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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.

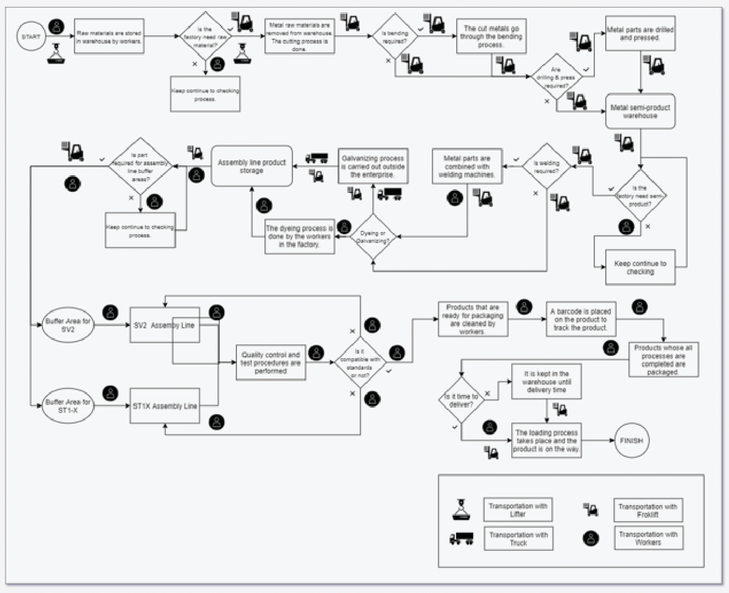

Figure 1. Workflow of the system

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

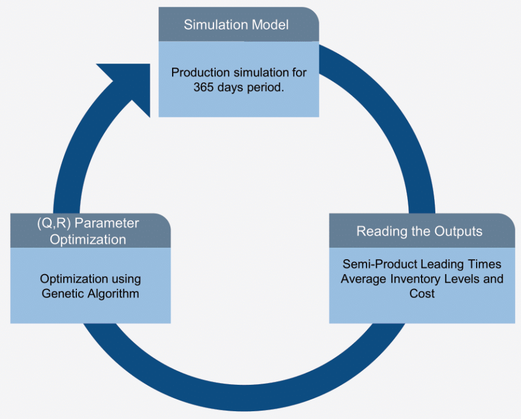

Figure 2. Cycle of applied method

Simulation Model

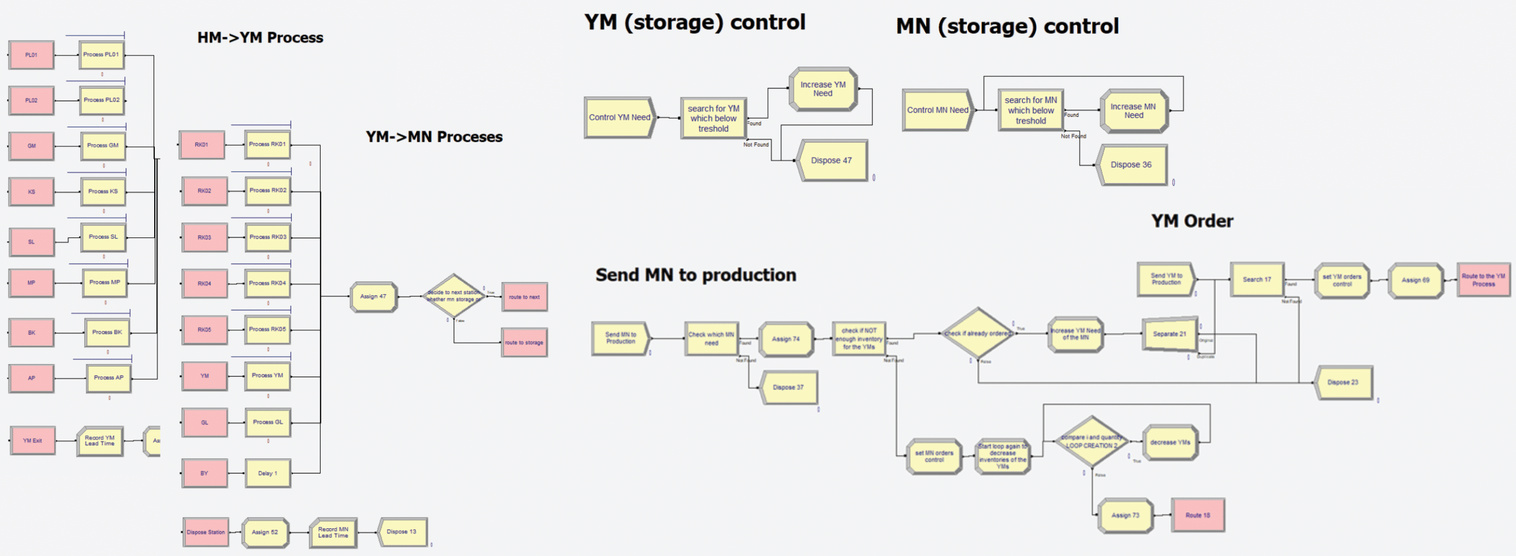

Figure 3. Arena Simulation Model Logic

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.

