

PRODUCTIVITY

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Expected Learning Outcome

- ✓ Define productivity
- ✓ Differentiate between production rate, efficiency, effectiveness, performance or production.
- ✓ Know the factors affecting productivity.
- ✓ Understand the general productivity model.

Expected Learning Outcome

- ✓ Explain the effect of different factors on labor productivity.
- ✓ Express the relation between Productivity & Quality.
- ✓ Suggest ideas to improve construction productivity.
- ✓ Reference: “Productivity Engineering and management” Author: D. J. Sumanth.

Definitions

- **Productivity** is the ratio of total output produced to the input of one element of production.

Definitions

- **Efficiency** (كفاءة) describes the extent to which time or effort is well used for the intended task or purpose.
- **Effectiveness** (فاعلية) means the capability of producing an effect.

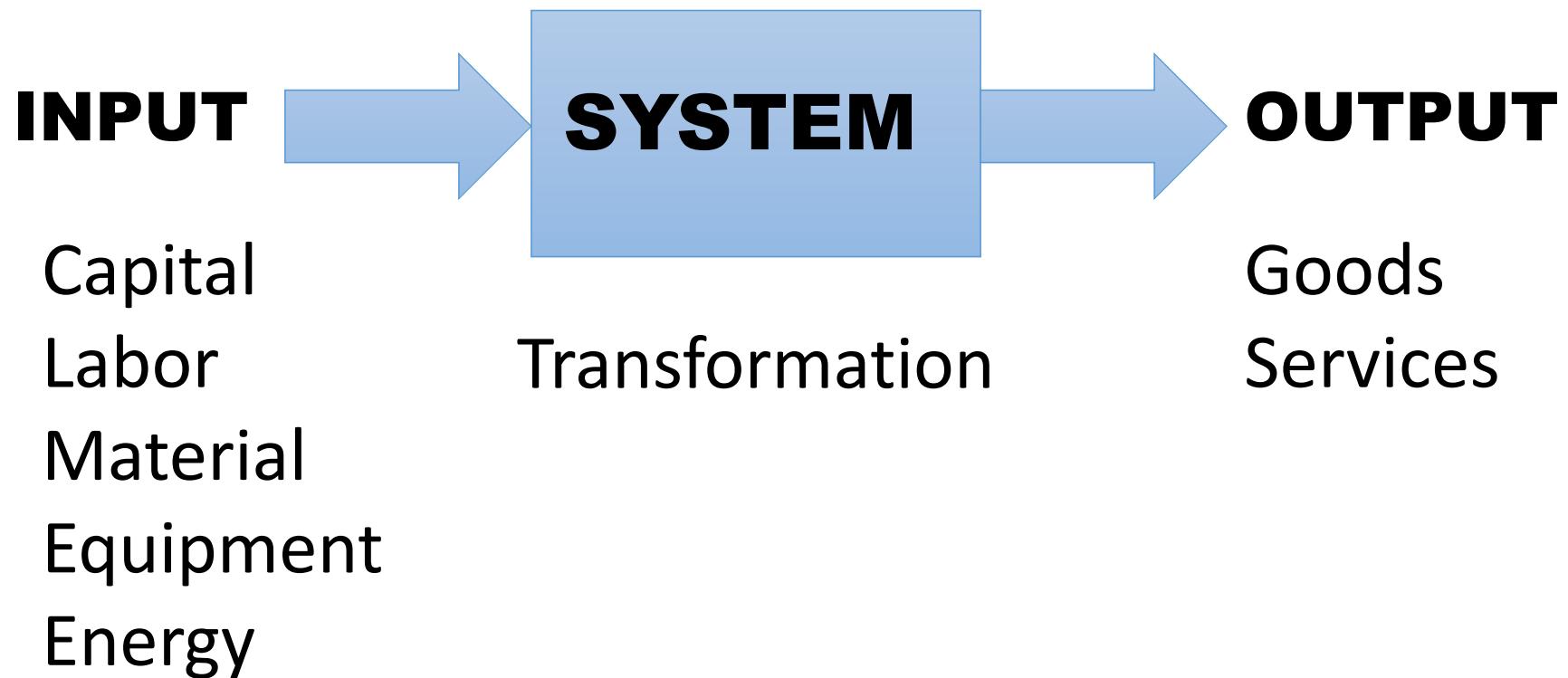
Definitions

- **Production** is concerned with the activity of production goods and services.
- **Production rate** is the quantity of total production produced in unit of time.

Definitions

- **Total productivity** is the ratio of total output produced to the total inputs used.
- It is not necessary that the greater the production, the greater the productivity.

