UNIT - I

INTRODUCTION

Concepts of Industrial Engineering:-

American Institute of Industrial Engineers (AIIE) defines Industrial Engineering as follows:

"Industrial Engineering is concerned with the design, improvement and installation of integrated system of people, material, equipment, energy and technology."

It draws upon specialized knowledge and skill in the mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems.

Industrial Engineering is engineering approach to the detailed analysis of the use and cost of the resources of an organisation.

The prime objective of industrial engineering is to increase the productivity by eliminating waste and non-value adding (unproductive) operations and improving efficient utilisation of resources.

History and development of Industrial Engineering

For the first time, industrial engineering emerged as a profession during the Industrial revolution. This was around year 1750. This was due to the need for technically qualified people, who were needed to plan, organize and control the manufacturing processes. The industrial revolution resulted from the advent of new inventions, especially in the textile industry, then steam engine, advances in metal cutting and the production of machine tools. These lead to factories with large number of workers. With the growth in the size of industries, came the beginning of management and management thinking.

Adam Smith (1776) through his book "Wealth of Nations" introduced the concept of "division of labour". Through this concept of division of labour which included the skill development, time savings and the use of specialised machine was able to influence the factory system.

James Watt (1864) - Steam engine advanced the use of mechanical power to increase productivity.

Frederick Taylor (1859-1915)- He is called as father of industrial management and industrial engineering. Taylor's contribution brought the era of scientific management. There was overall improvement in the planning, scheduling and control of the industrial process. Need for supervisors was being realised.

Henry L. Gantt (1913) - He provided the concept of planning and scheduling the activities on a graphical chart. This is very helpful in reviewing the progress and updating the schedule of a work.

Frank and Lillian Gilberth (1917)- Frank B Gillberth and his wife Lillian Gilberth developed method study as a tool for work analysis. His Contributions were helpful in designing a job, deciding the time required to perform a job and improvement in ways to perform a job

Roles of Industrial Engineer:

* Advisor / consultant :- Available to others for interpretation of data, review, etc.
* Advocate / Activist - Promote actively a process or approach.
* Analyst - Separate a whole into parts and examine them to explore for insight and characteristics.
* Boundary spanner - bridge the information / interest gap between industrial engineering and user.
* Motivator - Provide stimulus and skill availability to a ground or individual.
* Decision Maker - Select a preference from among many alternatives for topic of concern.
* Designer / Planner - Produce the solution specifications
* Expert - Provide a high level of knowledge, skill and experience on a specific topic.
* Coordinator and Integrator
* Innovator / inventor - Seek to produce a creative or advanced technology solution
* Measure - Obtain data and facts about existing conditions
* Project Manager - Operate, supervise and evaluate projects
* Trainer / educator - in the skills and knowledge of Industrial Engineering.
* Data gatherer
* Negotiator

Applications of industrial Engineering:

* Industrial Engineering was mainly applied to manufacturing industries for improving methods of production, to develop work standards or to formulate production control and wage policies.
* Industrial Engineering was applied to non-manufacturing activities such as construction and transportation, farm and air-line operations and maintenance, public utilities, government and military operations.
* Industrial Engineering concept is utilised in Marketing, Finance, Purchasing, industrial relations, etc.
* Industrial engineering is applied in banking.
* Industrial engineering is also applied in the companies which supply essential commodities such as water, gas, electricity, telephone services.

Production Management Vs Industrial Engineering

* Production Management attempts to familiarize a person with concepts and techniques specific to the analysis and Management of a production activity.
* Industrial engineering, on the other hand, deals with the analysis, design and control of productive systems.
* Production management tells how to manage human efforts in a production environment, with less attention paid to the analysis and design of productive systems.
* It is generally assumed that industrial engineers will not operate the systems they design.
* The training of an aircraft pilot is related to production management education whereas the designing of the aircraft is related to industrial engineering education.

Production System :-

* The production system is a part of a larger system — the business firm.

