BASIC CONSTRUCTION OF QUANTITATIVE MODELS

INTRODUCTION.

Simulation is a quantitative method that describes a process, developing a model of it, and subsequently carrying out controlled and organized experiments to observe and make predictions of its behavior over time.

Observing the experiments is equivalent to observing the process in operation, if you want to know how the real process would react to certain variations, these can be applied to the model and simulate the reactions to said variations in the real process. For example, when designing an airplane, the designer can solve various equations on the aerodynamics of the airplane, but if those equations are difficult to solve, what you can do is build a scale model and observe its behavior in a wind tunnel.

In simulation, in general, the construction of mathematical models of situations that are not easy to solve is carried out; these are executed with test data to simulate the behavior of the model in various situations; although on the other hand assumptions can also be made, making it possible for the simulation to obtain a clear perception of some decision-making problems when the mathematical evaluation of the model is not possible.

The decision-making process can sometimes be very complex, for this reason, you can choose to use a quantitative approach when the following situations exist:

- The problems are very complex, and the manager cannot find a solution without the support of a quantitative analysis.
- The problem involves investing large sums of money and careful analysis is necessary before attempting to make the decision.
- The problem is new and there is no previous experience on which the manager can build.

- The problem occurs repeatedly and allows the manager to save time and effort by using quantitative procedures to make recommendations in routine decision situations.

There are two differences between simulation models and mathematical models:

1. The simulation models are not designed to obtain optimal or better solutions as in the mathematical models, instead, different proposed options are evaluated, and a decision is made according to the comparison of results. In a few words, the performance of a previously specified system.

2. Simulation models focus on detailed operations, be they physical or financial; unlike mathematical models, simulation models represent the system as a whole, and consequently all cause-and-effect situations between model elements are considered in all system experiments. The simulation allows us to calculate both the expected values (means) of the descriptive measures of the performance of a system, as well as the extreme values or variances.

PROCESS MODELING

Currently more and more companies use simulation processes to improve their innovation processes, simulation can be used to show how different economic processes are developed, as examples we can mention: order of production / management, to improve services and the response time to customer requests, as well as inventory management, to select an effective cost system, or to improve the quality of delivery service, in the claims process, etc.

In each of these processes, the simulation allows creating the means to carry out an analysis of the system and allows obtaining an innovative approach to achieve better solutions, in addition to representing the processes, resources, products and services through the use of a computerized model. and very dynamic, through which all the real operations of a company are reproduced, considering the time factor.

The software used by the simulation models considers the statistics of the model elements, where the metric behavior can be evaluated through the analysis of the model's output data. There are situations in which both the cause and the effect are almost imperceptible and the effects in the intervention time are not so obvious, that is, they are complex.

ELABORATION AND IMPLEMENTATION OF A SIMULATION MODEL.

There are three phases for the execution of a simulation model:

- **Evaluation and design**
- **Execution**
- **Measurement of achievement and continuous improvement**

Next, we will see each of them in detail.

1. EVALUATION AND DESIGN.

In this first phase the following activities are carried out:

1. Identify in the organization the person in charge of the simulation process to get management to commit.

2. Define the needs of the simulation, for which the characteristics of the process to be modeled must be defined, and if the modeling will require process reengineering, and how often the simulations will be carried out, who will be the end users, etc.

3. Make an estimate of the necessary resources, through the preparation of a financial plan and a budget where the costs of start-up and the application of simulation technology are estimated.

4. Carry out an evaluation and choose the simulation technologies available. In this stage, the cost and time required to carry out the project are evaluated.

When starting a simulation study, to build a model it is recommended to use simple functions, either first or second degree polynomials, during initial experimentation, the model provides us with an approximation of the optimal response, and helps us to identify the following scanning processes. Later, when the first degree functions are not capable of explaining the answer logically, a second degree function is used, and once the optimal response has been defined, the simulation model will serve to estimate the optimal coefficients of the key variables to perform a sensitivity analysis of the system.

In order to choose a simulation technology, it is necessary to know the methods that exist, then we will see each of them.

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- Analytical methods. These methods employ techniques related to queuing theory, which consists of a set of nodes assembled together in a network called multilevel. This type of analytical simulation involves multiple agents competing for the same resource, in a variable environment with input-output processes. These analytical models perform estimates on stable aggregate events with greater precision than any analysis performed by data series.

- Continuous methods. Continuous methods can be useful to model large-volume processes or continuous productions; this method performs a simulation using differential equations that show the variation of each state variable over time. This state variable could be the rate of arrival of orders or the rate of processing of a resource, which vary continuously and differentiable over time. In general, continuous methods can be useful for modeling high-volume processes or continuous productions.

- Discreet methods. These models are made up of state variables that move over a discrete set of points, the temporal flows between these points compete with each other for the use of scarce resources. Discrete methods simulate certain random behaviors, introducing discrete probability distributions, therefore the results are also random, and can only be taken as an estimate of actual behavior, for which it is necessary to carry out various approximations so that the result obtained from the simulation approaches the real one. In a discrete model, entities represent products and services that compete for the resources that are necessary to carry out the activities. These types of methods are very common to model and analyze processes.

- Object-oriented methods. This method uses processes, products, services and resources as if they were objects, and each object is made up of attributes and methods, which are combined to make an example of them, for example, the "client" object may have attributes such as age, debt capacity and level of education. In object-oriented methods the development time of models is reduced, since an information template can be used and reused.

5. Carry out an analysis of the relationships between tools and simulation methods in order to obtain coordination between them. The simulation consists of certain tools and methods such as the development of flow charts, cost systems based on activities, as well as the design of experiments.

6. Evaluate and choose simulation software. In this step, a choice of the software to be used must be made, taking into account that the technology is useful to meet the objectives of the simulation.

7. Receive the necessary training and manage the pilot project. This stage involves actions such as the analysis and capture of input data, the construction of the pilot model, the design and performance of tests and analysis of output data.

2. EXECUTION

When the pilot project has been successful, and the simulation has been proven to be convenient, the execution stage can proceed, which consists of the following stages:

Simulation project design.

To carry out this stage the following tasks will be performed:

- Define the objectives to be achieved. These objectives can be the analysis of the operation of a process, the analysis of process capacity, a sensitivity analysis or an optimization analysis.
- Define the constraints. It is important to define constraints as time, since a simulation cannot be projected if the execution time exceeds the resolution period.
- Define the field of action. This includes aspects such as the degree of precision, the type of tests to be performed and the content and format of presentation of results. Defining the scope of a model is equivalent to delimiting the lower and upper limits as well as its beginning and end.

Data capture and analysis.

In this stage, the data is classified, differentiating the different variables of time, resources, and conditions, as well as differentiating the input and response variables, knowing the data requirements and the sources of collection.

Model construction.

When building a model, it is not necessary for it to be fully detailed, since improvements can be made in the construction process until it reaches its final format. It is recommended to start from a simple model and gradually add complexity. It should be remembered that object-oriented simulation technology allows models to be reused without having to build them again.

Model verification.

In this stage, a simulation analysis is performed, tests are applied and the results are presented.

3. MEASURE OF ACHIEVEMENTS AND CONTINUOUS IMPROVEMENT.

In this phase, activities such as the revision of goals and principles, the establishment of reports, the feedback process, and the execution of continuous improvement processes are carried out.

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