General Productivity Model



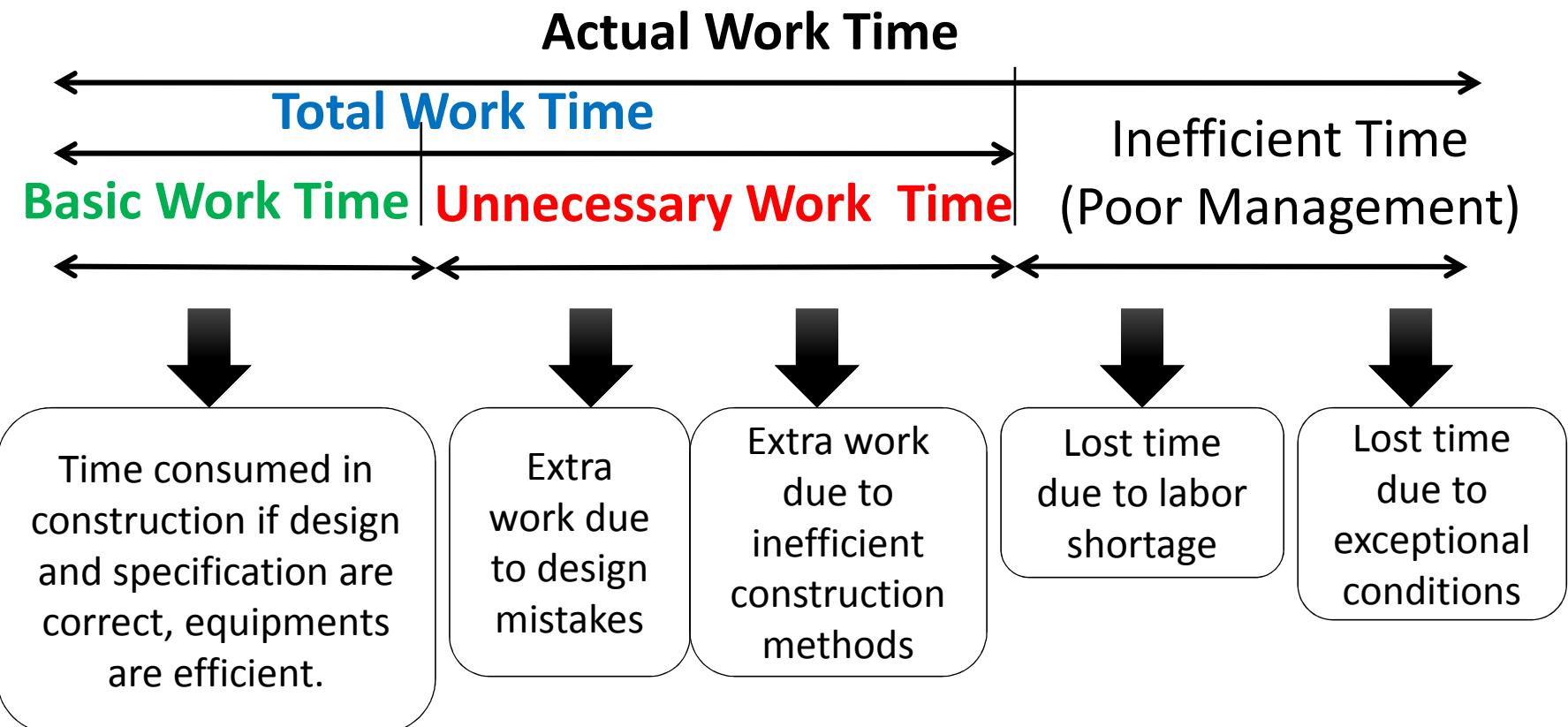
How to Improve the Productivity

- Increase output + decrease input $\begin{array}{c} + \\ - \end{array}$
- Increase output + same input $\begin{array}{c} + \\ = \end{array}$
- Same output + decrease input $\begin{array}{c} = \\ - \end{array}$
- High rate of output increase + low rate of input increase $\begin{array}{c} ++ \\ + \end{array}$
- Low rate of output decrease + high rate of input decrease. $\begin{array}{c} -- \\ - \end{array}$

How to Improve the Productivity

- **Generally, for developed countries:**
 - Replace labor with equipment
 - Replace old equipment with modern equipment
- **For developing countries:**
 - Lack of money → need for management to increase labor productivity.