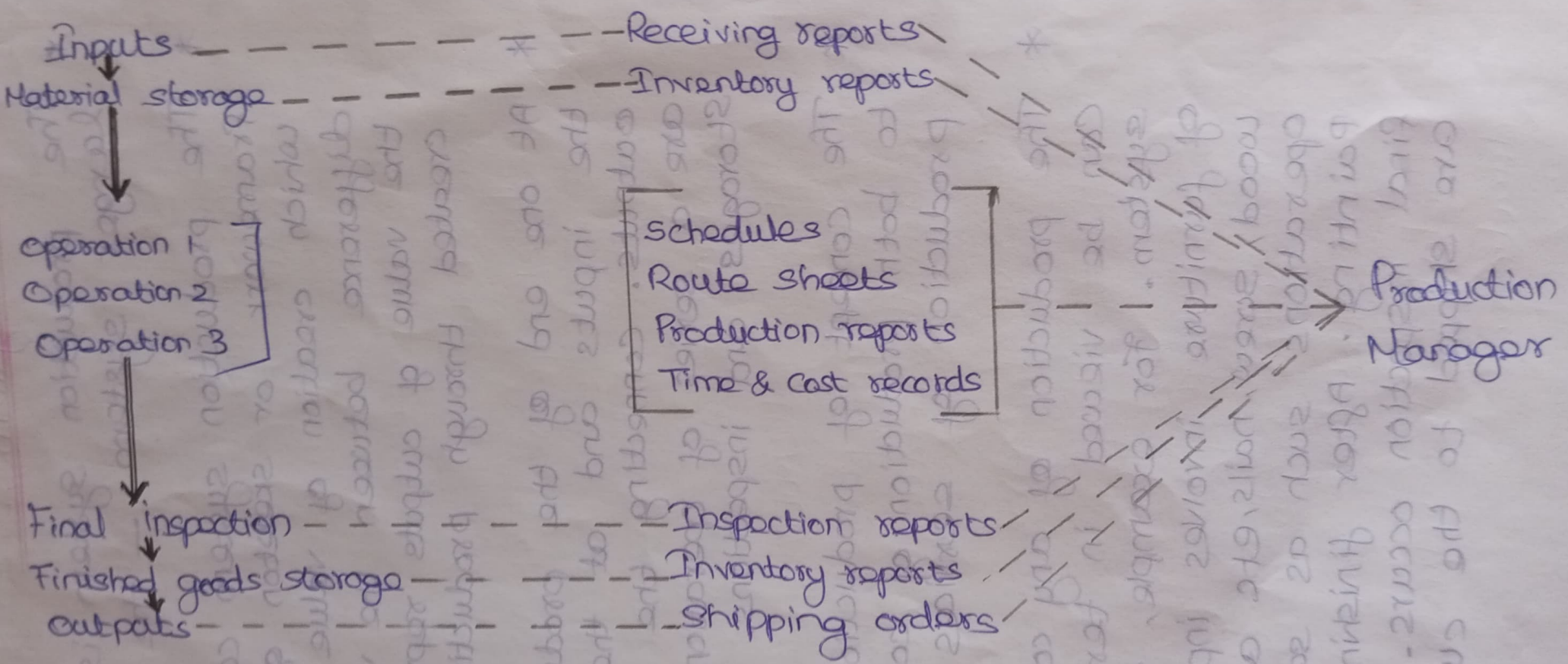
* The production system can be viewed as a framework or skeleton of activities within which creation of value can occur. The difference between the value of inputs and the value of outputs represents the value created through production activities.

* At one end of the production system are the inputs and at the other end are outputs. Connecting the inputs and outputs are a series of operations or processes, storages and inspections.

* The concept of production system is applicable to both production of components and production of services as well.

* The production of any component or service can be viewed in terms of a production system. For example, the manufacture of furniture involves inputs such as, wood, screw, nails, etc and then several operations such as sawing, nailing, painting. After finishing operation, a final inspection occurs. Then the outputs are shipped to the customers.

A simplified Production system



Types of Production system:

The most common types of production system are:

(i) Job shop production
(ii) Batch production
(iii) Mass production
(iv) Continuous Production

Job shop production:

The job shop production system is characterised by the low production volume. It has following characteristics:

(i) Commonly used to meet a particular customer need.
(ii) Production lot size is generally small.
(iii) Product variety is generally very high.
(iv) Production equipments are mostly general purpose and flexible to meet specific customer need.
(v) Highly skilled labour is needed to handle the equipments.

Batch Production :

Batch production is suited for medium volume lot of same variety. At regular intervals, the production order is repeated. More than 75% parts manufactured worldwired are in batches. Batch production has the following characteristics.

(i) Commonly used to meet repeated customer orders.

(ii) Production lot size is medium.

(iii) Suitable for moderate product variety.

(iv) Production equipments are general purpose but suitable for higher production volume.

(v) Specially designed jigs and fixtures may be used to reduce set-up time and increase the production rate.

