MEASUREMENT OF VARIABLES
CHAPTER - 3
MEASUREMENT OF VARIABLES

3.1. INTRODUCTION

Productivity is the relationship between output and input in the production process. Normally, there are three basic concepts of productivity viz. partial productivity, total factor productivity and total productivity. To analyse and interpret the productivity, it is necessary to review the concepts and measurement of productivity. Against this background, in this chapter, it is proposed to examine the conceptual and measurement issues involved in transportation productivity. For an orderly discussion, this chapter is divided into three sections. Section I deals with the issues involved in the measurement of output and inputs, whereas Section II highlights the measurement of productivity. Section III highlights the measurement of variables used as determinants of productivity in this study.

SECTION-I
MEASUREMENT OF OUTPUT AND INPUT

The operational content of the partial productivity and total factor productivity ratios depend on the meaning attached to the output and input variables used for the computation of these ratios. Hence, it is a pre-requisite to discuss clearly the measurement of each variable either in financial terms or physical terms for the measurement of productivity under this study.

The economists Kendrick (1961) and Salter (1966) made studies of productivity change by drawing attention to the productivity ratio of output per unit of labour input in terms of either man years or man hours. Such productivity ratios measuring the personal efficiency of labour are disposed of at an early
stage in their work and at a later stage of analysis Kendrick uses the more general ratio of output per unit of combined labour and capital input. It is necessary to understand that the volume of net output (gross value added) depends upon the quantities of factor input of labour and capital employed, the state of technology, the capacity of operations, the manner in which the factors are utilised, the degree of capacity utilisation and efficiency with which the entire production process is organised over time in relation to changes in total demand, competition, relative factor prices, technical knowledge, organisational practice and external factors of various kind. External factors include Government policies and institutional mechanisms, political, social and economic conditions, the business climate, the availability of finance, power, water, transport, communications and raw materials. In this context it seems logical to explain the types of variables to measure various types of productivity studies.

The types of variables used to measure productivity have been presented in Figure 3.1.

It is seen from the chart that variables used are grouped into output variables and input variables. The output variables may be considered either as gross output or net output. The input variables may be labour, capital or material input. Further, the material input variable may be grouped into fuel input and tyre input.

3.2. CONCEPT OF OUTPUT

The concept of output used to measure productivity may be either gross output or net output. The gross output is denoted as sales (i.e. traffic revenue in case of passenger transport undertakings) in real term, whereas net output is termed as value added (sales minus cost of intermediate inputs) in real term. The intermediate inputs are purchased goods and services from outside concerns.
CHART 3.1.

INPUT AND OUTPUT VARIABLES

Variables

Output variables

Gross output

Net output

Input variables

Labour input

Capital input

Material input

Fuel input

Tyre input

Source: Compiled
Although at the macro level, value added concept is appropriate, at the micro level of an enterprise like transport undertakings, both gross output and value added may be considered. If one is interested in measuring income generated within the industry, the choice falls on value added concept. Studies dealing with productivity evaluation often consider value added concept.

Value added is a valid performance and can be used in the same way as profit to evaluate company performance. It is a basic method to measure, because it indicates the net output or wealth created by the concern from its operations by its own employees. If a concern fails to generate wealth, it can’t survive and grow. A concern can exist without making profit, but not without generating value. The concern not making profit may be deemed as ill, but the one, not adding value may be regarded as an evil. It may be stated that the figures of value added are more important to measure, evaluate and judge the efficiency of a concern than the figures of profit because it excludes those costs over which the concern has either no control or at best, a little control. Thus, all the items included in the value added statement, viz. employees cost, and cost of infrastructure facilities, cost of capital, dividend and depreciation on fixed assets can be controlled to a large extent.

The term value added refers to excess of turnover plus income from services over the cost of bought-in-goods and services. Value added represents contribution made by an organisation over and above the value of material and services it purchases. It can be mainly increased either by increasing production, reducing material costs or increasing selling price in the manufacturing concern. On the other hand, in transport undertakings, it can be increased either by increasing passenger kilometre, reducing material costs or increasing ticket fare. The sum total of contribution made by all economic sectors of a nation constitutes gross national product, which serves as a useful indicator for measuring national income.
In recent years, there has been considerable interest shown in the use of "value added" as an alternative or additional approach to measure the efficiency of an undertaking. The concept of value added has gained additional currency after the publication of "The Corporate Report" by the Accounting Standard Committee, London in 1975. It is commonly believed that a concern not generating profit is sick, while a concern not generating value is an evil to the society.

The adoption of value added concept in state road passenger transport sector is supported by many earlier studies. Deakin and Seward (1969) used this concept as a measure of output in their study on productivity in transport. Venkateswaralu (1984) used this concept in measuring productivity in Air Transport Industry. Further, Misra and Misra (1990), Pathak (1990), Srinivasan and Mohan (1992), Krishna (1995), and Bhuvaneshwari (1998) used the value added concept in evaluating the performance of STUs in India.

