CHAPTER 16: SIMULATION

Question

What is simulation and what are the steps in simulation?

Answer

Simulation is a **quantitative procedure** which describes a process by **developing a model** of that process and then conducting a **series of organised trial and error experiments** to predict the behaviour of the process over time. Observing the experiments is much like observing the process in operation. To find how the real process would react to certain changes, we can introduce these changes in our model and simulate the reaction of the real process to them. For example, in designing an airplane, the designer can build a scale model and observe its behaviour in a wind tunnel. In simulation, we build mathematical models which we cannot solve and run them on trial data to simulate the behaviour of the system.

Steps in Simulation: Simulations vary in complexity from situation to situation. However, in general, the following steps are involved:

a. Define the problem or system you intend to simulate.
b. Formulate the model you intend to use.
c. Test the model and compare its behaviour with the behaviour of the actual problem environment.
d. Identify and collect the data needed to test the model.
e. Run the simulation.
f. Analyze the results of the simulation and, if desired, change the solution you are evaluating.
g. Rerun the simulation to test the new solution.
h. Validate the simulation, that is, increase the chances that any inferences you draw about the real situation from running the simulation will be valid.

Monte Carlo Simulation:

The Monte Carlo method is the earliest method of simulation named after its propounder. This method employs random numbers and is used to solve

problems that depend upon probability, where physical experimentation is impracticable and the creation of a mathematical formula impossible. First the probability distributions of the variables under consideration is determined; then a set of random numbers is used to generate a set of values that have the same distributional characteristics as the actual experience it is devised to simulate.

Monte Carlo methods (or **Monte Carlo experiments**) are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results i.e. by running simulations many times over in order to calculate those same probabilities realistically just like actually playing and recording your results in a real situation: hence the name. They are often used in physical and mathematical problems and are most suited to be applied when it is impossible to obtain a closed form of expression or infeasible to apply a deterministic algorithm.

Question

What are the steps involved in carrying out Monte Carlo simulation model?

Answer

Monte Carlo methods are mainly used in three distinct problems: optimisation, numerical integration and generation of samples from a probability distribution. Monte Carlo methods are especially useful for simulating systems with many coupled degrees of freedom, such as sequence and queuing situations, fluids. They are used to model phenomena with significant uncertainty in inputs, such as the calculation of risk in business. When Monte Carlo simulations have been applied in space exploration and oil exploration, their predictions of failures, cost and schedule overruns are routinely better than human intuition or alternative "soft" methods.

Monte Carlo methods vary, but tend to follow a particular pattern:

a. Define possible inputs.
b. Generate inputs randomly from a probability distribution.
c. Perform a deterministic computation on the inputs.
d. Aggregate the results.

Question

How would you use the Monte Carlo Simulation method in inventory control?

Answer

Monte Carlo Simulation method can be used in the following areas of inventory control

a. Determination of ROQ & ROL
b. Computation of stock out costs and impact on profit
c. Analysis of value of storage facilities for avoiding stock outs and impact on profit, and
d. Analysis of demand distribution during lead time etc.

Question

Write a short note on the advantages of simulation.

Answer

Advantages of simulation are:

1. Simulation techniques allow **experimentation** with a model of the system rather than the actual operating of the system.
2. Simulation is a **flexible** model and can be altered to variations.
3. Simulation is **easier** than complex mathematical models.
4. **Training** people on simulation is easier.
5. A simulation model is **easier to explain** to management personnel since it is a description of the behaviour of some system or process.
6. Simulation allows the manager to incorporate **time into an analysis**. In a computer simulation of business operation the manager can compress the result of several years or periods into a few minutes of running time.
7. Simulation allows a user to **analyse large complex problems**.

Question

State major reasons for using simulation technique to solve a problem.

Answer

Reasons for using simulation technique are:

a. It is **not always possible to develop a mathematical model** and solutions without some basic assumptions. In certain scenarios, the mathematical models are too complex to use.
b. It is **not always possible to find** all important **variables** of the model.
c. Sufficient **time may not be available** to allow the system to operate for a very long time.

d. Actual operation and observation of a real system may be too **disruptive and expensive.**

[Memory: Maths Variables are too difficult, untimely, costly and disruptive]

Random Numbers:

The most common methods used for generating random numbers are:

a. Mid Square method;
b. Spinning Arrow method;
c. Dice Rolling method;
d. Spinning Disc method; etc.