(vi) Skill level of labour in batch production should be reasonably high but may be less compared to job shop production. This is due to relatively less variety and variation.

Mass Production :-

Mass production is suited for the manufacturing of continuous identical parts. Production rate is generally very high. It is characterised by the following:

(i) Particularly suited for high demand items.

(ii) Production lot size is very high and production rate is continuous.

(iii) Product variety is very low, which may be one of its kind.

(iv) Special purpose tools and equipments may be needed.

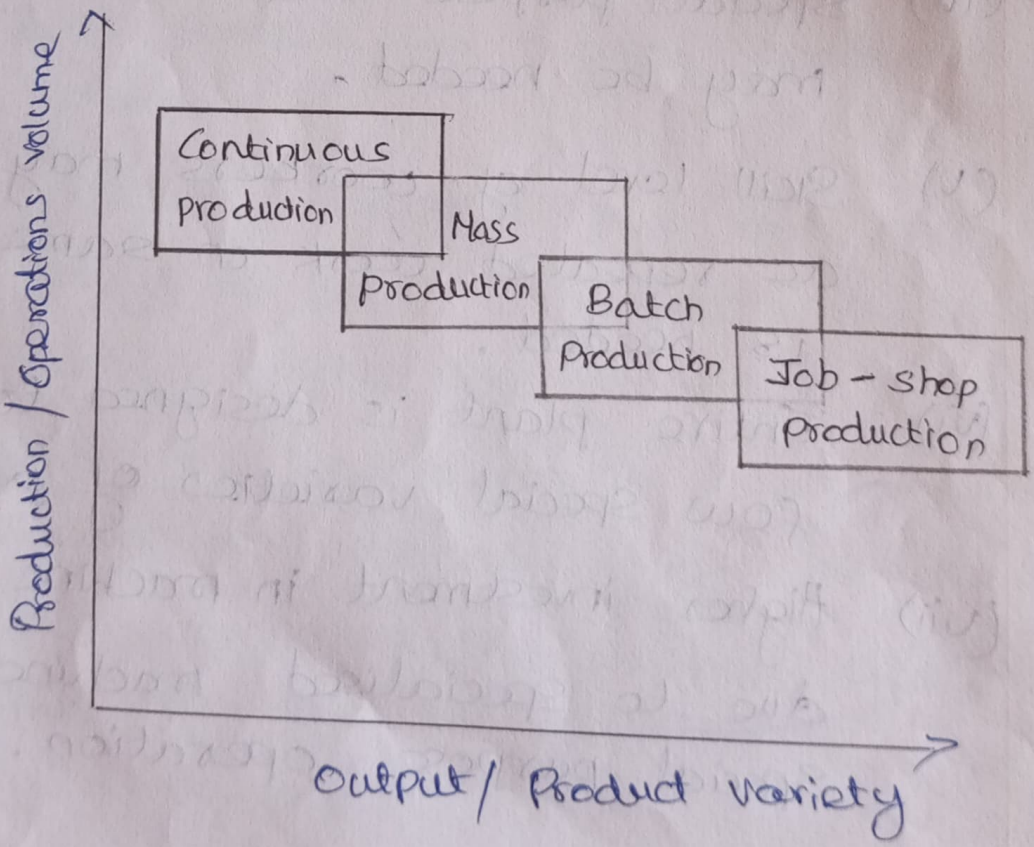
(v) Skill level of workers may be low as repeated work on same machine is needed.

(vi) Entire plant is designed to cater to few special varieties of products.

(vii) Higher investment in machine is needed due to specialised machine and special purpose operation.

Continuous Production :-

Continuous production is very common in food processing industry, oil refinery, drugs and pharmaceutical unit, chemical processing unit, etc. This is a special type of mass production unit in which production does not stop. Unlike discrete parts production system, the flow of output is continuous. Generally, online control and continuous system monitoring may be needed. All such controls are generally automatic and computer controlled.



Input Output Model :-

* It is one of the basic models of the production system. A production system is the set of inter connected input-output elements and is made up of three component parts namely input, process and outputs.

