MEE1014 Industrial Engineering and Management

B.Tech (Mechanical)

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Module-3

Productivity:
Definition – Factors affecting- Increasing productivity of resources - Kinds of productivity measures - Case study. (6 Hours)

Expected Outcome

| CO3 | Apply productivity techniques for continuous improvement in different functionalities of an industry. |

Productivity

Productivity - Definition

➤ The ratio between the volumes of output is measure by production indices and the corresponding volumes of labour input is measured by the employment indices.

➤ International Labour Organization (ILO)

➤ Measure of how much input is required to achieve a given output

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

➤ To increase the productivity, output should be as large as possible for the given input

Productivity - Definition

➢ **Input**: Labour, Materials, Energy, Cost of Equipment and other appropriate resources

➢ **Output**: Number of items produced

➢ Productivity is analogous to the efficiency

➢ It is an indicator how the inputs are utilized

➢ If the productivity is higher, it means the resources are well utilized
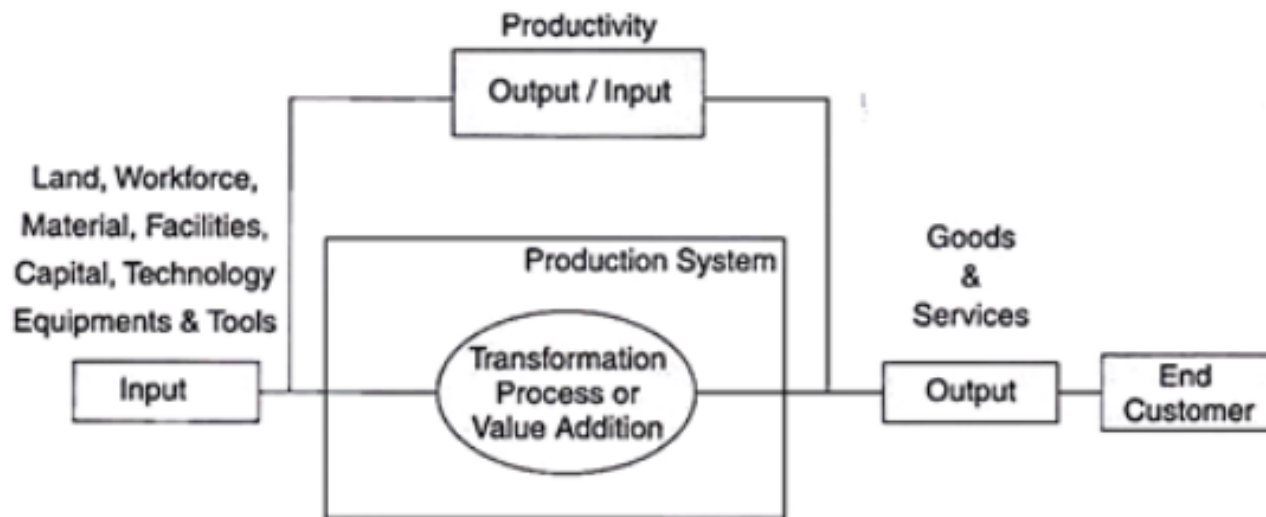
Factors Affecting Productivity

