ENGINEERING ECONOMY STUDY IN A TRANSPORT INDUSTRY

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Appreciation:

…….. With all protocol observed, I wish to thank the executive committee of the Institute of Appraisers and Cost Engineers, a division of Nigerian Society of Engineers, for the opportunity to have words/expose on this less understood but important arm of the Institute.

Introduction:

Engineering Economy as a study came to be because there are always alternatives to any decision, solution, goal, process, business, from which a studied choice has to be made. The choice could be based on technical and nontechnical, economic and non-economic, tangible and intangible factors. But the concern of engineering economy study is determining and selecting the most economic option/alternative, considering the

prevailing economic factors. In other words, engineering economy study involves determining the economic factors concerning the alternatives to a decision or choice and subjecting the factors to the applicable mathematical processes and principles in order to select the most economic.

Engineering economy study process:

Following problem-solution approach, the process involves the following steps:

1. Identify the problem and the goal of the study
2. Collect relevant data towards achieving the goal
3. Define the alternative solutions
4. Evaluate each alternative
5. Select the best economic alternative based on some criteria
6. Implement the solution and monitor the outcomes

Study Case:

Going by the topic, Engineering Economy Study in a transport Industry, I want to focus on tyre manufacturing industry for its relevance in road transportation and I shall draw a case from a typical tyre manufacturing industry in Nigeria like Dunlop Nig Plc. The case is that the company was experiencing frequent failure of the control system of one of their curing press machines. The company was considering replacing the press with modern one which offers the following advantages: reduced frequency and cost of maintenance because it has solid state control system instead of electromechanical system of the former; higher

productive capacity of about 5%, reduced operation and maintenance cost, Reduced scrap and rework cost. In other words, the company wanted the proposed replacement to have steady production at more or full capacity at reduced Total Cost.

Problem and Goal Identification

The problem here, as proposed by the company, was taking studied decision to either replace the press (designated the defender for the purpose of the study) with the modern equivalent (the challenger), or maintain the status quo. So the goal of the study was replacement analysis to help the company take informed decision on the matter.

Alternative Solutions Definition

The two alternative decision questions the company put forward are (1) Buy the modern press, (2) Retain the existing press. But in the analysis, I identified and defined another alternative: (3) Retrofit the existing press with new control system.

Data collection

To carry out the assignment, there are veritable economic data/estimates about the defender and the challenger needed. The data include

1. Estimated First Cost of the machines (purchase price, cost of delivery and installation)
2. Estimated Operation and maintenance cost in a year
3. Estimated life of the new machine and the remaining life of the existing machine

4. Operating interest rate or rate of return over the planning horizon in form of Minimum Attractive Rate of Return(MARR) estimate
5. Estimated annual income from the machines
6. Projected salvage value of the machines

The gathered information was as follows:

Description	Defender	Challenger
Initial Investment	Fair Market Value = N1.25M	First cost = N5M
Annual O&M Cost	As recorded in use = N0.5M	5% of First Cost in first 5yrs; 7.5% in the last 5yrs
Estimated Economic life	Residual life = 5yrs	Estimated economic life = 10yrs
Rate of Return or Interest Rate	estimated MARR = 15%	estimated MARR = 15%
Study period/horizon	10yrs – as the new press	Life of the new press = 10yrs
Estimated Salvage value	N0.25M	20% of First Cost = N1.0M

Evaluation of the alternative solutions

This is the crux of engineering economy study. The process involves the following:

(1) Decide on the approach to adopt: opportunity cost approach or cash-flow approach
(2) Draw the cash-flow for each alternative over the study period
(3) Elect the most convenient measure of worth computation models: Present worth (PW), Annual Worth(AW), Future Worth(FW), Rate of Return(ROR) and Capitalised Cost (CC)
(4) Formulate the mathematical equations for the respective cash flows of the alternatives, applying the elected measure of worth computation model
(5) Solve the equations for the alternatives

For the study, I used opportunity cost approach and annual worth analysis because the projected life of the new press and remaining life of the older one are not equal. It is the practice to have the alternatives analysed on equal terms. In the analysis, it is assumed that the services of the defender are available for the same AW value in the extra 5yrs above its residual life.

Selection of the Best Alternative

The solution to the equations resulted in values, which, compared, indicated the most economical of the alternatives. The basis for the selection was which alternative had the highest numerical value (highest net income or least expenses).

The result of the study favoured Alternative1 (purchase the modern press) as against Alternative2 (retain the existing press).

Consideration of other Factors

The above analysis that favoured the aternative1 was based purely on the economic factors inherent in the machines; the economic environment was not considered. So it might not be absolutely said that alternative1 was the best until we consider the external factors.