Steps involved in generation of random numbers are:

a. Collection of data related to the problem;
b. Construction of frequency distribution;
c. Construction of relative frequency distribution;
d. Adopting a coding system that relates the identified events to generate random numbers;
e. Ascertaining the method to generate random numbers;
f. Match random numbers to the events tabulation result;
g. Repeating the above steps until desired number of simulation runs are carried.

Limitations of Simulation:

a. Unlike other mathematical models, simulation is a **non optimising model.** We cannot be sure that the selection we make by this method is optimal.
b. Simulation **cannot be applied in all situations**.
c. Simulation model package may be **expensive**.
d. Obtaining representative **information** for simple models also will be **very huge** and substantial to satisfy the iteration criteria.

CHAPTER 17: LEARNING CURVE

Learning is the process by which an individual acquires skill, knowledge and ability. When a new product or process is started, performance of worker is not at its best and learning phenomenon takes place. As the experience is gained, the performance of worker improves, time taken per unit reduces and thus his productivity goes up. This improvement in productivity of workers is due to learning effect.

Question

What are the distinctive features of learning curve theory in manufacturing environment? Explain the learning curve ratio.

Answer

Learning curve is a geometrical progression, which reveals that there is steadily decreasing cost for the accomplishment of a given repetitive operation, as the identical operation is increasingly repeated. The amount of decrease will be less and less with each successive unit produced. The absolute amount of cost increase will be successively smaller but the rate of decrease will remain fixed and in due course gets stabilised as learning cannot go on infinitely. The slope of the decision curve is expressed as a percentage. The other names given to learning curve are Experience curve, Improvement curve and Progress curve. Learning occurs because of the following:

a. **Better tooling** methods are developed and used.
b. **More productive equipments** are designed and used to make the product.
c. **Design bugs** are detected and corrected.
d. **Better design** engineering reduces material and labour costs.
e. Early **teething problems are overcome**. As production progresses management is prompted to achieve better planning and better management.
f. **Rejections and rework tend to diminish** over time.

g. **As quantity** produced **increases**, the following **financial costs** per unit **decrease**:
   i. Direct **labour cost** since each unit entails Lesser labour and lesser time;
   ii. Direct **Material Cost** due to Greater productivity of material;
   iii. **Variable overheads** due to fewer delays and lesser time losses.

Learning Curve Ratio: The effect of experience on cost is summarised in the learning ratio or improvement ratio. For example, if the average labour cost for the first 500 units is Rs. 25 and the average labour cost for the first 1,000 units is Rs. 20, the learning curve ratio is (Rs. 20/25) or 80%. Since the average cost per unit of 1,000 units is Rs. 20, the average cost per unit of first 2,000 units is likely to be 80% of Rs. 20 or Rs. 16. Learning curve ratio is usually denoted with 'b' or's' and is calculated as:

$$\text{Learning Ratio (s or b)} = \frac{\text{Avg. Labour cost of first 2N units}}{\text{Avg. Labour cost of first N units}}$$

Learning Curve Equation: This is given by the formula:

$$\mathbf{Y_x = A\ X^b}$$ Where,

Y_x = Cumulative average cost of x units or lots;

A = Average cost of the first unit or lot;

X = Cumulative Number of units or lots;

b = Learning coefficient which is calculated by the formula:

b = log of learning ratio / log 2

Further, $Y_x = A\ X^b$ implies

$$\mathbf{\log Y_x} = \log A\ X^b = \log A + \log X^b \mathbf{= \log A + b \log X}$$

Question

Discuss the application of the learning curve.

Answer

Learning curve helps in the following areas:

a. Learning curve helps to analyse cost-volume profit relationships during familiarisation phase of product or process to arrive at cost estimates.

b. It helps in budgeting and profit planning.
c. Learning curve method will be very effective in high labour oriented areas and also machine jobs of repetitive nature.
d. It helps in pricing and consequent decision making – e.g. acceptance of an order, negotiations in establishing contract prices etc. with the advantage of the knowledge of decreasing unit cost.
e. It helps in setting standards in the learning phase.
f. It helps in negotiations.
g. Learning curve method can be applied to even non-production activities like marketing.