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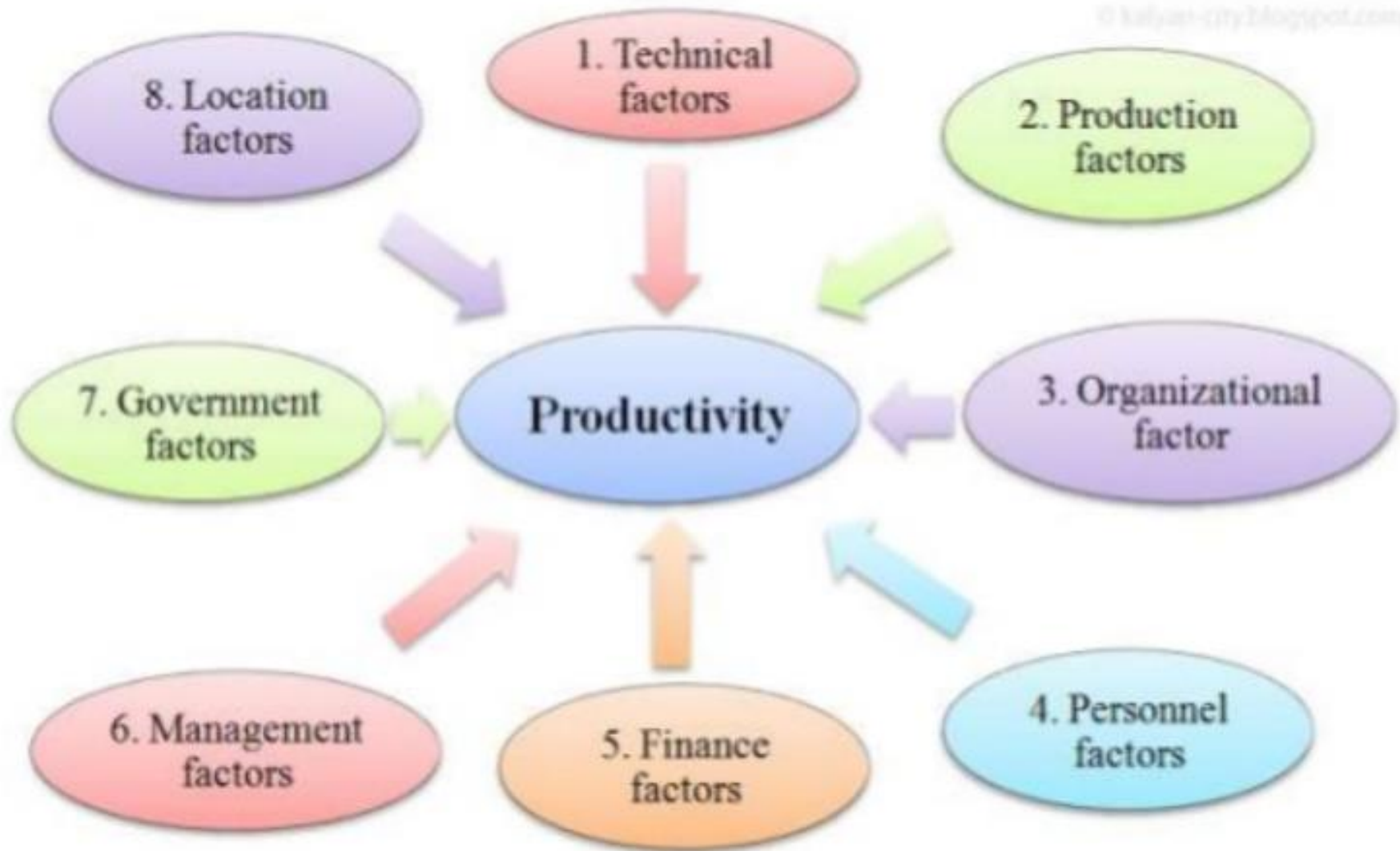
Increasing Productivity of Resources

Increasing Productivity of Resources

➢ **From the same amount of input, increase the output**

Material:

➢ Reduce the waste $\rightarrow$ higher productivity

➢ Change in the component layout or component design $\rightarrow$ Saving of material

➢ Using correct process

➢ Properly trained workers

➢ Proper material handling $\longrightarrow$ **Wastage reduction of Material**

➢ Storage facilities

➢ Appropriate Packaging

Increasing Productivity of Resources

➢ **From the same amount of input, increase the output**

Labour:

➢ Modifying (small change) the design of component part to get the final product results in increase in the output/day with the same number of labour

➢ Rate of production can also be increased by proper work methods

Increasing Productivity of Resources

➢ **From the same amount of input, increase the output**

Plant, Equipment and Machinery:

➢ Use of improved tools, additional attachments and other devices will lead to increased productivity

➢ Improve the loading of components procedure/ machine setting up methods to reduce the loading/set-up times → increased productivity

➢ Maintenance of machines → increased productivity

Increasing Productivity of Resources

➤ **From the same amount of input, increase the output**

Land & Buildings:

➤ Improved layout to accommodate more machines in the same space $\rightarrow$ increased productivity

➤ Proper construction, orientation and inside conditions of a building play a major role to increase productivity

