

# Strategic and Standardized Simulation of a Distribution Network A Case for a Drugstore Company in Mexico

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**Abstract:** Analysis of distribution network is a crucial issue in supply chain management. There is a vast array of analysis tools for logistics, but analytic tools cannot deal with the inherited variability. Thus, simulation might be a better alternative, and the use of standardized models represents a promising areas. In this paper, a simulation model facing a strategic approach will be proposed as a way to analyze a distribution network based on model consisting of two-echelons; this model can work both forwards and backwards in a recursive manner, and relies on operative key performance indicators that affect the strategy in the long term. Using a standardized model increases flexibility, focus the problem and provides a better computer performance. The model is validated through a business case for a Mexican company dealing with bottom of pyramid clients in the drugstore sector.

## 1 INTRODUCTION

Supply chain management is a challenge for every organization, and in the case of healthcare, suitable supply of medicines is a crucial issue, existing opportunities to improve distribution under a strategic approach using simulation techniques.

This paper is organized as follows: first, a literature review of strategy and simulation related to supply chain is presented; then, the focus of a standardized simulation model for distribution networks in a drugstore company is presented, followed by a test of this model in a real case in Mexico and finally, some conclusions and further research are mentioned.

## 2 LITERATURE REVIEW

### 2.1 Strategy

Strategic planning is a key issue for companies in today's world competition. It provides a guide to achieve sustainable results, and all activities within the companies must be aligned to their strategy, as stated by Porter (1996). Then, supply chain management must support the strategy of the

company, but it should be considered as "a dynamic, stochastic and complex system" (Pundoor and Hermann, 2006).

### 2.2 Supply Chain

One strategic objective of supply chain is "fulfilling customer demand, assuring the on-time delivery of high-quality products at a minimal cost and with the minimum lead-time" (Chang and Makatsoris, 2001). In the healthcare industry, having the required products at any moment of time is vital and also represents a social activity in the community served.

Hung, Kuchereko, Samsatti and Sha, 2004, have suggested that supply chain must deal with external strategic challenges and also with the operational uncertainty, so new opportunities can be detected.

### 2.3 Simulation and Supply Chain

Supply chain must be evaluated in an effective manner, and simulation can be used within the supply chain to analyze different issues: inventory policies, configuration of activities, distribution, lead times, costs, etc.

Shanthikumar and Gargent (1983) claim that simulation models are focused on dynamic models that resemble the behavior of a real system; and

Buxton, Fuqua and Wyland (2000) that supply chain must be flexible enough to adapt to a wide range of potential futures. Petrovic, Roy and Petrovic (1998) even consider a crucial issue the separation of strategic issues from those tactical or operational ones.

### 2.4 Standardized Models

Pundoor and Herrmann (2006) suggest that, no matter the components of the supply chain, there are always some common processes that can be reused, leading to the definition of standardized simulation models. Jain, Collins, Workman and Ervin (2001) suggest the use of generic tools to define a flexible model of the supply chain. Cope, Sam-Fayez, Mollaghasemi and Kaylani (2007) emphasize on using generic simulation models that can be reconfigured in an easy way to individual projects, while Brown and Powers (2000) suggest simulation models focused on a specific problem, but flexible enough to evolve in the future, as well as Longo and Mirabelli (2008) and Petrovic, Roy and Petrovic (1998).

## 3 SIMULATION MODEL

Considering a supply chain for a drugstore company, we propose a standardized simulation based on a two-echelon structure that can be reused on other parts of the chain, thus allowing a complete analysis, and under a strategic approach, to support relevant decisions in the long term. The assumptions of the model are:

### 3.1 Standardized and Recursive Model

A set of common operations has been defined and will be used as the logic to be standardized and recursively used both forwards and backwards.

