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INVENTORY MANAGEMENT AND OPTIMIZATION IN SUPPLY CHAINS: A CASE IN FOOD CHAINS

Alev TASKIN GUMUS
Ali Fuat GUNERI
Yildiz Technical University
Mechanical Faculty, Department of Industrial Engineering, Istanbul
Turkey

ABSTRACT
As the technology improves and widens, the companies change. Especially to be competitive in the market, the companies should renew themselves. In past, managers thought that if they had produced something they could sell it in the market, but now this is impossible. There are too many rivals in the market. For this reason, companies should control their inventories and they should arrange their supply chain mangement activities according to their inventories. Also companies should force their suppliers to deliver in time, at the highest quality and in minimum price. In such a competitive market, the customers should be satisfied and inventories should be effectively managed. So, inventory management and optimization is very important in supply chain management.
Supply chain inventory management (SCIM) is an integrated approach for planning and control of inventory, throughout the entire network of cooperating organizations from the source of supply to the end user. SCIM is focused on the end-customer demand and aims to improve customer service, increase product variety, and lower costs.
Inventory management and optimization is especially important for food chains. In this study; SCIM and optimization is examined and a case in a Turkish food chain is presented.
Keywords: Supply chain management, inventory management, optimization.

1. INVENTORY MANAGEMENT AND OPTIMIZATION IN SUPPLY CHAINS
Supply chain management (SCM) is an integrative approach for planning and control of materials and information flows with suppliers and customers as well as between different functions within a company. This bridges the inventory management focus in operations management and the analysis of relationships from industrial organization [5]. SCM is a set of approaches to integrate suppliers, manufacturers, warehouses, and stores efficiently, so that merchandise is produced and distributed at right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements [7, 8].

SCM has been defined to explicitly recognize the strategic nature of coordination between trading partners and to explain the dual purpose of SCM: to improve the performance of an individual organization, and to improve the performance of the entire supply chain. The goal of SCM is to create sourcing, making and delivery processes and logistics functions seamlessly across the supply chain as an effective competitive weapon [4]. SCM is the practice of coordinating the flow of goods, services, information and finances as they move from raw materials to parts supplier to manufacturer to wholesaler to retailer to consumer. This process includes order generation, order taking, information feedback and the efficient and timely delivery of goods and services [1]. Since the introduction of the term SCM in 1982 (see Oliver and Webber, 1992) it has received ever-growing interest both in the literature as well as from industrial practice. A reason for this might be that it has so many facets and

that the tasks of accomplishing the aims of SCM are so demanding that it is more an ongoing endeavour than a single short-term project [10].

A supply chain is a network of suppliers, manufacturing sites, assembly locations, distribution centers and customer locations through which stock keeping units such as components, subassemblies and finished products flow [9]. One of the most important aspects affecting the performance of a supply chain is the management of inventories, since the decisions taken in this respect have a significant impact on material flow time, throughput and availability of products [6]. Inventory management in supply chain networks involves keeping track of hundreds of items spread across multiple locations with complex interrelationships between them [9]. Inventory management is to a greater extent relevant when a whole supply chain, namely a network of procurement, transformation, and delivering firms, is considered. Inventory management is indeed a major issue in supply chain management, i.e. an approach that addresses supply chain issues under an integrated perspective.

Inventories exist throughout the supply chain in various forms for various reasons. Since carrying these inventories can cost anywhere from 20 to 40% of their value a year, managing them in a scientific manner to maintain minimal levels makes economic sense [2]. SCIM is an integrated approach to the planning and control of inventory, throughout the entire network of cooperating organizations from the source of supply to the end user. SCIM is focused on the end-customer demand and aims at improving customer service, increasing product variety, and lowering costs [3, 11].

2. INVENTORY MANAGEMENT AND OPTIMIZATION CASE IN A TURKISH FOOD CHAIN

Inventory management and optimization is especially important for food chains. In this study; SCIM and optimization is examined and a case in a Turkish food chain is presented.

The firm produces many types of foods that one of them is macaroni. Here, we are focused on stocking of packaging materials of macaronis. In the current system, the firm uses packages for its biggest X customer, and external polyster bags for other customers. For continuing the current system, the firm orders from its suppliers quarterly and instantaneously. Every day the stocks are controlled. This inventory calculation is made to determine current status: Inventory Position=Inventory on Hand+Given Orders. Thus, an order's re-ordering is disallowed. Safety stock must be consumed in a week. The firm shows the tendency of leaving the stock control system to its suppliers. Therefore, it needs a more systematic inventory approach.