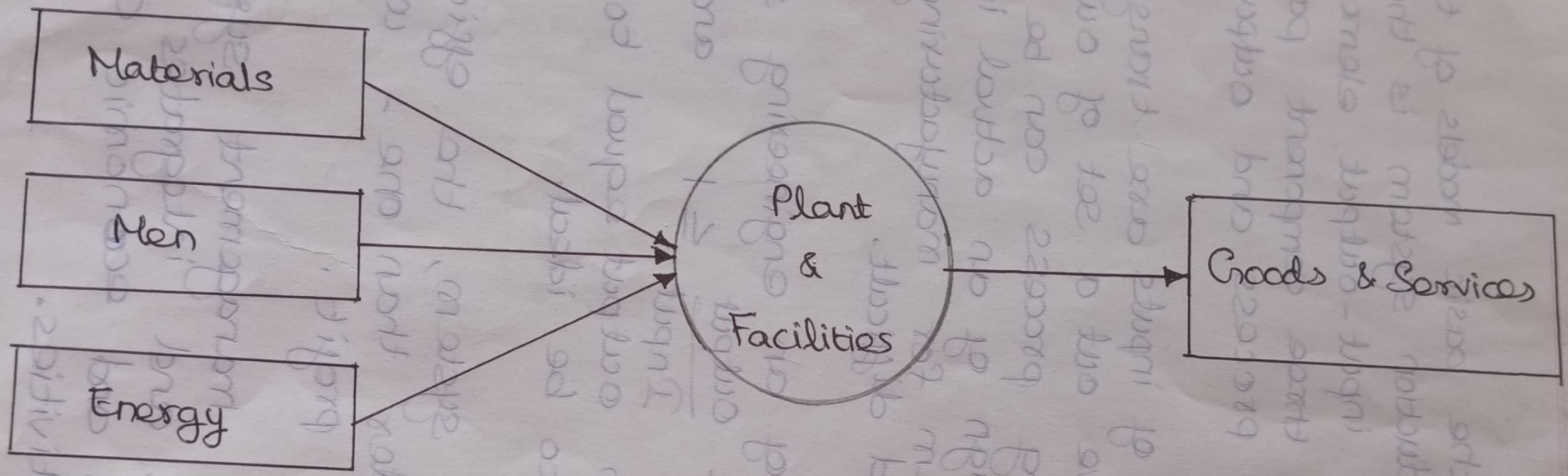
* A wide variety of inputs are transformed so that they give out a set of outputs. The transforming process can be complicated and the design of an actual input and output system for manufacturing may be expensive and difficult.

* The efficiency of an engineering system (a machine) = $\frac{\text{Output}}{\text{Input}} \leq 1$ and a system with output equal to input is considered to be ideal.

* In economic system, the efficiency has to be greater than one - which means a state of profit.

* A production management system comprehends and integrates both engineering and economic criteria in its activities.

Input Output Model



Productivity :

Productivity is the arithmetic ratio of amount produced (output) to the amount of resources (input).

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

Production is defined as a process or procedure to transform a set of input to output having the desired utility and quality. Production is a value addition process.

Productivity can be increased by

* Increasing production without increase in inputs.
* The same production with decrease in inputs.
* The rate of increase in output is more compared to rate of increase in input.

Increasing production without increase in inputs, increases productivity. Also, the rate of increase in output is more compared to the rate of increase in input increases productivity. But if the rate of increase in output is less compared to the rate of increase in input, productivity decreases. Increase in production may or may not be an indicator of increase in productivity. If the production is increased for the same output, then there is an increase in productivity.

Purpose of increasing productivity:

(i) To produce good profit.

(ii) Reduced price of articles.

(iii) To stand better in the market.

(iv) Higher wages and better working condition for workers.

Factors affecting productivity:-

(a) Factors affecting National productivity.

① Human Resources
② Technology and capital investment
③ Government Regulation

(b) Factors affecting productivity in Manufacturing and services

① Product or system design
② Machinery and equipment
③ The skill and effectiveness of the worker
④ Production volume

Human Resources:

The general level of education is an important factor in national productivity. The use of computers and other sophisticated equipment and systems requires better educated employees. Government can help by sponsoring more education, especially in fields that directly affect productivity.

Government Regulation : An excessive amount of government regulation may have a detrimental effect on productivity. Government can do much to eliminate unneeded regulations and to make cost-benefit analysis to determine necessary regulations on healt and safety.

Technology and Capital Investment: The major fa in long range continuing productivity improvemen is technology and new technology depends on Research and development. The goverment can promote R&D in Industries and Universities.

Product Design:

Through better product design, a product can be simplified by eliminating some of its parts. Value analysis can bring out many product design changes that improve productivity. R&D is a vital contributor to improved product design. Standardization and group technology increases productivity.