### 3.2 Strategic Approach

The model must encompass the long-term focus of the distribution network, but also includes two tactical or operational indicators in order to evaluate the network, being:

1. The location of inventories within the network (and their associated levels).
2. The transportation cost.

The integration of both indicators will provide a total cost, consisting of total inventory holding cost,

transportation cost and the financial cost of inventory.

The strategic consideration is supported by the use of an aggregate demand.

### 3.3 Unitary Transportation Cost

A unitary transportation cost, considering the routes, vehicles and aggregated amount of products transported, will be calculated.

### 3.4 Discrete Operation

All variables are transformed to observation based one, and the model is also based in a non-temporal time framework. The model is based on a single control entity that flows through the model and executes each of the logic steps defined.

### 3.5 Standard Logic

The model encompasses some common processes found during the inventory and replenishment systems in all major SC systems. The main logic of the model is embedded in a two-echelon framework, including non-strategic operations which affect the strategic deployment, and will be based in a one week time period.

The two-echelon logic can be replicated to a series of clients-suppliers in different parts of the supply chain, where a supplier becomes a client of another supplier. The replication, both forwards and backwards, can also be replicated in a parallel framework. The code is generic in a sense that is programmed only once for the common logic, and then can be reused, as can be seen in Figure 1.

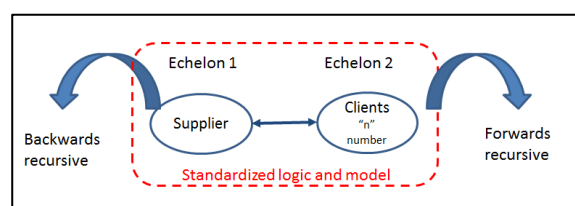


Figure 1: Standard model and recursion.

### 3.6 Simulation Software

The previous logic might be so complex to be performed by a graphical simulator, so it was developed in the simulation language SIMNET II, owed to Dr. Hamdy Taha, which provides the so-called PROCEDURES that can be considered as a standard part of the code that can be automatically

replicated both in series or parallel, providing a generic and reused code.

## 4 TESTING THE MODEL

### 4.1 Validation

A business case was developed using a drugstore company in Mexico, focused to serve the Bottom of Pyramid population, in order to test and validate the model based on its actual distribution network.

This company manages its distribution network through a master distribution center (MDC), which serves nine regional distribution centers (RDC). Each RDC serves specific regions. The base unit of aggregation of demand will be a region.

Furthermore, any region is formed by local warehouses and stores (some owned by the company and other ones are franchisees). There are a total of 35 warehouses and about 4,000 stores located across Mexico. A brief schema of the distribution network is shown in Figure 2:

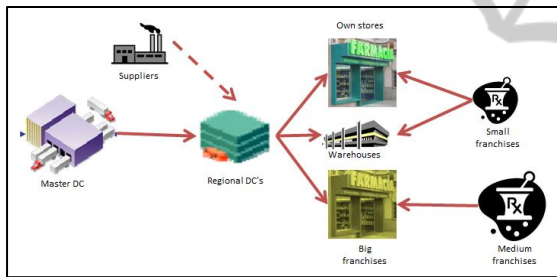


Figure 2: Layout of distribution network.

At any region, the RDC serves owned stores, big franchisees and local warehouses. There is no transportation cost to small franchisees, because they must pick up their products.

The MDC is used as a delivery station for products manufactured by the company in its private laboratory, located next to the MDC.

Transportation between MDC and RDC, and also between RDC and servicing facilities are carried out by an external company.

Each RDC operates independently from the others; there is no overlap in and therefore a two echelon network divided in two phases can be considered:

Phase 1: Each RDC and its associated region.

Phase 2: The MDC and its associated RDC.