Both gross concept and net concept are used as output to measure productivity in this study on selected State Road Passenger Transport Undertakings.

3.3. MEASUREMENT OF OUTPUT

Usually different methods of measuring productivity are classified according to different definitions of output. In SRPTUs at least two demand side measures (passengers carried and passenger kilometres affected) and two supply side measures (seat kilometres and vehicle seat hours) of output can be identified from the study of literature. The supply side output measures may be alternatively considered as intermediate outputs because not all of them may be used for service. Hence, demand-oriented output measures are considered. More specifically, being a composite measure of the passengers carried and the average distance travelled by passengers, 'passenger kilometres' have been
chosen as a single measure of output by Ramanathan in his study. Similar output variable has been employed on performance measurement in road transport industry by Hansher (1992), Hansher and Daniel (1995).

In this study gross output and net output are used. Gross output is measured by considering operating and non-operating revenues in real term. The revenue realised from transportation of passengers and incidental charges related to transportation of passengers constitute operating revenue. It includes sale of passenger tickets, accompanied luggage and seasonal tickets. On the other hand, income from other sources not directly related to transportation of passengers constitutes non-operating revenue. It includes the advertisements in vehicles, shelters, sale of scrap materials and interest on investments. The non-operating revenue constitutes approximately 5 per cent of the total revenue. The inclusion or exclusion of it from operating revenue does not influence the results of the study. However, in this study, the non-operating revenue is also included in the total revenue. The gross concept of output is used to measure material productivity.

On the other hand, the net revenue (value added) in real term is considered as net output. Net concept of output is obtained by deducting the total value of intermediate inputs from the value of total revenue. The net concept of output is used in this study to measure labour productivity, capital productivity and total factor productivity.

3.3.1. EVALUATION OF OUTPUT AT CONSTANT PRICES

In temporal studies, all the variables including output are to be evaluated in physical terms. Due to heterogeneity in the product mix, output is evaluated in money units and the revenue product is transformed into physical units by the method of deflation. One issue connected with deflation is whether double deflation or single deflation is to be preferred. It is held that depending on the
purpose, either may be chosen. If output and input prices move over a period of time in the same direction and to the same extent, single deflation method is preferred. In this study the total revenue is deflated by product price index to get gross output in real term, i.e., single deflation is used. If the value added in constant prices differs when there are separate price indices for output and inputs, the method for computing value added under such condition is known as double deflation method. The double deflation is a method of expressing value added in constant prices such that the deflation of final product is accomplished separately from the deflation of intermediate goods.17

It is in this context that the double deflation method becomes relevant. Under double deflation, gross output (Total Revenue) is deflated by product price index and intermediate inputs by relevant input price indices. First, the total revenue at constant price is obtained by deflating the current value of total revenue of each with the corresponding estimated product price index of the related base year. Here, the product price of each sample unit is calculated by dividing the operating revenue by the passenger kilometre of respective sample unit. Then product price index is calculated for each unit by using the following formula:

\[
\text{Product Price Index} = \frac{\text{Current year product price}}{\text{Base year product price}} \times 100
\]

Secondly, the value of intermediate inputs are deflated by simple average of the All India wholesale price indices of motor vehicle, fuel and tyre to get the value of intermediate inputs at constant price. Thirdly, the real value added is obtained by deducting the real value of intermediate inputs from the real value of total revenue. In the present study both gross as well as net concept of output is used.
3.4. CONCEPT OF INPUTS

Unlike outputs, which can be aggregated to an equivalent single ‘output’, inputs have been treated individually as factorial inputs as well as an aggregate of all the inputs. Inputs resource comprises mainly labour, material and capital. Depending upon the objectives of the organisation, they can be deployed in varying manners so as to affect the use of available capacity.

3.4.1. CONCEPT AND MEASUREMENT OF LABOUR INPUT

Although the measure of labour input is subject to less controversy than the other inputs, especially capital, there is still no universally accepted method. Labour input can be measured either in physical units of labour (such as employment, man hours, man days, man years, etc.) or in financial terms as personnel cost. John Gunaseelan, Ramanthan, Mahesh Chand, Mahender Singh and Bhuvaneshwary used total number of staff as labour input, whereas, Krishnan used wages and salaries as labour input in measuring labour productivity. Therefore, to measure labour productivity it is necessary to quantify the flow of labour services. It is important to note that the concept of total employment involves only the stock of man-power available within the industry and does not necessarily indicate the flow of services from the stock towards producing the output. This destination between the concept of labour measured in terms of its stock or flow is important because the output to which an input is related in productivity analysis refers to a flaw. This limitation of the concept of employment in measuring the labour input leads to the alternate measure of labour input, viz. man-hours worked and wages paid. However, the concept of man-hours in the Indian context refers to an aggregate of all types of workers whether skilled or otherwise and contains definite aggregation bias. Lump sum of all kinds of man-power together without any system of weightage is as erroneous as the adding machine adding different vintages together in the measurement of capital. But the problem of arriving at a weighted measure of
man-hours utilised cannot be overcome because of the absence of any meaningful conversion factors. The value of personnel cost at constant price (personnel cost in real term) may be the nearest substitute to a weighted measure of labour input in physical term. Hence, to measure the flow of labour services, it is necessary to deflate the monitory value of personnel cost by an appropriate consumer price index to arrive at its constant price value.