Productivity of Measures

Productivity Measures

Partial measures	$\dfrac{\text{Output}}{\text{Labor}}$	$\dfrac{\text{Output}}{\text{Machine}}$	$\dfrac{\text{Output}}{\text{Capital}}$	$\dfrac{\text{Output}}{\text{Energy}}$
Multifactor measures	$\dfrac{\text{Output}}{\text{Labor} + \text{Machine}}$		$\dfrac{\text{Output}}{\text{Labor} + \text{Capital} + \text{Energy}}$	
Total measure	$\dfrac{\text{Goods or services produced}}{\text{All inputs used to produce them}}$			

Labor productivity	Units of output per labor hour
	Units of output per shift
	Value-added per labor hour
	Dollar value of output per labor hour
Machine productivity	Units of output per machine hour
	Dollar value of output per machine hour
Capital productivity	Units of output per dollar input
	Dollar value of output per dollar input
Energy productivity	Units of output per kilowatt-hour
	Dollar value of output per kilowatt-hour

15

Single Factor Productivity

➢ **Determine the productivity for these cases on hourly basis:**

    a. Four workers installed 720 square yards of carpeting in eight hours.

    b. A machine produced 70 pieces in two hours. However, two pieces were unusable.

Single Factor Productivity

a. Productivity $= \dfrac{\text{Yards of carpet installed}}{\text{Labor hours worked}}$

$= \dfrac{720 \text{ square yards}}{4 \text{ workers} \times 8 \text{ hours/worker}}$

$= \dfrac{720 \text{ yards}}{32 \text{ hours}}$

$= 22.5 \text{ yards/hour}$

Single Factor Productivity

b. $\quad \text{Productivity} = \dfrac{\text{Usable pieces}}{\text{Production time}}$

$$= \dfrac{70 - 2 = 68 \text{ usable pieces}}{2 \text{ hours}}$$

$$= 34 \text{ pieces/hour}$$

Single Factor Productivity

- ➢ **Problem**

- ➢ **There are two industries manufacturing two types of socket. The standard time per piece is 1.4 minutes. The output of two industries is 310 and 210 respectively per shift of 8 hours.**

  (a) What is the productivity of each per shift of 8 hours?

  (b) What is the production of each per week (5 days) on the basis of double shift.

Single Factor Productivity

Solution

➢ **For industry -1,**

$$Productivity = \frac{Actual\ Production}{Standard\ Production}$$

$$Productivity = \frac{310}{\frac{(8\ x\ 60)}{1.4}} = 0.904$$

Single Factor Productivity

Solution

➤ **For industry -1,**

      Production per week = 310 * 5 * 2 = 3100

Single Factor Productivity

Ex.1

The manager of a crew that installs carpeting has tracked the crew's output over the past several weeks, obtaining these figures:

Week	Crew Size	Yards Installed
1	4	96
2	3	72
3	4	92
4	2	50
5	3	69
6	2	52

Compute the labor productivity for each of the weeks. On the basis of your calculations, what can you conclude about crew size and productivity?

Ex.2

A catering company prepared and served 300 meals at an anniversary celebration last week using eight workers. The week before, six workers prepared and served 240 meals at a wedding reception.

a. For which event was the labor productivity higher? Explain.

b. What are some possible reasons for the productivity differences?

Multi-Factor Productivity

Determine the multifactor productivity for the combined input of labor and machine time using the following data:

Output: 16,000 units

Input

    Labor: 65 hours

    Machine: 15 hours

$$\frac{\text{Multifactor}}{\text{Productivity}} = \frac{\text{Output}}{\text{Labor} + \text{Machine}} = \frac{16{,}000 \text{ units}}{65 \text{ hr.} + 15 \text{ hr.}} = 200 \text{ units per hr.}$$

Multi-Factor Productivity

Compute the multifactor productivity measure for an eight-hour day in which the usable output was 300 units, produced by three workers who used 600 pounds of materials. Workers have an hourly wage of $20, and material cost is $1 per pound. Overhead is 1.5 times labor cost.

$$\text{Multifactor productivity} = \frac{\text{Usable output}}{\text{Labor cost} + \text{Material cost} + \text{Overhead cost}}$$

$$= \frac{300 \text{ units}}{(3 \text{ workers} \times 8 \text{ hours} \times \$20/\text{hour}) + (600 \text{ pounds} \times \$1/\text{pound}) + (3 \text{ workers} \times 8 \text{ hours} \times \$20/\text{hour} \times 1.50)}$$

$$= \frac{300 \text{ units}}{\$480 + \$600 + \$720}$$

$$= .167 \text{ units of output per dollar of input}$$

Multi-Factor Productivity

Ex.3

Compute the multifactor productivity measure for each of the weeks shown for production of chocolate bars. What do the productivity figures suggest? Assume 40-hour weeks and an hourly wage of $12. Overhead is 1.5 times weekly labor cost. Material cost is $6 per pound.