The model can be used as nine-independent analysis of the RDC and regions, where the RDC is the supplier and each region is a client. Then, the RDC

become clients of the MDC in another analysis, as can be seen in Figure 3:

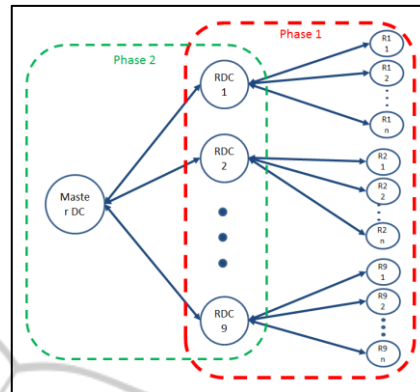


Figure 3: Recursive use of the standardized model.

Data from one complete year was available and used for validation purposes. Once the regions were defined, model was tested under the actual policy of 30 day of stock in inventory levels and under steady-state analysis, and the differences in the total inventory level were about 2.7% versus historical data. Figure 4 presents comparisons versus simulation and historical data based on a percentage basis, where history is represented by 100%.

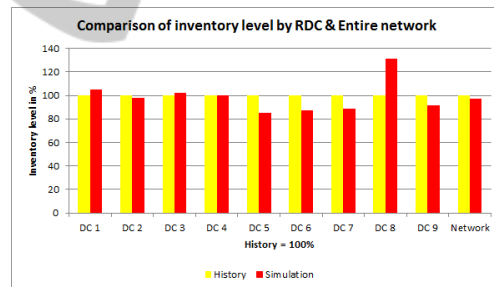


Figure 4: Comparison of inventory level of base case versus simulation model.

In the case of transportation cost, difference of simulation versus historical data is about 3.2%, as can be seen in Figure 5:

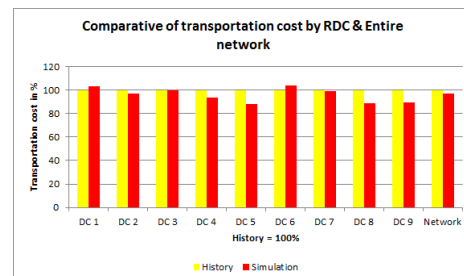


Figure 5: Comparison of transportation cost of base case versus simulation model.

Considering this differences and a target error of 5%, results from simulation model is within tolerances.

## 4.2 Improvement Case

The model was used to analyze some alternatives to improve the distribution network, including:

- Opening/Closing/Merging of RDC.
- Reassignment of regions to RDC.
- Adding delivery frequencies.
- Using multiechelon inventories.

About twenty scenarios were simulated and the model only required adding a small code to manage the multiechelon inventory and the additional delivery frequencies. A new distribution network was found, composed by eight RDC, using multiechelon inventories and serving twice-per week to the metro areas, as shown in Figure 6:

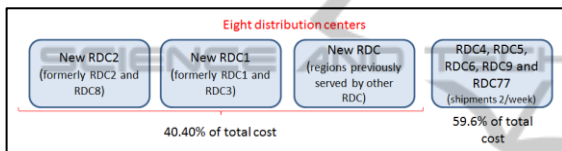


Figure 6: Configuration of proposed distribution network after simulation analysis.

Considering the actual distribution network as 100%, there are significant savings, as shown in table 1:

Table 1: Comparison of key performance indicators of base case versus proposed network.

Indicator	Actual	Proposed	Savings
Inventory (pieces.)	100%	50.1%	49.9%
Transportation cost \$\$\$	100%	98.6%	1.4%
Total cost \$\$\$	100%	80.7%	19.3%

The final savings of 19.3% of the total costs is important for the company; this savings can be used to reinforce the competitive position of the firm.

## 5 CONCLUSIONS

The proposed model, based on a two-echelon system that can be replicated both forwards and backwards, has been tested and used in a real situation to improve a distribution network; its operation has been fast, and helped to focus on the most important characteristics of the model.

Finally, it is really critical to consider that any simulation model, specially a strategic one, must be

designed to support a company to comply with its strategy. This model must fit within the “reducing cost” strategy to improve service to the bottom of pyramid clients.

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