In the present study, the estimate of personnel cost at constant price 1981/82 is taken as the measure of labour input. In other words, the personnel cost in real term is taken as the labour input. The personnel cost includes salaries and wages (including Managing Director's remuneration), bonus, provident fund contribution, gratuity, contribution to employees state insurance, batta and incentive, travelling expenses and welfare expenses. To get the personnel cost in real terms, the personnel cost at current price is deflated by indices of consumer prices for industrial workers in India.

3.4.2. CONCEPT AND MEASUREMENT OF CAPITAL INPUT

For the quantification of the capital inputs, two approaches have been used. Kendrick and Creamer have proposed capital inputs to be considered in categories of 'technical services' and expected returns after technical services. Technical services are inferred as the capital inputs such as land, plants, equipments, etc. which does not lose their identity after the production activity begins. Other goods such as purchased parts etc. which get used in the manufacturing of finished goods and therefore lose their identity are not 'technical services'. A surrogate measure of 'hours operated' is used to evaluate these capital inputs. For the second group of capital inputs, expected return on own assets are measured on the grounds that the rate of return in the base period is also the rate of return for measured period. In the second approach, both technical services and expected returns are treated alike. Craig and Harris advocate that the total of capital inputs can be represented by a series of
annuities. Acquisition cost is the present value of annuity. By knowing the acquisition cost, the expected periods of operation and expected rate of return the value of service in each period can be arrived at.

Ordinarily, capital is measured in currency units rather than physical units. In order to weigh capital relative to other inputs, (cost share weights), it is necessary to have capital expressed in current money value. The most common procedure is the Christenson Jorgenson (1969) perpetual inventory method in which historical investments are accumulated for each year, converted to constant money value by a price index for capital assets, less an assumed rate of economic depreciation not on tax based depreciation rates. In some studies, book value of capital series of Annual Survey of Industries (ASI) is used directly without making any price corrections. It may be noted that capital series without price corrections are not suitable for productivity analysis, since they are book value of capital assets net of depreciation. In some studies, attempts have been made to correct capital series for price changes although the price index used for this purpose is often not appropriate. Serious drawbacks are also noted with regard to the deflation procedures. On the other hand, some studies used perpetual inventory method in which additions to capital stock are deflated rather than stock itself. However, in these studies they have estimated the capital series as net of depreciation at the rate given by Central Statistical Organisation [CSO] as it is well-known that the reported data on depreciation do not represent true capital consumption which is a serious limitation.

Evidently, net capital stock is a better measure of its basic capacity to production and revenue than gross capital stock. For the reason mentioned earlier, the amount of depreciation allowed for in each year does not form an economically meaningful category. In fact, George Rosen observes that in under-developed countries, a machine is probably more often used at approximately constant levels of output for a period far beyond the accountancy life of the
machine measured by normal depreciation, until it is eventually discarded or sold for scrap.\textsuperscript{27} Under these circumstances, gross rather than depreciated value of the stock would be more closely related to the capital services consumed by the industry. Hence, gross fixed capital in real terms is used as capital input in this study.

The real gross fixed capital stock at constant price (1981/82) is used as the measure of capital input. It is calculated as follows:

First, the value of net fixed capital stock is obtained by adding net block and work-in-progress. The net block includes vehicle, plant, machinery and equipment, land, buildings, furniture and fixtures. To estimate time series of the real value of gross fixed capital, stock perpetual inventory method is employed. This method of estimation of capital stock in the manufacturing sector in India is already well-documented in Goldar (1983),\textsuperscript{28} Ahluwalia (1985, 1991)\textsuperscript{29} and Balakrishnan and Pushpangadan (1994).\textsuperscript{30} As per this method for the generation of capital stock series $K(t)$ requires an initial or bench mark capital stock $K(0)$ and the investment series $I(t)$. The wholesale price index of motor vehicles (1981/82) has been used for the purpose of deflation. As per this method, the real gross fixed capital stock $K(t)$ in period $t$ is given by

$$K(t) = K(0) + \sum_{t=1}^{n} I(t)$$

Where,

$K(0) =$ the bench year real capital stock

$I(t) =$ the real gross investment in fixed capital in a year

$K(t) =$ real gross fixed capital for the year $T$.