[Memory: CVP, BUDGETS, STD. COSTING, PRICING, PROFIT, (i.e. Chapters IN Costing) NEGOTIATE, NON PRODN.]

Important areas of Learning Curve affecting Management accounting are:

a. Direct Labour costs;
b. Variable overheads;
c. Standard Costing;
d. Pricing Decision;
e. Output capacity; etc.

[Memory: 2 Cost Elements (L & VOH), 5 Costing Chapters. (CVP, BUDGETS, STD. COSTING, PRICING, PROFIT)]

Li**mitations of Learning Curve Theory**: These are:

1. All activities of an enterprise are not subject to learning effect.
   a. **Activities** that have **not** been **performed in** this **present** operational **mode**.
   b. Activities which are being performed by **new workmen**, new employees or others not familiar with the particular activity. In contrast, activities being performed by **experienced workmen**, who are thoroughly familiar with those activities will not be subject to learning effect.
   c. Activities involving utilization of **material not used by firm so far**.
2. It is correct that learning effect does take place and average time taken is likely to reduce. But in practice it is highly unlikely that there will be a regular consistent rate of decrease. In cases where the operations are **highly automated**, learning effect will be very low or even nil. Therefore, any cost predictions based on conventional learning curves should be viewed with caution.
3. Considerable **difficulty** arises **in obtaining valid data** that will form basis for computation of learning effect.
4. **Job rotation of workers is inversely related** to learning benefit.

5. Even slight change in circumstances quickly renders the learning curve obsolete. While the regularity of conventional learning curves can be questioned, it would be wrong to ignore learning effect altogether in predicting future costs for decision purposes.

Question

The following information is provided by a firm. The factory manager wants to use appropriate average learning rate on activities, so that he may forecast costs and prices for certain levels of activity.

(i) A set of very experienced people feed data into the computer for processing inventory records in the factory. The manager wishes to apply 80% learning rate on data entry and calculation of inventory.

(ii) A new type of machinery is to be installed in the factory. This is patented process and the output may take a year for full fledged production. The factory manager wants to use a learning rate on the workers at the new machine.

(iii) An operation uses contract labour. The contractor shifts people among various jobs once in two days. The labour force performs one task in 3 days. The manager wants to apply an average learning rate for these workers.

You are required to advise to the manager with reasons on the applicability of the learning curve theory on the above information.

Answer

The learning curve does not apply to very experienced people for the same job, since time taken can never tend to become zero or reduce very considerably after a certain range of output. This is the limitation of the learning curve.

(i) Data entry is a manual job so learning rate theory may be applied. Calculation of inventory is a computerized job. Learning rate applies only to manual labour.

(ii) Learning rate should not be applied to a new process which the firm has never tried before.

(iii) The workers are shifted even before completion of one unit of work. Hence learning rate will not apply.

Question

State whether the learning curve theory can be applied to .the following independent situations briefly justifying your decision:

a. *A labour intensive sculpted product is carved from the metal provided to the staff. The metal is sourced from different suppliers since it is scarce. The alloy composition of the input metal is quite different among the suppliers.*
b. *Pieces of hand-made furniture are assembled by the company in a far off location. The labourers do not know anything about the final product which utilizes their work. As a matter of further precaution, rotation of labour is done frequently.*
c. *Skilled workers have been employed for a long time. The company has adequate market for the craft pieces done by these experts.*
d. *A company finds that it always has an adverse usage of indirect material. It wants to apply learning curve theory to improve the way standards have been set.*

Answer

a. 'Learning Curve Theory' will not be applicable as alloy combination of the input metal is quite different among the suppliers. Learning experience with one type of metal may not be beneficial for the workers to deal with other metal with separate alloy composition.
b. 'Learning Curve Theory' will not be applicable as in this situation rotation of labour is done frequently. Labourers will not be able to get the benefit of learning and apply their learning.
c. 'Learning Curve Theory' will not be applicable as in this situation workers are skilled and employed for a long time. They have already achieved maximum level of expertise by taking advantage of learning.
d. 'Learning Curve Theory' will not be applicable as indirect materials are the materials which are not used directly in the production (not directly proportionate with volume of output) and are usually used for machines (e.g. lubricants, spares parts etc.) with less human interactions. Adverse usage of indirect materials can be controlled through proper monitoring and appropriate standard settings and not from applying learning curve theory.