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REVIEW ARTICLE

APPLICATION OF OPTIMIZATION IN INVENTORY MODELLING

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ABSTRACT

Optimization is key to any trouble involved in decision making, whether in industries, factories, engineering, market or economics. Inventory modelling has broad applications of optimization techniques. In this paper, the various applications in inventory modelling are presented.

INTRODUCTION

The project objective of optimization could be just to minimize the cost of production or to maximize the proficiency or efficiency of production. An optimization algorithm is an operation which is executed iteratively by comparing successive solutions to an optimum or an acceptable solution is found. The world is facing several revolutions like digitalization, globalization and security threats, which affect companies, industries and supply chains worldwide. So, in this computer-friendly world, optimization has turned a part of computer-aided activities. Fig. 1 demonstrates the sketch of the steps involved in an optimization formulation. John Holland introduced a Genetic Algorithm in his book named "Adaptation in Natural and Artificial Systems" in 1975 (Holland, 1975). The new optimization techniques are honey bee swarm for numerical optimization by (Karaboga, 2005), Assessing trade-offs among multiple objectives for humanitarian (Gralla, 2014), design of eco-industrial parks (Boix, 2015), Bi-criteria group scheduling in hybrid flow shops (Bozorgirad, 2013) etc.

Classical Optimization Techniques:

- The classical optimization techniques are beneficial in obtaining the unconstrained maxima and minima or optimum solution of continuous and differentiable functions.
- These methods give analytical solutions and utilise the differential calculus in positioning the optimum solution.
- The classical techniques have limited scope in practical applications because some objective functions may be not continuous and/or differentiable.
- There are mainly three kinds of problems, formulated by the classical optimization techniques:
- Single variable functions.
- Multivariable functions with no constraints.
- Multivariable functions with both equality and inequality constraints.
- The Lagrange Multiplier Method can be used to formulate the problems with equality constraints.
- The Kuhn-Tucker conditions can be used to obtain the optimum solution for problems have inequality constraints.
- Also, there are more methods of optimization namely, numerical methods of optimization, advanced optimization techniques, simulated annealing, genetic algorithms, ant colony optimization.

Pricing Optimization: Pricing optimization is the keystone for growing your business profitability. The primary idea regarding pricing optimization is quite easy. First, determine the demand curve, then connect it with the cost function and finally calibrate the point where marginal revenue equals marginal costs. Also, we calculate how demand varies at different price settings. We should construct such an effective pricing optimization framework which will maximize long-term profit and growth. It is the practice of mathematical analysis (Fig.1) by an organization to diagnose how customers react to different price settings and services provided through different channels for the products. It is also essential to determine the best-suited price, which meets its objectives such as maximizing profit and minimizing cost.

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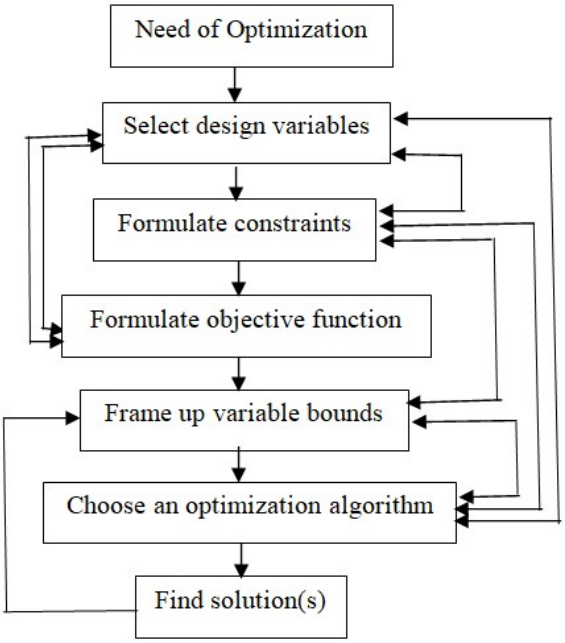

Fig. 1. A flowchart of the optimization formulation

The data used in price optimization can include survey data, operating costs, inventories and historic prices and sales. Price optimization practice has been implemented in industries including banking, airlines, hotels, retailers, casinos, insurance etc. Companies or managers use price optimization methods to decide the price constructions for initial pricing, production pricing, discount pricing and promotional pricing.