The real gross investment in fixed capital stock $I(t)$ is calculated as.

$$I(t) = (NFC(t) - NFC(t-1) + D(t)/P(t)$$

42
Where,

\[
\begin{align*}
\text{NFC (t)} &= \text{value of net fixed capital stock in year t} \\
\text{D (t)} &= \text{value of depreciation in year t} \\
\text{P(t)} &= \text{capital goods price deflator in year t}
\end{align*}
\]

Here, it may be noted that capital stock includes only fixed capital and work-in-progress and not working capital and investment in outside the firm. The exclusion of working capital from the capital productivity analysis is supported by many earlier studies. In this connection, Rosen (1959)\(^{31}\) feels that “the relationship between working capital and output is less influenced by technological factors than the relationship between fixed capital and output. The inclusion of work-in-progress in capital productivity analysis is also supported by many earlier studies. In this context, Anitha Kumari (1993)\(^{32}\) and Krishnan (1994)\(^{33}\) included work in progress as part of fixed capital stock to analyse productivity trends at the group level of public sector enterprises and productivity and profitability of selected transport corporations of Tamilnadu respectively. Besides, no attempt has been made to correct the capital figures for capacity utilisation.

3.4.3. CONCEPT AND MEASUREMENT OF MATERIAL INPUT

Material represents an important asset and is the largest single item of cost in almost every business; accordingly the success or failure of a concern may depend largely upon efficient purchasing, storage, utilisation and accounting.\(^{34}\) Material costs in industries generally comprise, on an average, the highest percentage of manufacturing cost throughout the world. In India, the average is about 64 paise per rupee of production cost (for 29 major industries) and the balance 36 paise represent labour costs and overheads.

The material cost constituted nearly 31 per cent of total cost in most of the SRPTUs in India during the year 1999/2000. The material input is also
measured in physical unit of material (such as tons, litres, number of units etc.,) or in financial terms such as material cost or fuel cost etc. Muraleetharan (1994), David Hensher (1995), Agarwal (1997) and Made gowda (2000) used physical unit of material as material input. On the other hand, Mohi-ud-din Sangmi (2001) used material input in financial term. In this study, the material cost in financial term is used.

In this study, total material cost in real term is taken into account as material input. To get material cost in real term, total material cost of each sample unit for each year is deflated by the simple average of each year’s, wholesale price index of fuel, tyres and tubes and spare parts. Material cost includes the costs incurred in the form of fuel, lubricating oil, spare parts, tyres and tubes, batteries, other consumables, other stores and reconditioning of accessories and busses.

3.4. CONCEPT AND MEASUREMENT OF FUEL INPUT

Fuel and lubricant constitute 75% of material cost in SRPTUs and even a marginal saving on the consumption of fuel and lubricant can lead to substantial economies in operation. Fuel input is measured either in physical term i.e. the volume of quantity either in litres or kilowatts of power or in tonnes used or in financial terms like fuel cost or power cost etc. In transport undertakings it may be used either in total litres consumed or the total amount in financial terms. In a majority of the studies, it is measured in physical terms. But in this study, fuel input is used in financial term.

In this study, total cost of quantity of high speed diesel oil, engine oil and lubricant oil consumed by the vehicle during the year represents the fuel cost. The fuel cost of each sample undertaking at constant price is taken as the base for the measure of fuel input. To arrive at the fuel cost in real term, each year’s fuel cost is deflated by each year’s wholesale price index of fuel.
3.4.5. CONCEPT AND MEASUREMENT OF TYRE INPUT

Tyre also constitutes a significant element in the propulsion cost in transport undertakings. The tyre input is also measured in physical terms such as number of tyres used or in financial terms. In most of the studies the tyre input is used in financial terms. In this study, financial cost of tyre input is considered.

In this study, tyre cost includes both cost of tyres and tubes. The total cost of tyre is deflated to get real tyre cost. For this purpose the total tyre cost of each sample unit at constant price is taken and is deflated by the wholesale price index of tyre for each year.

SECTION-II

CONCEPT OF MEASUREMENT OF PRODUCTIVITY

Traditionally productivity is defined as the relation between the output generated by a production or service system and the inputs provided to create this output in a given period of time. Thus, productivity is defined as the efficient use of all resources available—land, labour, capital, materials, energy and information in the production of various goods and services.40

In the words of John Kendrick, productivity is the relationship between output (O) of goods and services and the inputs (I) of resources, human and non-human, used in the production process; the relationship is usually expressed in ratio form of O/I. That is productivity is the ratio of output to input. The higher the numerical value of this ratio, the greater the productivity. 41 Productivity is the relationship between the results and the time it takes to accomplish them. Time is often a good denominator since it is a universal measurement and it is beyond human control.42 The less time it takes to achieve the desired result, the more productive is the system. In its elementary form, productivity is the relationship between an output/group of inputs and the input form of the production process.
However, if we closely examine the various definitions and interpretations of the term productivity three basic types of productivity appear to be emerging, viz. partial productivity, total factor productivity and total productivity. Partial productivity is the ratio of output to one class of input. For example, labour productivity (the ratio of output to labour input) capital productivity (the ratio of output to capital input) and material productivity (the ratio of output to material input) are examples of partial productivities. Total factor productivity is the ratio of net output to the sum of associated labour and capital (factor) inputs. Net output means total output minus intermediate goods and services purchased. The denominator of total factor productivity ratio is made up of only the labour and capital input factors. On the other hand, total productivity is the ratio of total output to the sum of all input factors. Thus, a total productivity measure reflects the joint impact of all the inputs in producing the output.