Machinery and Equipment: Computer has helped design the products (CAD), it helps operating complicated machine tools (CNC machies) and it controls the inventory of material and parts. It has become an essential ingredient in productivity improvement.

Skill and Effectiveness of the Worker:

The trained and experienced worker can do the same job in a much shorter time and with far greater effectiveness than a new one. The well-trained employees must be motivated to be productive.

Production Volume: Assume that the volume of of output is to be doubled. The number of direct workers would have to be doubled and few indirect workers also be needed. But no need for more engineers, research scientists, headquarters staff people. So if the output is doubled, the productivity of these support people is in effect doubled.

Increasing Productivity of resources :-

It implies, getting more number of goods (output) from the same amount of resources (input), as explained under:

(a) Material : Industries in which cost of raw material is a big percentage of the cost of the finished goods, higher productivity can be achieved through proper use of materials, ie., by reducing scrap. Sometimes a little change in the design of the component or component layout may save a lot of material. Productivity of materials can also be increased by using correct process, properly trained workers, suitable material handling and storage facilities and proper packaging. All these factors reduce scrap rate.

(b) Labour :

A little change in the design of component parts so as to facilitate final assembly, can increase the number of products assembled per day with the same amount of labour. Work methods if improved through work study techniques, can substantially increase the rate of production.

(c) Plant, Equipment and Machinery :

Productivity can be increased through

the use of improved tools (eg: cutting tools in a machine shop), simple attachments and other devices. Total production times can be cut short considerably by improving machine setting up methods, there by reducing set-up times. Proper maintenance will avoid sudden breakdown and add to the productivity.

(d) Land and Buildings:-

A suitable plant layout can accomodate more machinery in the same space and thus raise productivity. Proper orientation, construction and inside conditions of a building definitely. Proper orientation, construction and inside conditions of a building definitely affect producting.

Productivity of any system can be improved either by proper use of resources or by effective utilization of system and processes.

Kinds of Productivity Measures:-

(i) Labour Productivity or Human productivity:

$$\text{Labour Productivity} = \frac{\text{Output}}{\text{Human Input}}$$

The resource inputs are aggregated in terms of labor hours. Hence this index is relatively free of changes caused by wage rates and labour mix.

Uses:

To understand the effect of increase/decrease in hiring of labour and to see how they perform.

(ii) Direct labour cost productivity:

The resource inputs are aggregated in terms of direct labor cost. This index will reflect the effect of both wage rates and changes in the labour mix.

(iii) Capital Productivity:

$$\text{Capital productivity} = \frac{\text{Output}}{\text{Capital input}}$$

Several formulations are possible. In one, the resource inputs may be the charges during the period to depreciation; in another the inputs may be the book value of capital investment.

Use: In financial assessment

(iv) Direct cost productivity:

In this formulation all items of direct cost associated with resources used are aggregated on a monetary value basis.

(v) Energy Productivity:

In this formulation the only resource considered is the amount of energy consumed.

$$\text{Energy productivity} = \frac{\text{Output}}{\text{Energy Input}}$$

Use: In the consideration of energy required by the system.

(vi) Raw material productivity:

In this formulation, the numerators are usually weight of product, the denominators are the weight of the raw material consumed.

$$\text{Material productivity} = \frac{\text{Output}}{\text{Material Input}}$$

Use: In material management

(vii) Partial Productivity:

$$\text{Partial Productivity} = \frac{\text{Total Output}}{\text{Individual Input}}$$

Partial productivity is defined on the basis of the class of the input being considered. For example, if the labour is increased during last financial year, its effect on the increased output is represented by partial productivity

Advantages:

(*) It is a good diagnostic measure to identify areas where improvements may be done.

* Easy to calculate as independent of other inputs.

* Easy to understand and pinpoint the logic for its improvement

(viii) Total Factor productivity:

It is the ratio of net output to the sum of labour and capital inputs.

$$\text{Total factor productivity} = \frac{\text{Net output}}{\text{Labour + Capital Inputs}}$$

Advantages:

* It is relatively easy to compile data from company records.

* Economists prefer this as it is easy to compare in cross-industry context.

(ix) Total Productivity:

It is the ratio of total output to the sum of all input factors.

Advantages:

* It is a more accurate representation of real economic performance of the organisation.
* It is easy for top management to understand the company performance.
* Focussed areas of improvements may be identified.
* Easy for cost accountants to compare.
* Easy to do sensitivity analysis.

Limitations:

* Difficult to generate companywise and sectorwise data.
* Many indirect measures of input / output are ignored.