Week	Output (units)	Workers	Material (lbs)
1	30,000	6	450
2	33,600	7	470
3	32,200	7	460
4	35,400	8	480

Productivity

3.03

2.99

2.88

2.84

(First week)

Inputs = (40x12x6) + 450x6 + 1.5(40x12x6)

Output = 30000

Productivity = 30000/9900 = 3.03

Multi-Factor Productivity

Ex.4

Last week employees at Bluegill produced 46 chairs after working a total of 200 hours. Of the 46 chairs produced, 12 were damaged due to a problem with the new sanding machine. The damaged chairs can be discounted and sold for $25 each. The undamaged chairs are sold to a department store retail chain for $70 each. What was the labor productivity ratio for last week? If labor productivity was $15 in sales per hour the previous week, what was the change in labor productivity?

Input = 200 h

Output = [(34x70) + (12x 25] = 2680 dollars

Productivity = 13.4

Multi-Factor Productivity

Ex.4

Last week employees at Bluegill produced 46 chairs after working a total of 200 hours. Of the 46 chairs produced, 12 were damaged due to a problem with the new sanding machine. The damaged chairs can be discounted and sold for $25 each. The undamaged chairs are sold to a department store retail chain for $70 each. What was the labor productivity ratio for last week? If labor productivity was $15 in sales per hour the previous week, what was the change in labor productivity?

$$\text{Change in Productivity} = \frac{13.4 - 15}{15} \times 100$$

$$= -0.106 \times 100$$

$$= 10.6 \%$$

$$\therefore \text{Productivity is reduced by } 10.6\%.$$

Kinds of Productivity Measures

Kinds of Productivity Measures

➢ Labour Productivity

➢ Direct labour cost Productivity

➢ Capital Productivity

➢ Direct cost Productivity

➢ Energy Productivity

➢ Raw material Productivity

Kinds of Productivity Measures

Labour Productivity

➢Resource inputs are accumulated in terms of labour hours

➢Because of this, the index is relatively free of charges caused by wage rates and labour mix

Kinds of Productivity Measures

Direct Labour Cost Productivity

➢ Resource inputs are accumulated in terms of direct labour costs

➢ This index will reflect the effect of wage rates and changes in labour mix

Kinds of Productivity Measures

Capital Productivity

➢ Resource inputs may be book value of investment/ charges during depreciation

Kinds of Productivity Measures

Direct Cost Productivity

➢ All items of direct cost associated with resources used are accumulated on a monetary value basis

Kinds of Productivity Measures

Energy Productivity

➢ Amount of energy consumed is the only resource

Kinds of Productivity Measures

Raw Material Productivity

➢Product weight is in the numerator

➢Raw material consumed is the input

Case Study

Case Study

Case study on Diamond Industry

Factors

- ➤ Employees Training.
- ➤ Automation.
- ➤ Equipments Used by Employees-
  - ▪ polishing tangs.
  - ▪ diamond wheels.
- ➤ Quality and Availability of Raw Diamonds.
- ➤ Standard of Diamonds Produced by firms.
- ➤ Management Policies.

Case Study

	Company A	Company B
Rate of Production	200 units per day	175 units per day
Polishing tangs	Fully geared	Semi geared
Diamond wheels	Latest	Latest
Automation	Automation in all phases	Automation in later phases
Wastage level	Less	More
Workload on work force	Less	More
No. of working days in a month	28	28
No. of Employees	10	12
Employees Training Level	same	same
No. of labor hours per days	10	10

Case Study

Cost Patterns per diamond of two firms

Cost per Unit	Company A	Company B
Labor Cost-	Rs 70	Rs 80
Electricity Cost	Rs 10	Rs 15
Capital Cost	Rs 40	Rs 35
Packaging Cost	Rs 05	Rs 05
Management Cost	Rs 20	Rs 20
Other Cost	Rs 05	Rs 05
Total Cost Per Unit	Rs 150	Rs 160

Compute Multifactor productivity of the firms monthly and identify which firm has high productivity?

End of Module-3