In all these definitions, both the output and input(s) are expressed in real or physical terms by being reduced to constant price of a base period. This reduction to base period is accomplished by dividing the values of output and input(s) by deflators or inflators, depending upon whether the prices of outputs and inputs have gone up or gone down respectively. In other words, the effect of reducing the output and input(s) to a base period is to eliminate the effects of price variations, so that only ‘physical’ changes in output and input(s) are considered in any of the productivity ratios. 43

In this study, the concepts of total factor productivity and partial factor productivity have been used to analyse productivity. Increase in any of the partial productivity (labour, capital or material productivity) will mean that there is saving in the use of that particular factor. But if these productivity ratios indicate conflicting trends, then it will be difficult to judge the overall productivity. In such situations analysis of the trends of total factor productivity
indices would be extremely useful for studying year to year variation in the productivity. In the case of road passenger transport industry, there are many inputs such as material, labour and capital and hence, more number of productivities are possible like labour productivity, capital productivity and material productivity. Hence, it is necessary to measure output and various inputs either in financial terms or physical terms.

### 3.5. MEASUREMENT OF PRODUCTIVITY

Productivity is the ratio between the units of goods or services produced and the resources consumed in production during a specified period of time. Productivity measurement can be used for shaping general economic policy, output, labour requirement, material requirement, etc. Theoretically, there are as many indices of productivity as there are inputs. Mainly three types of productivity ratios can be used to measure productivity, viz. partial productivity, total productivity and total factor productivity. Partial productivity is the relationship between output and any one of the input factor. It is the total productivity which is the ratio of the output to the combined effect of input factors. Total factor productivity is the ratio of output to the combined effect of labour and capital input factor. In this study, partial factor productivity, material productivity and total factor productivity are used. In this study to measure the material productivity, gross output in real term is used as output and for other productivity measurements the net output in real term is used. The inputs are used in real term. The following chart (Chart 3.2) shows the measurement of various productivities generally used.
CHART 3.2.
MEASUREMENT OF PRODUCTIVITY

Productivity \([\text{Output (O)} / \text{Input (I)}]\)

\[
\frac{O}{I} = \frac{O}{L + K} = \frac{O}{T}
\]

**Total Factor**

- **Labour (LP)**
  \[
  \frac{O}{I} = \frac{O}{K} = \frac{Output}{Labour}
  \]

- **Capital (CP)**
  \[
  \frac{O}{I} = \frac{O}{K} = \frac{Output}{Capital}
  \]

**Material (MP)**

\[
\frac{O}{I} = \frac{O}{M} = \frac{Output}{Material}
\]

**Total**

\[
\frac{O}{I} = \frac{O}{L+K+M+OH} = \frac{Output}{Total \Inputs}
\]

**Partial Factor**

- **Fuel (FP)**
  \[
  \frac{O}{I} = \frac{O}{F} = \frac{Output}{Fuel}
  \]

- **Tyre (TP)**
  \[
  \frac{O}{I} = \frac{O}{T} = \frac{Output}{Tyre}
  \]

Source: Compiled
3.5.1. MEASUREMENT OF PARTIAL FACTOR PRODUCTIVITY

Productivity means the output per unit of input and hence, theoretically there are as many indices of productivity as there are inputs. However, by adopting gross value added as output, only two factors of input viz., Labour and Capital are considered in this study. The partial factor productivity of labour and capital are estimated as:

Labour Productivity = Real Value Added / Real Personnel Cost.
Capital Productivity = Real Value Added / Real Gross Fixed Capital.

Since them both contribute to output, their productivities are known as partial productivity ratio. The partial productivity serves a limited purpose. If capital-labour (K/L) ratio remains constant, one can carry the productivity analysis with partial productivity analysis of labour alone. So long as the role of capital and technology is insignificant, growth in productivity may be viewed as growth in labour productivity. But, ascribing all the increments in production to labour alone is inappropriate. Hence, economists started computing and analysing partial productivity indices along with total productivity indices.

3.5.2. MEASUREMENT OF TOTAL FACTOR PRODUCTIVITY

The drawbacks of partial productivity analysis led to the popularity of total factor productivity studies. Since productivity growth is the result of the combined efforts of various factors of inputs, total factor productivity rather than labour or capital productivity is relevant. The partial productivity measures, though useful, fail to distinguish between output growth due to the use of more inputs per labourer and output growth due to improved efficiency. Therefore, relevance has been placed on total factor productivity.

The concept of total factor productivity has been defined as the ratio of output to a weighted combination of inputs (labour and capital) used. This tries
to reflect on the overall efficiency of factor-mix. On the other hand, partial factor productivities can mean approximate change in output from the use of inputs setting aside their interdependence of other inputs. In the present study, an attempt has been made to test the popular productivity models. This study considered two models, namely, Kendrick measure and Solow measure. Each model differs from the other with regard to the weighting scheme used in the present study.