Work Time Component



Construction Productivity Facts

- Labor productivity
 - Reach max on Sunday
 - Decreases after Tuesday and reach min on Thursday
- Best time for labor production is 10am – 12am
- Labor need 10-15% of work time as rest time
- Average lift capacity is 41,36 kg

Construction Productivity Facts

- In repetitive jobs.... Labor productivity decrease after 60:70 min
- Labor productivity is min before lunch time and at the end of the day
- labor productivity is max when works 5 days a week, 8 hours a day
- Productivity of first shift is more than second shift

Construction Productivity Facts

- Labor productivity affected by overtime for long time
- Accidents happen during unproductive time, productive time is safe
- Most injuries happen on Saturday and Thursday

Standard of Living and Productivity

Relation between standard of living and productivity:

- Efficient use of inputs decrease the cost of production
- The production increases
- Amount of output increases.
- Cost of input decreases .
- Productivity increases.

Measures of productivity

- Productivity is not simply **performance** and not the **efficient use of resources**, but a combination of both.
- Its measurement is carried out by means of ratios:
 - Output variables: units produced; products sold; tasks completed; or revenue obtained.
 - Input variables: the number of people employed; hours worked; capital used; material costs.

Total and Partial Productivity

Total productivity is “the ratio of the total output produced to the total inputs used”

$$\text{Total Productivity} = \frac{\text{Total output}}{\text{Total inputs}} \\ (\text{labor+ material+ equipment})$$

Total and Partial Productivity

- Partial productivity is “the ratio of the total output produced to the input of one element of production”

$$\text{Partial Productivity} = \frac{\text{Total output}}{\text{Input of one production element}}$$

$$\text{Labor Productivity} = \frac{\text{Total output}}{\text{Labor input}}$$

$$\text{Material Productivity} = \frac{\text{Total output}}{\text{Material input}}$$

Highest Productivity

- Converting all productive elements inputs into output in order to deliver a quality product, achieve maximum cost effectiveness, through the maximum efficient use of resource.

Labor productivity measures

a) Average labor productivity:

$$\text{Labor Productivity} = \frac{\text{Total output}}{\text{Labor input}}$$

$$\text{Average Labor Productivity} = \frac{\text{Total output}}{\text{Man-hours of Labor input}}$$

Labor productivity measures

b) Marginal labor productivity:

- A measure of the impact on production of the addition of one more unit of labor while keeping other factor fixed.

$$\text{Marginal Labor Productivity} = \frac{\text{Increase in output}}{\text{One unit of Man-hour}}$$

Example 1

- A construction company produces 1,000 blocks by employing 40 workers at 7 hours/day for one month. Assume this month has a 25 working days.
- What are the production rate and productivity of labor?

Example 1

Production rate = 1,000 Blocks/month

$$\text{Labor productivity} = \frac{1,000 \text{ Blocks}}{40 \text{ workers} \times 25 \text{ days} \times 7 \text{ hrs/day}}$$

Labor productivity = 1 Block/ 7 man-hours.

Example 2

- Suppose this company increased its production to **1,500 Blocks** by employing **30 additional workers** at **7 hours/day** for one month, this month has a **25 working days**.
- What are the production rate and productivity of labor now?

Example 2

Production rate = 1,500 blocks/month

$$\text{Labor productivity} = \frac{1,500 \text{ Blocks/month}}{(40+30) \text{ workers} \times 25 \text{ days} \times 7 \text{ hrs/day}}$$

Labor productivity = 1 block / 8.2 man-hrs

- The production of blocks has gone up by 50%
- The labor productivity gone down by 17%
- Increased production does not mean increased productivity.

Factors Affecting Productivity

- Factors affecting construction labor productivity:
 - 1. Industry related factors**
 - 2. Project related factors**
 - 3. Labor related factors**
 - 4. Management related factors**



Industry related factors

- Investment
- Government
- Research and development
- Weather
- Building code and specification

Project related factors

- Project design
- Design changes
- Method of construction
- Type of contract
- Location
- Type of project
- Work type
- Physical element



Labor related factors

- Supply and demand
- Unions rules
- Crew composition
- Crew size
- Skills
- Capabilities
- Motive



Management related factors

- Planning and scheduling
- Control
- Project organization
- Supervision
- Materials and tools availability
- Lack of motivation of workers
- Site layout
- Work redoing over crowded areas



**The management
ineffectiveness causes
delays which result in
....poor productivity.**

Planning and scheduling

- Lack of project planning and scheduling is one of the important reasons of low construction productivity.
- Planning a project can reduce production costs by increasing productivity of craftsman and optimizing utilization of available resources.

Control

- Problems arise every day that could not have been foreseen.
 - Adverse weather
 - Material delivery delays
 - Labor disputes
 - Job accidents
- Productivity will suffer due to lack of coordination and communication and resource shortage.