For enhancing a new model, the capacity and the necessities of the firm must be examined. As a new stok control system, "lot size-reorder point system (Q, R)" is appropriate for the firm. Q represents the order quantity and R is the reorder point. For optimal Q and R, total cost must be calculated:

1. The cost of inventory on hand:

$$h \times (Q/2 + R - \lambda\tau) \quad \ldots (1)$$

h is the unit cost of inventory on hand. λ, expected annual demand and τ is the expected lead time. A responsible from the firm is denoted that the rate of interest is 0.21. So h can be calculated: h = unit variable cost $\times$ rate of interest.

2. The annual total fixed cost:

$$K \times (\lambda / Q) \quad \ldots (2)$$

K is fixed cost, λ / Q the quantity of annual total orders.

3. The penalty cost:

$$pn(R)\lambda / Q \quad \ldots (3)$$

p is the penalty cost of lack of inventory, $n(R)$ is the quantity of expected quantity of lack of inventory.

Then the total cost function:

$$G(Q,R) = h \times (Q/2 + R - \lambda\tau) + K\lambda / Q + pn(R)\lambda / Q \quad \ldots (4)$$

To separate Q and R, there are two more functions:

$$Q = \sqrt{\frac{2\lambda[K + pn(R)]}{h}} \quad \ldots (5)$$

and

$$F(R) = 1 - Qh / p\lambda \quad \ldots (6)$$

In this study Kolmogorov – Smirnov test is used to determine the demand distribution.

The results for a specific product, as an example: For 99% service interval, average inventroy on hand is 44 ton polyster bags and 26100 packages, for 95% service interval 42 ton polyster bags and 23800 packages, and for 90% service interval 39.5 ton polyster bags and 22500 packages. According to these values the total costs are respectively 51000, 48000 and 46000 YTL, and for each probability level the safety stock levels are: for 99%, 10 ton polyster bags and 7500 packages; for 95%, 7.7 ton polyster bags and 5100 packages; for 90% 5.25 ton polyster bags and 3850 packages.

As a result, a new inventory management system is integrated to the chain. Depending on this system, the total costs are decreased, and the determined service level for the firm by the reorder point and safety stock level.

4. CONCLUSION

Inventory management and optimization is especially important for food chains. In this study; SCIM and optimization is examined and a case in a Turkish food chain is presented. The current inventroy management system of the firm is revised. Depending on this system, the total costs are decreased, and the reorder point and safety stock level cover the service level determined for the firm.

5. REFERENCES

[1] Aburto L., Weber R.: Improved supply chain management based on hybrid demand forecasts, Applied Soft Computing, In Press, Corrected Proof, Available online 22 August 2005,

[2] Ganeshan R.: Managing supply chain inventories: A multiple retailer, one warehouse, multiple supplier model, International Journal of Production Economics 59, pp. 341–354, 1999,

[3] Giannoccaro I., Pontrandolfo, P. ve Scozzi, B.: A fuzzy echelon approach for inventory management in supply chains, European Journal of Operational Research 149, pp. 185–196, 2003,

[4] Li S., Rao S.S., Ragu-Nathan T.S., Ragu-Nathan B.: Development and validation of a measurement instrument for studying supply chain management practices, Journal of Operations Management 23, pp. 618–641, 2005,

[5] Minner S.: Multiple-Supplier Inventory Models in Supply Chain Management: A Review, International Journal of Production Economics 81–82, pp. 265–279, 2003,

[6] Musalem E.P., Dekker R.: Controlling inventories in a supply chain: A case study, International Journal of Production Economics 93–94, pp. 179–188, 2005,

[7] Routroy S., Kodali R.: Differential evolution algorithm for supply chain inventory planning", Journal of Manufacturing Technology Management 16:1, pp. 7-17, 2005,

[8] Simchi-Lev D., Kaminsky P., Simchi-Lev E.: Designing and Managing the Supply Chain, Irwin McGraw-Hill, Boston, MA, 2000,

[9] Srinivasan M., Moon Y.B.: A comprehensive clustering algorithm for strategic analysis of supply chain networks, Computers & Industrial Engineering 36, pp. 615-633, 1999,
[10] Stadtler H.: Supply chain management and advanced planning-basics, overview and challenges, European Journal of Operational Research 163, pp. 575–588, 2005,
[11] Verwijmeren M., van der Vlist P., van Donselaar K.: Networked inventory management information systems: Materializing supply chain management, International Journal of Physical Distribution and Logistics Management 26 (6), pp. 16–31, 1996.