon the management-workers relationship.
Similar to the relationship between total output and individual input variables $X_i$, the total input cost of the organisation can also take a particular form of function, depending upon the individual nature of the company. One popular form of such a relationship is linear, based on the common accounting method followed in most industries, i.e.

$$T_I = b_0 + \Sigma b_i x_i \quad (3.25)$$

Where $T_I =$ Total gross input cost (in financial terms)

$b_i =$ Parameter to convert ith variable into cost

$b_0 =$ Constant (fixed cost).

Thus variation of these factors will also influence the selection of the strategy. For different complexities and non linearities involved within several variables due to internal factors of the organisation, different total productivity optimisation strategies may be appropriate.

3.3 RELATIONSHIP BETWEEN PROFITABILITY AND PRODUCTIVITY:

In an organisation, many have the common belief that productivity improvement can enhance the financial performance of the company. Many researchers, like Craig and Harris (1973), Taylor and Davis (1977), Sumanth (1980, 1987) have also advocated for increasing productivity to improve financial performance. However, there is little empirical study available in literature which favours or rejects this hypothesis. Some
researchers are reported by Brayton (1985), Taussing and Shaw (1985), Harl and Bresses (1984) and Mohanty and Rastogi (1988). Brayton (1985) Taussing and Shaw (1985) have explained the link between productivity and profitability for a single specific company have recommended more researches to establish this relationship. Harl and Bresses (1984), on the other hand have explored this relationship for some industrial sectors in USA and Mohanty and Rastogi (1988) have studied this relationship for some industrial sector in India and have observed that productivity changes have positive effect on profitability but there exists significant amount of variances. Sink and Swain (1983) and Miller (1984) have suggested an interesting link between profitability and productivity of an organisation through a concept of Price Recovery Factor, which is explained in details in the next section.

3.3.1 MONITORING OF PROFITABILITY THROUGH PHYSICAL PRODUCTIVITY MEASURES:

Miller (1984) has tried to explain the relationship between profitability and productivity through a cause-effect type of diagram. This diagram indicates that growth (or shortfall) of profitability of an organisation can be effected by two clearly identifiable factors. One is the physical productivity contribution accounting for the impact of change in physical productivity on direct labour productivity, material productivity, plant and equipment productivity, energy productivity and productivity of other physical resources and some other management factors like product-mix etc. The second is purely in terms of financial factors, accounting the impact of changes in sales prices to offset
the effect of inflation rates on direct labour rate, raw materials prices, energy prices, and other prices. He has suggested the relationship in terms of the following equation:

\[
\text{PROFITABILITY} = \text{PHYSICAL PRODUCTIVITY} + \text{PRICE RECOVERY FACTOR}
\]

(3.26)

In this equation, the changes in profitability have been explained through physical and financial price recovery factor (PRF) through additive relationship. Swain and Sink (1983), on the other side, have enunciated a multiplicative relationship, namely:

\[
\text{PROFITABILITY} = \text{PRODUCTIVITY} \times \text{PRICE RECOVERY FACTOR}
\]

(3.27)

But both Swain and Sink (1983) and Miller (1984) have tried to explain that an organisation can generate profit growth from both productivity improvement and also from price recovery. Price recovery relates to the changes in output prices in response to changes in input costs and thus accounts for the inflation. In other words, price recovery is the degree to which input cost increases are passed on the customers. However, we feel that PRF is not only related to inflation but also to many other external parameters such as market structure, competitiveness of the firm, fiscal and monetary policies of the Government etc. Many of these parameters are not under the control of the organisations, and organisations do not have much choice to influence PRF on many occasions.
3.3.2. NEED FOR CONTROL THROUGH PHYSICAL PRODUCTIVITY MEASURES:

Extending the recommendations of Swain and Sink (1983) and Miller (1984), it can be said that the profitability of the organisation can be influenced favourably both by improving physical productivity as well as by modifying the price recovery factor. But, since price recovery factor is not within the control of management in most situations, as also explained in the section above, it is the physical productivity that is more within the control of management. Therefore, even to influence the profitability of the organisation, the organisation should focus their efforts more on improving their physical productivity. Besides this, it is felt that productivity improvement strategies are geared towards long-term goals. Keeping these viewpoints in mind, the focus of this research study has been oriented towards on the physical productivity planning and improvement rather than on PRF and financial factors. Another focus has been kept on the utility of various productivity management models to the decision makers and practitioners. Following section gives the focus of this research in more specific terms.

3.4 DEFICIENCIES IN THE CONTEMPORARY LITERATURE:

A critical look into all the models described in the earlier sections leads us to identify the following deficiencies
(i) Lack of strategy support
(ii) Lack of total system intervention
(iii) Lack of integration between total productivity and total quality.
STRATEGY SUPPORT:

Total productivity management should be considered as a set of strategy rather than a set of models. Many of the methods and models have provided decision support to executives but have not provided strategy support. Not a single paper in the literature provide for an effective assessment of strategic productivity improvement proposals. We conceptualise that the process of strategy support development should be as per FIG. 3.4. According to us a strategy support model is intended to influence managerial action in a company. Managers must be the primary architects of productivity improvement strategy.

TOTAL SYSTEM INTERVENTION: (T.S.I.)

