INTEGRATION OF STOCK KEEPING AREAS AND INVENTORY PLANNING

Murat Düzgün¹, Mehmet Tanyaş²

Abstract – Inventory are a company’s merchandise, raw materials, semi-finished and finished products which have not yet been sold. The derivation of stocking levels throughout the supply chain planning network based upon service level and inventory holding cost inputs. Warehouse is a place in which goods or merchandise are stored. Constructing and fitting out a modern warehouse with all its required equipment and tools require significant capital expenditure. The early warehouse planning and design stage is the key. Mistakes in warehouse capacity planning and layout will decrease warehouse utility and performance while increasing your operational costs. Careful attention should be paid to operational optimization; even a warehouse which operated effectively before may not do so under increasing loads. Special and reserved place(s) for stocks are called “Stock keeping areas”. Therefore fixing these places is very important for warehouse design also for all products which will be stored in. Evaluating the values of integrating warehouse and inventory make the decisions easier accordingly. That’s why, global warehouse and inventory mathematical and practical model is handled and solved out for this explanation. Also solution methodologies are developed which offer different level of integration of warehouse and inventory decisions. Total cost of the inventory and warehouse systems can be reduced systematically by taking into account the warehouse capacity restrictions in the inventory planning decisions. In this paper is intended for the need of systematic design approach that considers different parameters for warehouse and inventory mainly focused on Stock keeping area issue in warehouses.

Keywords – Inventory Planning, Warehouse Design, Integration of Warehouse and Inventory Planning, Gap Analysis.

¹ Murat Düzgün, Okan University, Graduate School – Social Sciences, Business Administration Ph.D. Program, Mecidiyeköy, Istanbul, Turkey, duzgunmurat@yahoo.com

² Mehmet Tanyaş, Maltepe University, Faculty of Economics and Administrative Sciences, International Trade and Logistics Management Department, Maltepe, Istanbul, Turkey, mehmettanyas@maltepe.edu.tr
1. Introduction

Managers are faced with the need to deliver a high service level with minimal both warehouse and inventory cost. The order picking activity represents 65% of the total cost and 50% of the workforce of a warehouse (WERC 1986). In the case of distribution warehouses, this proportion is even more important because the main activity is to receive pallets of items from vendors, stock them and deliver customer orders containing different items. In addition, with the improvement in information technology, it becomes possible to develop tools which can help managers to handle warehouse and inventory issues more efficiently. Logistics managers have to tackle problems which can be divided into two broad classes: warehouse management (assigning the products inside the warehouse) and inventory management (how much of each product) problems. Up to nowadays, warehouse and inventory issues are handled in a pyramidal top-down approach where the flexibility of decisions decreases from top to bottom. Strategic decisions are first taken and then create limits to decisions taken at the tactical and operational levels. On top of this, decisions taken at each level of the pyramid are also handled independently and sequentially. (Strack and Pochet, 2010)

In warehouses, specified and reserved place for each stock keeping unit is called “Stock keeping area”. Total of these places constitutes total stock keeping field of warehouse itself. Therefore warehouse design and stock optimization are very related each other closely. In this work primarily we checked out that the impact of Stock and Inventory planning on the Logistic Performance by applying a survey as explained below. So all outcomes that have been gained are evaluated as Statistical Analysis in SPSS™ computer program and then finally up to reached results, a sequential decision making methodology has been developed for having dynamic and better Inventory’s decisions.

If we look at briefly over the sections, in the second part we will make a brief review of the literature available on the subject, third part will introduce the Gap Analysis Approach, in the fourth part the computational results based on gap analysis questionnaire are given, in the fifth part a description of the methodology used to solve the integrated model is proposed and finally conclusion appear in the sixth part.

2. Literature Review

Most tactical issues in warehouse and inventory management are tackled independently and sequentially. The models developed and Parameters explained in those three fields are presented separately.

2.1. Forward-Reserve Area Models (Strack and Pochet, 2010)

The Forward-Reserve Problem (FRP) is the problem of assigning products to the forward and reserve areas in order to reduce the overall work content in order picking. Nowadays, most warehouses are divided into two areas: forward and reserve. The forward area is used for broken-case and full-case picking and the reserve area is used for pallet picking and reserve storage. Once a product is stored in the forward area (reserved area), all picks must be performed from the forward area. When the inventory of an item stored in the forward area reaches its reorder point an internal replenishment is performed (from the reserve area to the forward area).