The new machine had the capacity to produce 5% more. The relevant questions I asked were: was the demand there to pick up the additional production? If not, what was the cost of storage for the additional production? The study was carried out when, as is now, there was fragrant importation cheaper tyres, both new and second hand ones. So the data was updated to have the cost of storage charged on the challenger.

With the additional output considered, the alternatives were evaluated and the computation showed that alternative1 was not significantly better.

Then I redefined an alternative solution to test alternative1 against alternative3: retrofit the control system of the existing press.

The data for this is as below:

Description	Defender (option3)	Challenger (0ption1)
Initial Investment	Retrofit cost = N0.75M	First cost = N5M
Estimated Annual	As recorded in use =	5% of First Cost in

O&M Cost	N0.5M	first 5yrs; 7.5% in the last 5yrs
Estimated Economic life	Residual life = 5yrs	Estimated economic life = 10yrs
Rate of Return or interest Rate	the company's MARR = 15%	the company's MARR = 15%
Study period/horizon	10yrs	Life of New press = 10yrs
Estimated Salvage value	N0.25M	20% of First Cost = N1.0M
Cost of storage per annum	-	N0.25M

The result of the computations showed the alternative3 was the best option and report was so delivered. However, the ultimate decision was then left with the company. It might find non-economic factors more impelling to take alternative one.

Conclusion:

Engineering economy study is a veritable tool in decision making. It provides a background to consider other factors as non-economic, social, and environmental ones that bear on selecting a projects or investment. If Nigerian governments and organisations will appreciate the import of engineering economy and engage the services of accredited Engineering economists in conception of projects, lots money will be saved. Engineering economy study is relevant in the following choices:

1. Which technology to adopt for a particular activity or project?

2. Which manufacturing process holds more economic promise for a proposed plant?
3. This new building project with new technology and material, what is the maintenance cost especially of the expertise is not there? Looking at the maintenance cost, is economical? The First Cost is not only the issue in engineering economy but the entire life cycle.
4. What are the economies of rail transportation to road, to marine, to air?
5. In Electricity generation, what are the economies of coal-fired plant to gas-fired, thermal plant to hydro plant? For a mix generation, what is the optimum?
6. In Build-operate-and-transfer (BOT) agreements, how many years will the lease transfer the facility from commencement? At what annual charge? At what rate of return?
7. Ore-Benin road fails yearly in the raining season. So would the federal government do remedial works on the road on the public outcry. What is the economy of doing the repairs for, say 5, years to doing the road afresh? The waste will be obvious.

These are samples of questions that engineering economy study answers.

Thanks and God bless.

References:

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Appendix: Tyre manufacturing processes:

1. **Compounding and Banbury Mixing**: Banbury mixer combines rubber stock, carbon black and other chemical ingredients(compounds which act as accelerators, anti-oxidants, anti-ozonants, extenders, vulcanizers, pigments, plasticizers, reinforcing agents and resins) to create a homogeneous rubber material (compounded rubber). Time,

heat and raw materials are factors utilized to engineer material composition.

2. **Milling**: Shaping of rubber begins in the milling process. The compounded rubber is placed onto a drop mill. The milling process shapes the rubber into flat, long strips by forcing it through two set rolls rotating in different directions at different speeds.
3. **Calendering and Extruding**: The calender operation continues to shape rubber. The calender machine consists of one or more (often four) rolls, through which the rubber sheets are forced to prepare compounded rubber as a uniform sheet of definite thickness and width, to place a thin coat of rubber on a fabric ("coating" or "skimming"), to force rubber into the interstices of fabric by friction ("frictioning"). The rubber sheets coming off the calender are wound on drums, called "shells," with fabric spacers, called "liners," to prevent sticking.

   The extruder creates tube-like rubber components by forcing rubber through dies of appropriate shape. The extruder consists of a screw, barrel or cylinder, head and die. A core or spider is used to form the hollow inside of tubing. The extruder makes the large, flat section of tyre treads.
4. **Tyre component assembly and building**: The tyre assembly machine consists of a rotating drum, on which the components are assembled, and feeding devices to supply the tyre builder with the components to assembl. The components of a tyre include beads, plies, side walls and

treads. After the components are assembled, the tyre is often referred to as a “green tyre”.

5. **Curing and Vulcanising**: After being assembled, the green tyre is sprayed with a solvent- or water-based material to keep it from adhering to the curing press. The press utilizes steam to heat or cure the green tyre. Rubber curing or vulcanization transforms the tacky and pliable material to a non-tacky, less pliable, long-lasting state.

To these processes, there are different technologies for the machinery used. Which is better in economic sense, is one of the questions engineering economy study can answer? But that is not the case of our study in this lecture.