Q, R								
122, 485	973, 807	530, 834	470, 386	208, 641	843, 735	409, 505	608, 164	359, 778
307, 664	758, 550	218, 652	522, 408	282, 452	987, 381	933, 425	935, 150	314, 916
359, 654	684, 997	754, 502	137, 633	155, 123	133, 242	185, 283	664, 467	999, 432
258, 720	358, 879	247, 686	143, 266	411, 232	429, 988	677, 235	906, 250	638, 591
186,942	973, 107	221, 702	129, 842	505, 298	814, 876	208, 272	925, 590	280, 141
986, 688	327, 501	829, 407	573, 385	280, 863	694, 399	760, 765	915, 846	935, 899
801, 929	462, 164	768, 708	560, 996	272, 105	555, 714	738, 684	667, 975	
942, 171	321, 553	604, 995	498, 999	942, 171	118, 579	691, 938	800, 314	
647, 980	423, 861	261, 287	401, 495	374, 469	846, 731	181, 428	391, 991	
749,126	806, 925	991, 330	725, 805	503, 181	160, 418	639, 895	586, 628	
643, 343	817, 918	104, 447	381, 517	818, 649	898, 107	689, 443	774, 541	
705, 695	321, 151	993, 472	916, 584	135, 102	153, 770	110, 504	801, 681	
981, 765	227, 857	536, 202	408, 282	743, 559	874, 464	825, 472	154, 840	
706, 812	477, 845	154, 512	611,296	538, 361	597, 221	312, 595	111, 879	
387, 596	506, 182	542, 548	308, 405	392, 873	557, 255	938, 479	329, 322	
551, 374	788, 252	866, 979	842, 577	695, 751	336, 408	200, 956	977, 781	
648, 735	602, 165	151, 674	596, 956	332, 437	940, 976	703, 587	747, 692	
315, 369	977, 928	296, 181	594, 521	205, 568	565, 949	344, 657	760, 281	
872, 912	781, 115	641, 317	984, 718	428, 737	321, 257	162, 683	593, 343	
623, 964	774, 223	285, 230	712, 826	256, 442	758, 354	143, 836	330, 808	

Figure 4. Optimum Q,R values

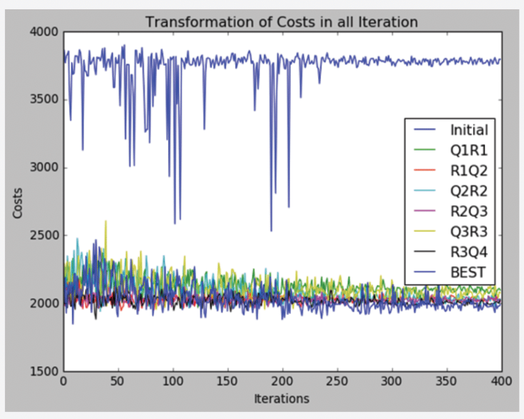

Figure 6. Costs' comparison over all chromosomes of iterations

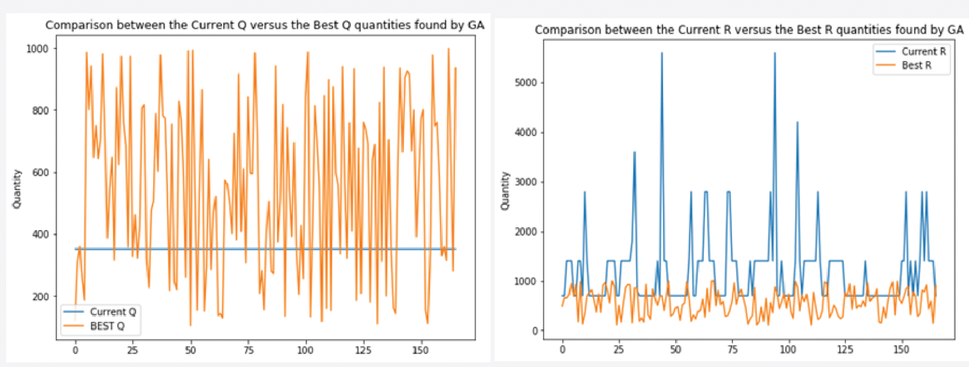

Figure 5. Comparion of the Current Q,R with optimum Q,R

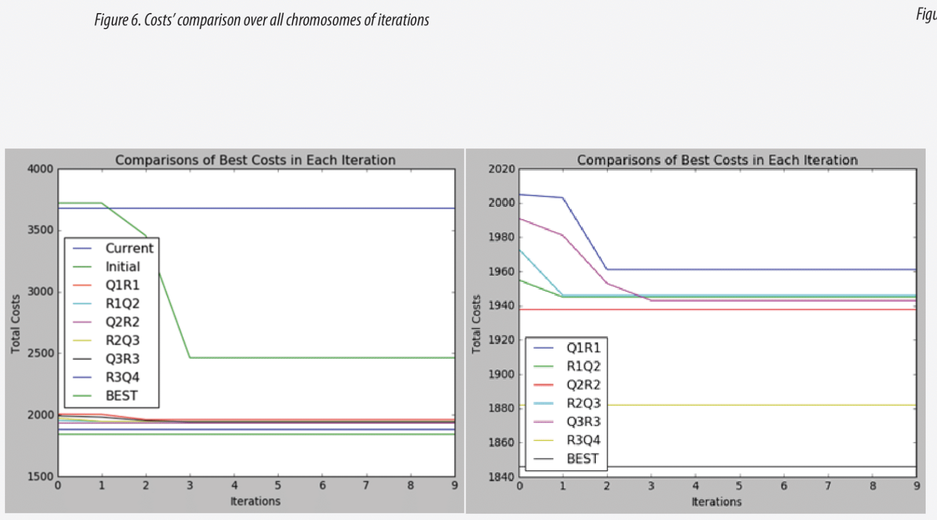

Figure 7. Costs' comparison over iterations

Daily Average	Current	Best	Alternative
Cost (₺)	3502	1846 (%46)	1882 (%47)
SV2	70	70	70
ST1-X	15	15	15
Leading Time (hours)	7.34	2.76	3.33

Yearly	Current	Best	Alternative
Cost (₺)	1,278,230	673,790	686,930
Leading Time (days)	111.93	41.98	50.64

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