# ENGINEERING EFFICIENCY, TECHNICAL EFFICIENCY AND ECONOMIC EFFICIENCY

**ENGINEERING EFFICIENCY:** It is defined as the ratio of output to the input of a physical system. The physical system may be a diesel engine, shop floor, machine working etc. It is the physical amount of some single key input used in production and is measured by the ratio of that input to output.

Engineering efficiency (%) = **(Output/Key Input) x 100**

Engineering efficiency does not take financial considerations. It is purely about physical relationships.

*Ex. engineering efficiency of an engine: Let a steam engine is 40 percent efficient means that 40 percent of the energy in the fuel is converted into work done, while the other 60 percent is lost in friction, heat loss, and other unavoidable sources of waste.*

Efficiency is the measure of "usefulness" of an operation, process or machine - and can be expressed on the generic form

$\mu = W_o / W_i \quad (1)$

*where*

$\mu$ = *efficiency*

$W_o$ = *output from the operation - can be work, power, produced products ...*

$W_i$ = *input to the operation - can work, power, input products ...*

Efficiency can be expressed as a percentage or as a per-unit decimal fraction of *1*.

**Q1: Example - Efficiency of an Electric Motor**

The input power to an electric motor is *2000 W*. The output power to the shaft is *1800 W*. The efficiency of the motor can be calculated as

$\mu = (1800\ W) / (2000\ W)$
$= 0.9$
$= 90\%$

**Q2: Example - Efficiency of a Wind Mill**

The teoretical energy potential for a wind mill is *300 kWh* at given conditions. The power produced is *70 kWh*. The efficiency of the wind mill can be calculated as

$\mu = (70\ kWh) / (300\ kWh)$
$= 0.23$
$= 23\%$

- Any efficiency calculated from real-world values will be between 0% and 100%.
- An **efficiency of 0%** means that **all the input energy is wasted**, and the energy output is equal to zero.
- On the other hand, an **efficiency of 100%** means that there is **no waste of energy** whatsoever.

**Q3: What is meant by 60% efficiency of a machine?**

An efficiency of 60% means that **only 60% of the energy supplied to the machine can be converted into useful work** and the rest is lost.

**Q4: Can a real machine have an efficiency of 100%?**

**No**, a real machine can't have an efficiency of 100%. An efficiency of 100% means that there is no loss and the output energy (or work) of the machine is equal to input energy (or work). **In real machines, there is always some loss of energy to overcome friction and air resistance**.

**Q5: Example**

If a cyclist puts 600 J of work on his bicycle and the bicycle gives out 140 J of useful work. Calculate the efficiency of a cyclist.

**Solution:**

Given:

Work Input = 600 J,

Work Output = 140 J

The efficiency is given as

$\eta = \{ \text{Work Output} / \text{Work Input} \} \times 100\ \%$

$= \{140 / 600\} \times 100\ \%$

$= 23.3\ \%$

**Q6: Calculate individual operator efficiency**

Let's find the efficiency of a stitching machine operator.

The machine operator is worked 8 hours and he has produced 400 garments in the given job. The standard time of the job was 30 seconds. Note that to calculate produced minutes you need to know the standard minute of the job (operation).

He has produced minutes (400 X 30)/60 = 200 minutes. He has worked 480 minutes.

So, his efficiency is (200/480)*100 = 41.67 %

Q7: **Question-** A laborer puts in around 20 J of energy in one strike of his hammer on the nail's head. The energy which the laborer inputs to drive the nail in the wood is 8.0 J. Calculate the efficiency of the laborer's hammering?

**Answer-** We see over here that we have got our energy output as 8.0 J. Further, the energy input of the laborer is 20 J. Thus, we can calculate the efficiency by using the formula as below:

$\eta = \frac{W_{out}}{W_{in}} \times 100\%$

$\eta = 8.0J20J \times 100\%$
$\eta = 0.40 \times 100\%$
$\eta = 40\%$

Therefore, we see that the efficiency of the hammer strike was 40%. Vibrations and heating of the nail are two potential causes for the loss of energy.

**Q8: Question-** A certain process of the chemical has an energy efficiency of just 3.00%. In order to complete this chemical process on a large-scale, 140,000 J of energy is put in. Calculate the energy output of this process.

**Answer-** We see that we have energy input which is 140,000 J. We also know the efficiency as 3.00%. In order to calculate the energy output, we need to rearrange the formula for efficiency.

$\eta = WoutWin \times 100\% \rightarrow Wout = Win\eta 100$
$Wout = Win\eta 100$
$Wout = (140{,}000\ J)\ (0.03)$
$Wout = 4{,}200\ J$

Therefore, the energy output of this chemical process comes out as 4,200 J.

## Technical efficiency rate

- **Technical Efficiency:** is related to physical amount of all resources used in producing a product.
- Technical efficiency (%) = **(Output produced / All Input resources ) x 100**

Thus technical efficiency is about getting the most output from any given set of inputs; or, equivalently, about producing a given level of output using the least amount of physical inputs. Ex. Technical efficiency of a diesel engine Technical efficiency (%) = (Heat equivalent of mechanical energy produced/ Heat equivalent of fuel used ) x 100

$$\text{Technical efficiency} = \frac{\text{Actual output from given inputs}}{\text{Max. potential output from given inputs}} \times 100$$

Q1: Example: Suppose a firm produces 300 cars a week from its current workforce and quantity of robots. If the maximum potential output was 320.

The technical efficiency rate of the firm would be (300/320) = 93.75%

In this case, some workers and factor inputs are underemployed, and there is a degree of potential output missed.

Q2: Let a firm is using 100 units of labour and 50 units of capital to produce a level of output. If the firm could maintain its output level by using only 90 units of labour without using more capital, then it is being technically inefficient in current methods as it is “wasting” 10 labour units.

# Economic Efficiency

**Economic Efficiency** is related to the value or cost (rather than the physical amounts) of all inputs used in producing a given output. It is defined as the ratio of output to the input of a business system. Worth is the annual revenue generated by the way of operating business and cost is the total annual expenses incurred in carrying out the business.

**Economic efficiency (%) = (Output/ Input) x 100 = (Worth/ Cost) × 100**

The production of a given output is economically efficient if there are no other ways of producing the output that use a smaller total value of inputs.

Ex. a firm have three alternative production methods.

First require a lot of labour but only a little capital,

Second requires a lot of capital and only a little labour, while third production method may require a lot of land but relatively little of both labour and capital. In order to be economically efficient (maximize its profits) the firm should choose the production method that costs the least.

Economic efficiency is also called ‘productivity’