Inventory Optimization: There are many real-life examples of optimization. Some of them are:

- World largest distributor of electronics products in the United kingdom, namely, "Electrocomponents", has increased profits by $36 million by using inventory optimization (Lafferty, 2012).
- "Castrol" reduces finished goods inventory by an average of 17 percent while increasing service levels by 9 percent by using inventory optimization (Forcino, 2013).
- A division of Smiths group, "Smiths Medical", used inventory optimization to study the demand unpredictability and supply unevenness. In the result of this, reducing the risk of understocks and overstocks for the smooth running of business affairs (Bowman, 2012).

Inventory is always one of the top factors for profitability. Inventory optimization is a method of adjusting capital investment constraints or objectives, demand and supply unpredictability, meet service-level goals while keeping a sufficient amount of inventory in stock. Also, trying to extend the minimum amount of capital in inventory. Inventory optimization is an important level of inventory management for warehouse, or supply chain manager or manufacturer. Inventory optimization models can be either deterministic—with every set 0f variable parameters are uniquely determined in the model or stochastic—with variable parameters have probability distributions. This optimization takes a supply of uncertainty into account. The result of the stochastic approach is a better understanding of the inventory requirements than with a deterministic approach. Companies have achieved an economical advantage by employing inventory optimization (Brandel, 2009).

Key elements of Inventory Optimization: Inventory optimization aims to compute the amount of inventory required to meet demand. You have to answer mainly two questions for optimizing your inventory. First, how much to order of every single stock-keeping unit and second when to order, so that you serve your customers well. In this way, you will always have the right quantity products in the right time at warehouse, without investment of too much capital. Therefore some key elements of inventory optimization:

- Demand forecasting
- Inventory policy
- Replenishment

Suppose an enterprise runs a single deteriorating item with the deterioration rate $\lambda(\alpha)$ and an item is purchased at the rate D(p) (Namdeo, 2020). The initial stock of each cycle is Q. The accumulated inventory decreases due to demand and deterioration over the interval $(0, T_1)$. After the time T_1, the price discount starts. In the interval, (T_1, T_2), management decides to sell the items at a discount rate that influences demand rate and the level of inventory reaches zero at $t = T_2$. Hence, after time $t = T_2$, the shortage occurs in the interval (T_2, T). The rate of change of inventory follows the pattern depicted in Fig. 2, and the inventory level is formulated by the differential equation that is shown below:

$$\frac{\partial I(t)}{\partial t} + \lambda(\alpha) I(t) = -D(p), \quad 0 \le t \le T,$$

By solving this equation we get the inventory level. After that, the inventory optimization process can be applied to it for important results.

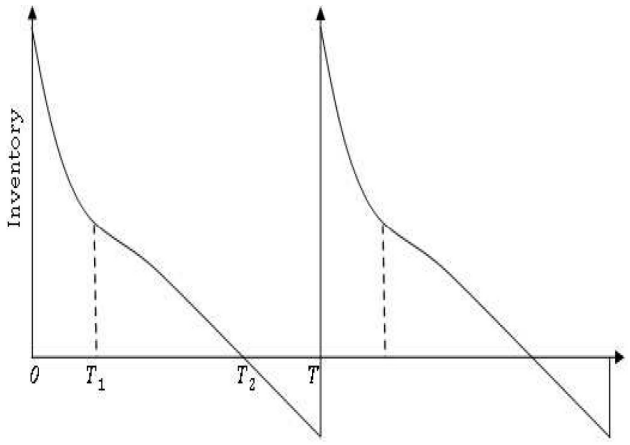

Fig. 2. Graphical representation of theinventory system

CONCLUSIONS

A basic overview of optimization in inventory modelling is provided. The flowchart for the formulation of non-linear, constrained optimization problem is presented and many optimization techniques for solving the problem are discussed. The advantages of pricing and inventory optimization are highlighted, and suggestions regarding key elements are made to aid the retailer in making the best decision for a specific problem on hand. Also, a short example is represented to discuss the particular case for optimization.

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