Project Organization

- The main task of any organization is to plan, direct and control.
- Poor organization result in poor productivity.
- Defining individual positions of authority and responsibility will lead to an effective operating environment and good productivity.

Supervision

- Although unnecessary supervision will increase the cost of work, insufficient supervision will result in confusion delays and decrease productivity.
- The labor productivity is increased by increasing the number of man hours per day that the field supervisor spent in contact with the crew.

Material and tool availability

- Unavailability of material and tool had a significant adverse impact on the productivity of labor.
- When formal material management programs are applied in any project, a minimum 6% improvement in labor productivity should be achieved.

Work redoing and delays

- Work redone maintained a position as **one of three worst problems** leading to poor productivity.
- Causes of work redone were mainly due to **engineering and management inefficiencies**.
- Craftsmen spent an average of **14.3%** of their time redoing work.

Lack of motivation

- The greater the worker motivation, the greater his effort.
- The followings frustrate the worker and cause low productivity:
 - Lack of material,
 - frequent change orders,
 - conflict of crews because of improper scheduling,
 - lack of equipment, etc.

Site layout

- Site layout of the project is a very important organization tasks.
- The assigned location of different job components affects productivity, safety, workers satisfaction, and communication.
- Approximately, 7% of a day is nonproductive because of a non optimal site layout.

Information and communication

- Lack of information, uncertainty regarding design factors, site conditions, client wishes, and regulatory requirement result in design delay, redesign and substantial loss of productivity.
- Approximately, 9% of a day is nonproductive because of poor or inadequate communications at the job site.

Authority and decision making

- Group participation in decision making has been proven to be an effective method of increasing productivity.
- Participation of work group in changing work methods increases productivity by 14% compared to non participating groups.