It is an approach to problem solving for any organisation. It centers around holistic intent of systems thinking and helps in the task of making best use of methods and models. According to this approach, total productivity management can be viewed as a set of productivity improvement problems. In the productivity literature although total productivity has been viewed from the angle of measurement and evaluation but has never been viewed as a whole system of management. According to Flood (1995), the total system view has six stages of construction. They are as follows:

(i) An organisation comprises of technical and human activities. Interactions in organisations are represented in terms of an interactive mixture of technical and human activities.
FIG. 3.4  AN ANALOGY BETWEEN DECISION SUPPORT AND STRATEGY SUPPORT
(ii) Activities of an organisation must be efficiently and effectively controlled whilst maintaining viability in the organisation. Activities are controlled by technical procedures, and socio-cultural and socio-political rules and practices. Procedures, rules and practices must be attuned so that viability can be achieved. Environmental factors may also be influenced or controlled.

(iii) Activities of an organisation must be directed to achieve some purpose. An organisation will normally have an officially declared mission to which these activities are ideally directed.

(iv) People in organisations appreciate (i) to (iii) above in different ways. Individuals and groups naturally make their own interpretations of the interacting activities, the way activities are controlled, and the organisation's purpose. They hold a view of their own role and purpose in the organisation which can cause conflict, a lack of cohesion, inefficiency, ineffectiveness, rigidity and non-viability in the organisation.

(v) (iii) and (iv) above must be harmonised through organisational design and management style. An organisational design and management style must be chosen that balance people's needs with the organisation's needs, remembering that the organisation's needs also reflect the business organisational context.
(vi) The whole organisational effort must accept responsibility for the impact of policies on the biological and social environments.

When applied to organisational ‘problem solving’ actually means managing sets of interacting issues. Issues to be managed arise from the interaction of technical and human activities, how they are controlled, interaction of the organisation with the environment, the organisation’s mission, organisational design and management style, and people’s interpretations of all of these. ‘Problem solving’ is a particular type of human activity that is, by definition, a part of the interacting activities. An organisation, then, can be understood in terms of interacting issues and ‘problem solving’, or intervention, as being part of a continuous process of managing these issues (which is a part of the interacting activities).

Intervention, accordingly, will go something like this. Issues are ‘surfaced’ through creative analysis. By undertaking careful reasoning, an approach most suitable to tackle the issues is chosen. Change proposals to manage the issues are worked out using the chosen approach. Implementation of change proposals takes place. Some issues are dealt with purposefully and directly, some purposefully but indirectly, whilst others are surprisingly impacted on as a result of counter-intuitive activities (i.e. things that occur counter to our intuitive sense). New issues arise as a further consequence of intervention. The organisation as described as a set of interacting issues changes and reformulated intervention directed at these issues takes place. Intervention is therefore a continuous process of managing organisational issues
throughout the whole organisation, taking into account wider concerns.

TOTAL PRODUCTIVITY AND TOTAL QUALITY:

Competitiveness of organisation in today's world is centering around Total Quality Management (TQM) and Total productivity Management (TPM).

According to Mohanty (1997) quality and productivity improvements lead to creation of more value. The objective of improvement in productivity is the maximisation of utilisation of resources. Such an objective is to be pursued mainly in two strategic directions; namely, Total Cost Management and Total Capacity Management. Eventually, these two strategies are interrelated, cost per unit of output decreases while more output can be produced during the same time. Similarly, improvement in quality is to be pursued by taking several strategic initiatives in the functional domains of design, procurements, manufacturing and delivery etc. The ultimate objective is to minimise the total cost. Increased profitability due to reduced unit cost and production of more outputs can help to reduce the price. Better quality and a lower price keep the customers satisfied which help in sustaining the market share and penetrating into the new markets. A sustainable position in the market provides values to the various stakeholders on a continuous basis and induces motivation for evolving innovative strategies.

The current literature does not consider the integration of Total Quality Management (TQM) and Total productivity
Management (TPM). Therefore, there is a scope of further research to consider the three above mentioned aspects of total productivity management.
3.5 FOCUS OF THE PRESENT RESEARCH:

Historically, productivity management theories and paradigms have evolved from the western countries with the paramount objective centered around improving labour productivity. These theories and methodologies have been amply researched over the last several decades. Productivity management has evolved over the years to emancipate and accommodate the other input factors of production. Total factor productivity and total productivity have been focused by researchers, which have shown new directions for recognising resources. While this; growing maturity and diversity may be accepted as a sound foundation for research, in practice many of the models have led to disagreements and to fragmentation. The debate in real-life is rooted not on which method is the best, rather than the best use of the methods. From a system viewpoints, this breaks with the original holistic intent of investigation, which is to unify things and apply them. In our opinion, Total Productivity Management is an approach towards "problem solving" for any organisation - profit or non-profit, production or service. Total Productivity Management assumes here that all problem solving activities can be organised and operated successfully as an edifying system. According to us, we view the total productivity management as a process that can enable managers to employ a spread of methods, first by creatively surfacing issues of an organisation and then constructing and choosing suitable models to tackle those issues effectively. Selection of an appropriate method depends upon the knowledge of, strengths and weaknesses of each method. The main aim of this thesis is to understand Total Productivity
Management as a practical problem solving process rather than justifying through theoretical debates.

The principles that we enunciate in this thesis relate to organisational problem solving through Total Productivity Management:

1. The organisation comprises of an integration of human and technical subsystems.
2. Each subsystem has horizontal and vertical interconnections.
3. Activities of the organisation are mission-driven and that
4. Mission is in pursuance of total productivity.

3.6. SUMMARY & CONCLUDING OVERVIEW:

There are very few productivity models reported in the literature pertaining to productivity planning and improvement. Out of the reported models, most are descriptive models. There are very few quantitative models for productivity planning and improvement. The few models available also are not very useful to management to plan and select strategies for productivity planning and improvement in real-life situations. There is a great need to develop quantitative models which can facilitate top management in productivity planning and improvement. The objective of this research is to provide some mathematical, optimisation, statistical and productivity audit models which can provide some managerial guidelines at all levels of an organisation.