(1) Kendrick measure of total factor productivity, denoted by TFPK is estimated as:

\[ TFPK_t = \frac{V_t}{W_0L_t + r_0K_t} \]

Where
- \( V_t \) = Indices of real value added.
- \( L_t \) = Indices of real personnel cost.
- \( K_t \) = Indices of real gross fixed capital.
- \( W_0 \) = Share of labour in value added in base year.
- \( r_0 \) = Share of capital in value added in base year.

The weights are the percentage shares of labour and capital in base year. The weighted inputs of labour and capital in each year are added to get the total input. Then an index of output and total input is prepared. The ratio of output to that of total input will yield the TFP index under Kendrick measure.

(2) Solow measure of TFP, denoted by TFPS is based on the rate of productivity change and is obtained as follows:

\[ \frac{\Delta A_t}{A_t} = \frac{\Delta V_t}{V_t} - \left( \frac{\Delta L_t}{L_t} \cdot W_t + \frac{\Delta K_t}{K_t} \cdot r_t \right) \]

Where
- \( \frac{\Delta V_t}{V_t} \) = Rate of change of real value
\[ \frac{\Delta L_t}{L_t} = \text{Rate of change of labour in real terms.} \]
\[ \frac{\Delta K_t}{K_t} = \text{Rate of change of real gross fixed capital.} \]
\[ W_t = \text{Share of labour in value added in year } t. \]
\[ r_t = \text{Share of capital in value added in year } t. \]

Once computation of \( \Delta A_t / A_t \) is done (for different years), the Solow measure of total factor productivity is obtained by following identity by taking the initial value of \( (A_t) \) as one.

\[
A_{t+1} = A_t \left( 1 + \frac{\Delta A_t}{\Delta A_t} \right)
\]

Thus, the rate of change of total factor productivity is the difference between the rate of change of labour and capital. The weights are the percentage shares of labour and capital.

**ESTIMATE OF FACTOR SHARES**

The labour share has been calculated as the percentage share of personnel cost in gross value added at current price. The capital share is then obtained as a residual by subtracting the labour share from the corresponding value added at current price.

**ESTIMATE OF GROWTH RATE**

It is customary to present the growth rates of economic variables in any study on productivity. The trend rate of growth presented in this study is estimated from a semi log equation,

\[ \log Y = a + bt \]

Where, \( Y \) represents the variable concerned and \( t \) the year.
3.5.3. MEASUREMENT OF MATERIAL PRODUCTIVITY

In this study material productivity is also measured due to the importance of material in passenger transport undertakings. Material productivity is calculated separately by considering material cost as input and also by giving importance individually to fuel and tyre costs as inputs. For material productivity calculation, the value of material in real term is used as input. For fuel productivity, fuel cost in real term is used as input. For tyre productivity, tyre cost in real term is used as input. The total revenue in real term is used as the input for material productivity and its subdivision. The material productivity and its various subdivisions of productivity are estimated as:

Material Productivity = Real Total Revenue / Real Material Cost.
Fuel Productivity = Real Total Revenue / Real Fuel Cost.
Tyre Productivity = Real Total Revenue / Real Tyre Cost.

SECTION-III

MEASUREMENT OF DETERMINANT VARIABLES

There are several factors that contribute to the decline of productivity growth. The most important of them are investment, capital labour ratio, capacity utilisation, government regulation, age of bus, and unions' influence. None of the above factors has individually contributed to the decline of productivity growth; it could only be a collective effect that might have been the cause. When all possible determinants of productivity are considered, its empirical analysis becomes quite complex. On ‘a priori’ grounds, the following factors are taken into account as factors which affect the changes in productivity of the selected SRPTUs operating city services. They are size of firm, capital intensity, capacity utilisation, quality of service and labour management relations. The measurement of determinant variables is discussed below:
3.6. SIZE OF FIRM

It has been suggested in the empirical works that productivity is associated with the scale of production. The gross output is used here as a proxy variable for the scale of production to measure material productivity and net output is used here as a proxy variable to measure factor and total productivities. Gross output is denoted as sale (traffic revenue) in real term, whereas net output is termed as value added. The value added is the ‘distributable surplus’ generated from the value of operation of services, after meeting the costs of intermediate inputs.