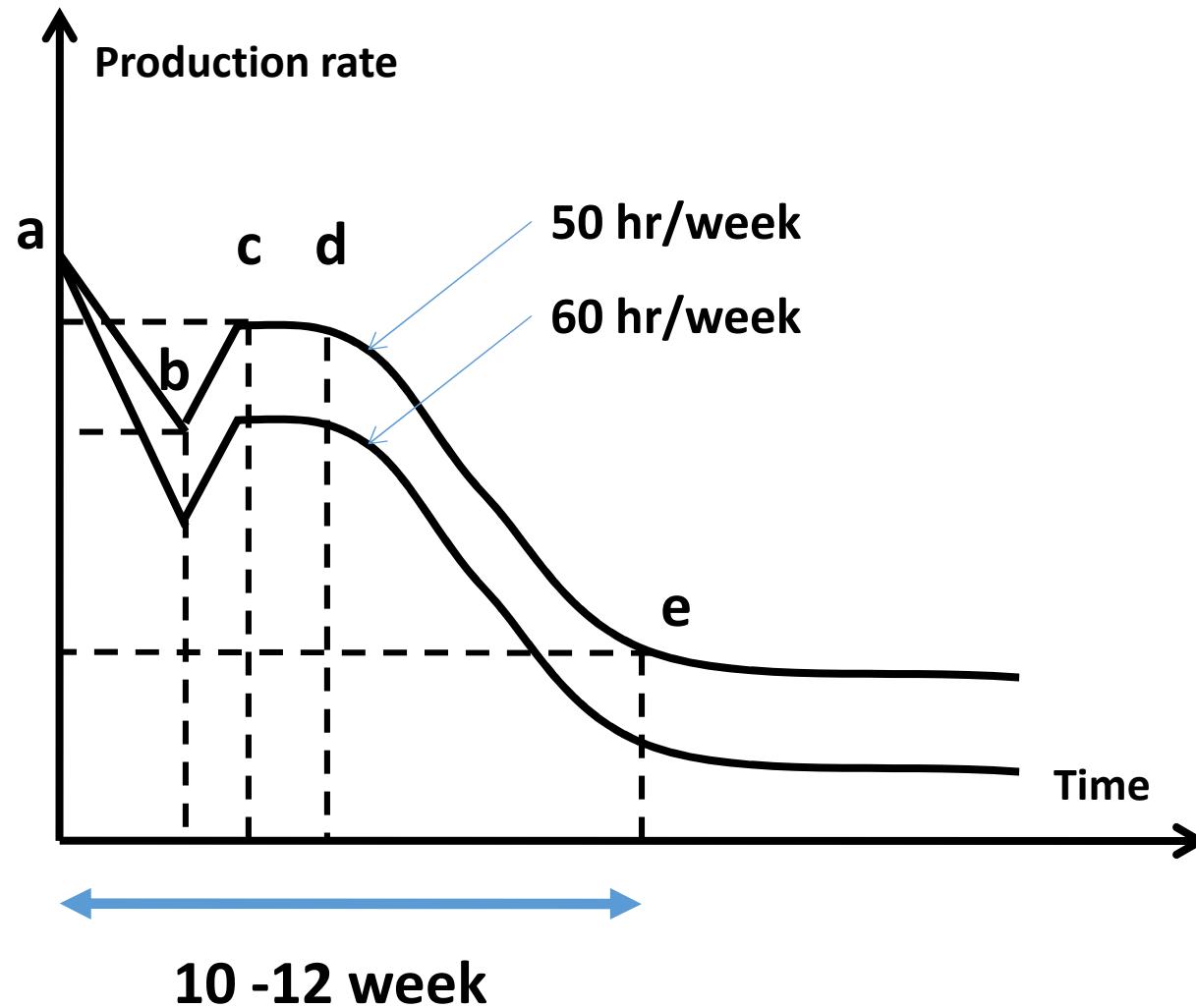
Productivity VS Quality

- Quality means; inspection, quality control, quality assurance, and total quality management.
- Low quality of construction will cause redoing work.
- Redoing work affects the production rate and decrease the output.
- When output decreases, productivity decreases.

Production rate increase

- Use shifts
 - Use two or more shifts instead of one shifts
- Apply overtime
 - Increase shift period to 10 hours instead of 8 hours
- Increase resources
 - Use more resources to increase production rate

Overtime Effect on Output



Methods to improve construction productivity

Step 1 → Inspire Your Workers

Step 2 → Improve Communications

Step 3 → Lay Out A Productive Jobsite

Step 4 → Schedule Your Work

Step 5 → Analyze Project Reports

Step 6 → Manage Equipment Productively

Step 7 → Improve Safety

Step 8 → Pay Attention To Quality

Example 3

- The following data are given for a construction operation:
- Quantity of work = 4680 units
- Number of laborer = 4 laborers
- **Normal conditions:**
 - 42 hours/workweek – 7 hours/day – 6 days/week
 - Production rates = 3 units/man-hour
 - Labor cost = 3 L.E./hour/labor
- **Scheduled conditions:**
 - 60 hours/workweek – 10 hours/day – 6 days/week
 - Production rates = as shown in table
 - Labor cost = 3 L.E./hour/labor (for 7 hour/day) & 4.5 L.E./hour/labor (for hours over 7 hour/day)

Example 3

Week number	1	2	3	4	5	6	7	8	9	10	11	12
Av. Commutative % normal production rate	83	88	88	83	79	74	70	67	66	65	64	63

- a) Calculate the duration and labor cost for this operation in the following cases:
 - i. Normal conditions: 42 hours/workweek
 - ii. Scheduled conditions: 60 hours/workweek
- b) Compare between the results of both cases

Example 3

- Normal conditions:
 - Duration = quantity / production rate
 - Quantity = **4680 units**
 - Production rate = $3 \text{ units/man-hours} \times 7 \text{ hours/day}$
 $\times 6 \text{ days/week} \times 4 \text{ labors} = 504 \text{ units/week}$
- **Duration = 9.3 weeks**
- **Cost =** $3 \text{ LE/man-hour} \times 7 \text{ hours} \times 6 \text{ days/week}$
 $\times 9.3 \text{ weeks} \times 4 \text{ labors} = \text{4687.2 L.E.}$

Example 3

Scheduled overtime:

For 9 weeks:

$$\begin{aligned}\text{Quantity of Production} &= (3 \text{ units/man-hours} \times 0.66) \times 4 \text{ labors} \\ &\quad \times 10 \text{ hours/day} \times 6 \text{ days/week} \times 9 \text{ weeks} \\ &= 4276.8 \text{ units}\end{aligned}$$

From Table



For 10 weeks:

$$\begin{aligned}\text{Quantity of Production} &= (3 \text{ units/man-hours} \times 0.65) \times 4 \text{ labors} \\ &\quad \times 10 \text{ hours/day} \times 6 \text{ days/week} \times 10 \text{ weeks} \\ &= 4680 \text{ units}\end{aligned}$$

From Table



Example 3

Using scheduled overtime will take 10 weeks

**Cost = (3 LE/man-hour x 4 laborsx 7 hours/day x 6 days/week
x 10 weeks)+(4.5 LE/man-hour x 4 labors x 3 hours/day
x 6 days/weekx 10 weeks)= 8280 L.E.**

- Overtime should not be implemented for long time.
- Overtime may not save time or money.
- Using overtime should be limited to follow up with late project schedule.

Questions

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