OPTIMIZATION OF THE INVENTORY POLICY

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Introduction

In today's world, there is an increasing competition among companies due to growth in international trade and technological developments. Customers desire to satisfy their needs on desired time and desired quality.Hence, this forces companies to fulfil their customers' needs.

In this case, inventory management and determining reliable policies has significant importance regarding fulfilling customers needs. Having optimized inventory provides reduction in inventory cost, prevents the product from being out of stock and thus it leads to a competitive advantage for the company. Hereby, companies aim to manage their inventories efficiently and look for best policy by conducting different analyses.

This study is carried out with Stryker focusing on optimization of (Q,R) inventory policy for semi-finished product storage using a combination of discrete event simulation and multi-objective genetic algorithm. The continuous review policy is implemented since lead times for production of semi-finished products are stochastic. However, the framework developed is flexible and other inventory policies will be easy to implement, if needed.

Current System

Stryker mainly focuses on the production of SV2 beds and ST1-X stretchers mostly in recent years. Metal, wooden and plastic raw materials are used for production. These raw materials are supplied from different suppliers in Turkey and also from abroad. These raw materials are operationalised on different machines and are turned into semi-products.

Then, metal semi-finished products are sent to the storage of semi-finished products. The metal semi-finished products coming out of the storage pass through different processes, are transformed into assembly materials and they are stored in assembly material storage. In the factory, there are two main assembly lines, one is for SV2 type bed and another one is for ST1-X type stretcher.

Required materials for bed production and assembly are obtained from assembly material storage and carried to the assembly buffer area. These materials are used by assembly workers to complete assembly.
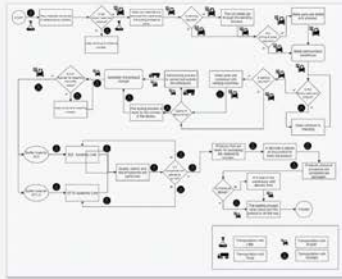

Figure 1. Workflow of the system

The factory operates just a single shift in 5 days a week. The departments that fall behind the production plan operate 2 shifts. If this would not be sufficient, the factory works overtime on weekends.

The factory sets a daily production plan for producing 70 SV2 beds and 15 ST1-X stretchers. Some other products other than bed and stretchers are manufactured in some days. These products are manufactured for an amount that is equivalent to 85-bed income.

Problem Definition

In the current system, there is a lack of systematic inventory policy and the policy followed based on the experience of the foremens in the company. These foremen intuitively choose the base inventory, order quantities and replenishment points of the items in the inventory. In consequence of these, redundant inventory causes storage to take more place and cost overrun. On the other hand, insufficient inventory causes troubles in satisfying demands.

Objective

In the current system, there is a lack of systematic inventory policy and the policy followed based on the experience of the foremens in the company. These foremen intuitively choose the base inventory, order quantities and replenishment points of the items in the inventory. In consequence of these, redundant inventory causes storage to take more place and cost overrun. On the other hand, insufficient inventory causes troubles in satisfying demands.

Methodology

A simulation-based optimization method is proposed to solve the problem.
- Simulation Model
- Multi-Objective Genetic Algorithm
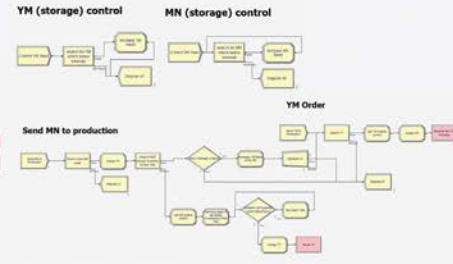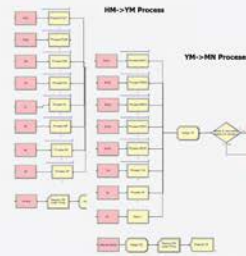

Figure 2. Cycle of applied method

Simulation Model

Figure 3. Arena Simulation Model Logic

Results

The GA model is coded in Python using Jupyter Notebook and the connection between Arena and Python is automated.

To get optimal pair of Q and R, a total of 800 chromosomes are generated in which each 400 of them is embodied in a population.

- The model took 7-8 hours to finish a population.
- Arena runtime was 1 - 1.5 minutes on average per year.
- In total, the model took 400x80 = 3,200 runs to converge.

Figure 4. Optimum Q,R values

Figure 6. Costs' comparison over all chromosomes at iterations

Figure 5. Comparison of the Current Q,R with optimum Q,R

Figure 7. Costs' comparison over iterations

Daily Average	Current	Best	Alternative
Cost (₺)	3602	1846 (%46)	1982 (%47)
SV2	70	70	70
ST1-X	15	15	15
Leading Time (hours)	7.34	2.78	3.33

Yearly	Current	Best	Alternative
Cost (₺)	1.278,230	673,790	686,930
Leading Time (days)	111.93	41.98	50.64

Mathematical Formulation

Sets

i : semifinished products $[i=1,...,166]$

Decision Variables

Q_i : order quantity for each item
R_i : replenishment point for each item

Parameters

A_i : Average Daily Inventory
L_i : Average daily lead time for each item
C_i : Part Cost

Objective Function

$$Min\ Z_{Q,R} = \Sigma W_1 {}^*L_i + W_2 {}^*C_i {}^*A_i$$

Constraints

$$\Sigma W_1 + W_2 = 1$$