3.7. CAPITAL INTENSITY

The linking factor of labour and capital in a production function relationship would be what is called capital intensity, i.e. proxying for technical changes. The possible role this technical change might have performed in productivity increases could be assessed from the changes in capital-labour ratio. It is, therefore, considered desirable to measure the extent of increase in capital intensity in the selected SRPTUs. The capital intensity is the ratio which indicates capital requirement per unit of output. The capital intensity can be estimated as:

\[ \frac{K}{L} = \frac{\text{Real Gross Fixed Assets (K)}}{\text{Real Personnel Cost (L)}} \]

3.8. LOAD FACTOR

This study considers the possible relationship between productivity performance and system of load factor, which can be taken as an indicator of capacity utilisation. The ‘a priori’ expectation is that higher load factor (LF) is associated with higher total productivity.
Load factor or occupation ratio represents the percentage share of passenger-kilometres obtained to the passenger-kilometres offered. Seventy per cent of load factor is generally considered as a standard ratio. If the ratio is less than seventy per cent, it means a low load factor, warranting scope for improvement. If the load factor is low, it would mean that many seats are vacant, entailing a loss of revenue. Alternatively, if the load factor is high and beyond 100 per cent, it can be interpreted as representing a situation of overcrowding which, of course, is financially profitable but in terms of quality of service, it reveals that there is considerable scope for augmentation of buses. But in practice it is not possible to realise higher occupation ratio because of the influence of seasonal variations in the traffic. Calculation of this ratio does not include concessional pass holders and social obligations. The corporation is required to ply buses even in unremunerative routes which give an average occupation ratio far less than the optimum. Sudarsanam Padam states that, while traffic is increasing by 10 to 12 per cent every year, SRPTUs are not registering a proportionate increase in load factor.

It is, therefore, considered necessary to indicate the extent of variations in load factor in the respective corporations. Inter-corporation variations in the utilisation of capacity would have its impact on factor productivity. It is well known that once a bus company has expanded its capacity for providing more passenger kilometres, any decrease in its utilisation by passenger will not bring about proportionate reductions even in the variable components of the total cost, mainly because of irreversibility of its operations.

3.9. QUALITY OF SERVICE

In this study, quality of service is also considered as one of the determinant variables of productivity. In transport undertakings quality of services is measured in terms of safety and security and punctuality in service. Breakdown, accidents and causalities are used as indicators to measure safety
and security. In punctuality in services, percentage of departure and arrival in time and number of scheduled trips cancelled are considered as indicators. In this study, only breakdown and accidents are used to measure the quality of service and it is calculated on the basis of per lakh vehicle kilometre.

A breakdown in a machine in a factory may result in loss of production and other consequent losses. But if it occurs in transport undertakings when the vehicle is in motion, it may result not only in a damage to the fleet but also result in injury and loss of life to the passengers and other road users. A failure of a vehicle because of a mechanical or non mechanical defect rendering the vehicle immobile irrespective of the time involved is a breakdown. Breakdowns are caused by many factors. Important among them are the poor quality of roads, bad driving, inadequate tools and equipment, use of substandard spare parts, etc.

The analysis of breakdown indicates that about one third of the total breakdown is caused due to tyre punctures, one-third on account of engine system and the rest are mostly from transmission brake and suspension system. They can be controlled if timely and preventive maintenance is done, drivers are trained, quality spares are used and managerial control is exercised. Some breakdowns can also be minimised if the government improves the road conditions. Every breakdown means so much of loss of load factor and therefore, zero breakdown approach would seem to be the only way which would minimise the incidence of breakdowns.

Worldwide, there are estimated to be approximately 1 million road accident fatalities and 10 million people get injured annually, many with long term disabilities. Fouracre and Jacobs (1976) calculated that for any country the cost of road accidents was equivalent to approximately one per cent of its Gross National product (GNP) although it is thought to be between one and three per cent.
In India during the period 1961 - 1996 the registered motor fleet grew by over 40 times whilst the road network increased by 3.5 times; thus the growth in vehicle far outpaced the quantum of road network and other infrastructure. As a consequence, over the two decades during 1975 – 1995, the number of road accident fatalities increased by 282 per cent and injuries by 220 per cent and an average of 200 accidents were reported daily leading to 23 fatalities and 134 injured persons. 

An accident is defined as “An occurrence in the use of vehicle on revenue earning trip resulting in injury to or death of a person and /or damage to property”. Accidents are classified into fatal, major, minor or insignificant depending upon its nature or extent of damage. For various reasons so well-known a citizen faces problem of mobility. In urban areas during peak hours buses are sardine packed. People, fully knowing that it is dangerous to life, travel on foot boards, and hang on sides as they know that it is not possible to be mobile without undertaking such great risks. Such critical operating conditions do become accident hazards. Other causes of bus accidents can be drivers and driving habits, vehicle condition and road condition. In addition to measures taken for improving the vehicle and the road and the quality of drivers, it is equally necessary to educate the passengers in particular and the public in general regarding the road behavior to avoid accidents.

3.10. LABOUR - MANAGEMENT RELATIONS

Management and workers are two partners of an organisation and its progress depends on success in finding common bonds between the two. A sense of partnership and belonging in works will create an atmosphere of trust and good will, which is an effective factor contributing to increased human motivation and increasing productivity. Management of SRPTUs has a significant role in productivity growth. It plays an intricate role in the motivation of workers towards higher productivity. Transport managers learn to manage
transport on the job through induction training imparted to them as part of management training or through structured programmes conducted by institutions like Central Institute of Road Transport in Pune.  

A study conducted by National Institute of Training of Industrial Engineers – Bombay on Indian industry has quantified the contribution of some of the management practices as below:

"Other factors remaining the same, a ten per cent improvement in supervisory control might improve labour productivity by two per cent. A ten per cent improvement in job security might improve labour productivity by half a per cent, while a ten per cent loss due to industrial relations reduces labour productivity by half a per cent and in the absence of proper incentive scheme one per cent increase in wage reduces labour productivity by three per cent."

A professional manager can use money and materials to achieve higher productivity but only with the help and cooperation of willing workers. If this co-operation is not forthcoming, productivity techniques, whatever they may be, to harness material resources will fail miserably. It is obvious that in a labour intensive industry like road passenger transport, good industrial relations would be a sine qua non for effective operations. He must not only harness technical expertise but also inspire confidence in workers for raising the productivity level.

The next important instrument of ensuring industrial harmony is the process of communication. It must be a continual process. They must be given refresher courses at suitable intervals. Training facilities are most essential, if productivity is to be encouraged. In transport industry, productivity suffers mainly because of lack of adequate training to drivers, conductors and mechanics. Effective communication between management and workers apart from ensuring optimum productivity develops into labour-management synergy.
in all matters of concern, such as promotion policy, grievance handling, welfare activities, work study, training schemes, and their responsibilities towards passengers and so on.

It is now established by experience that effective utilisation of manpower is the surest means of improving productivity. The only practicable means of improving manpower utilisation is to introduce incentive schemes and stimulate human exertion to provide a positive motivation to operate with more effort. Incentive schemes could be based on a) individual performance and b) group performance - depending upon the nature of work carried out by workers. A bus conductor could be given a share in the additional earnings beyond the minimum control limit. Similarly drivers could be given incentive bonus for completing the required numbers of trips / kilometres. Engineering staff - fitters, cleaners, etc., could be included in a group scheme if they improve the fleet utilisation and vehicle utilisation. 54

What is the role of the union? Are they responsible for the decline in productivity? This question must be seriously considered whether the management likes it or not. “Although more scientific evidence is needed to answer this question, a poll of 782 company executives by the 'Wall Street Journal' reveals the negative influence of unions on several factors, including productivity”. 55 Kohei Goshi (1980), 56 the President of Japan Productivity Center, believes that the most important reason for Japan’s sustained high growth in productivity is the co-operative attitude between management and labour.

The role of management in the productivity decline may have been a major factor, although more studies are needed to establish this as a fact. Fortunately, American management recognises that poor management is the principal causes of the productivity decline. In a survey conducted by “Productivity”, a monthly news letter, about 80 per cent of the top managers in
21 concerns cite "poor management" as the key reason for lack lustre productivity. In another survey, 236 top level executives representing a cross section of 159 U.S. industrial companies conceded that managements' ineffectiveness is by a single greatest cause of decline in productivity in the United States. "Much of the current problem of low productivity has been caused by management. Better allocation of resources is the key to changing a company's performance and to increasing overall management productivity".

"Clearly, management plays the leading role in any organisation's productivity and it is, therefore, upon management that all organisations should focus primary attention in their quest for peak productivity. Differences in productivity depend primarily upon attitude and motivation. Management not only directly determines its own attitude, motivation and productivity, but is also extremely important in influencing the attitude of the entire work force."

"As a matter of fact, the success of the organisation depends on how best the human resources are utilised. In any drive towards higher productivity, the human factors play the most vital role. To improve productivity we must devise ways and means to improve human productivity". This ultimately depends on the management practices followed by the organisation concerned.

3.11. CONCLUSION

From the above analysis, it is concluded that labour, capital and material are the most important productivity measures in any manufacturing and service industry including transport industry. Productivity is generally defined as output divided by input concerned. Labour productivity has been measured as net output in real term / personnel cost in real term, capital productivity as gross output in real term/ net fixed capital in real term, material productivity as gross output in real term/ total material cost in real term, fuel productivity as gross output in real term/ fuel cost in real term and tyre productivity as gross output in
real term/ tyre cost in real term. On the other hand, total factor productivity is measured as net output in real term/personnel cost and fixed capital in real term. Size of firm, capital intensity, capacity utilisation, quality of service and labour management relations are considered as some of the variables that determine productivity growth. A detailed analysis of labour, capital, total factor and material productivities of the selected road passenger transport undertakings which operate city service is attempted in the following chapters.
REFERENCE

2. Prokoparko Joseph op. cit., p-15
22. Mahinder singh op- cit.
42. I bid.
43. Sumanth David J. op-cit, pp 7-8
44. Anantha MPV., op.cit, pp 19-20.
45. Dr. Sudarsanam padam, op.cit.
47. Road passenger transport in India pp 123–124.
51. Book as Compendious of Transport Terms; CIRT; Pune.


58. I bid.