Hackman and Rosenblatt were the first to address the issues of deciding which product to store in the forward area (assignment issue) and how much to store (allocation issue). They considered a warehouse composed of a small area (forward area) where picking of products is based on an efficient (less time consuming) Automated Storage and Retrieval System (AS/RS). The reserve area is a large area handled through an inefficient manual/semi-automated storage and retrieval system. The question tackled in this article is to decide which
and how much product must be stored in the forward area taking into account picking costs and internal replenishment costs and the capacity constraint of the forward area.

Frazelle propose a model that tackles three warehouse decisions; the size of the forward area and the allocation/assignment of products to the forward area. They propose a model which minimizes the total warehouse costs, which depends on the size of the forward area under forward capacity and congestion constraints. They show that the congestion constraint is redundant. Consequently, the optimal quantity assignment/allocation solution can be found based on Hackman and Rosenblatt work.

Van den Berg propose a model to solve the forward-reserve problem in the case of unit load replenishment. Those replenishments can occur during busy or idle pickle periods. The objective is to minimize the number of urgent or concurrent replenishments of the forward area arriving during the busy periods.

2.2. Inventory Models (Strack and Pochet, 2010)

The aim of inventory management is to minimize total operating costs while satisfying customer service requirements. In order to accomplish this objective, an optimal ordering policy will be determined by answering to questions such as when and how much to order. The operating costs taken into account are the procurement costs, the holding costs and the shortage costs which are incurred when the demand of a client cannot be satisfied (either lost sales costs or backorder costs). There is two different inventory policies. The first policy implies that the stock level will be checked after a fixed period of time and an ordering decision will be made in order to complete the stock to an upper limit. In the second policy, the stock level will be monitored continuously and a fixed quantity will be ordered when the stock level reaches a reorder point. The order quantity will only be delivered after a fixed lead time and shortage can exist if the inventory is exhausted before the receipt of the order quantity. (Strack and Pochet 2010)

2.3. Inventory Planning Parameters (Ganeshan, Boone and Stenger, 2001)

The general structure of supply chain consists of four levels: the market level, the distribution center (DC) level, the manufacturing or plant level and the supplier level. At each level, there must be more than one of each of the entities. Mainly, we are interested in the elect of three key inventory planning parameters on supply chain; I) Forecast methodology (error), II) “Flow Planning” methodology and III) Replanning frequency. Forecast methodology refers to the accuracy of the forecast. A lower forecast error can be assumed to correspond to a better forecast methodology. Flow planning refers to the way in which the product requirements are planned and communicated at the distribution centers.

We identified three key supply chain performance parameters that used in this study: I) Observed service level II) Supply chain cycle time and III) Return on investment (ROI). The observed service level refers to the proportion of demand satisfied at the DCs from inventory. The overall service level of the supply chain is defined as the volume-weighted average of the service levels at each of the DCs that are in operation. The cycle time, meanwhile, refers to the time spent by the product, either as raw material, work-in process or a finished good, in the supply chain. It is simply the profit contribution as the proportion of the total investment in DCs plant warehouses, plants and inventory.

3. Gap Analysis

Production companies today are faced with a substantially more complex situation than ever before because of the increasing market demands and growing complexity of production. Inventory planning has become a core competency, a strategic weapon that many companies are using to enhance their competitive position. At the
same time, the warehouse is undergoing unbelievable challenges that make warehouse excellence harder. These criterias as follows have to be taken care as Ganeshan, Boone and Stenger (2001) said.

1- A significantly larger number of Stock Keeping Units (SKU’s),
2- Increased customer service requirements,
3- Demands to reduce inventory and cost,
4- Demands to increase warehouse operating efficiency and space utilization,
5- The need for increased integration of the warehouse within the Total Logistics system,
6- The changes in logistics philosophies from a “push” environment to a “pull”

The planning, managing and improving of today’s warehouse and inventory planning operations require a much more professional approach to warehousing than previously adopted. So Inventory Planning Gap Analysis is benchmarking methodology for assessing the utilization of inventory and warehouse infrastructure (systems, people and space) in meeting the mission of the warehouse (shipping perfect orders) also consolidating inventory. Warehouse and Inventory performance indicators are productivity (lines per hour), storage density (case storage capacity per m²) shipping accuracy (percent lines shipped in error), stock accuracy, travel time and order preparation time. The value in the gap analysis is the statistical presentation of the performance profile. This analysis quickly points out weak and strong points in the performance of a warehouse operations other aspect of the gap analysis can also be used in justifying capital expenditures for new information and/or material handling systems for better and the best operation(s). (Ganeshan, Boone and Stenger, 2001)

For Inventory Planning had been a survey among the some companies and asked the questions as follows to get the results which hoping and trying to have by using likert scale:

**QUESTIONS:**

A) If you take consideration on Stock Level each as expressed in different level below, what is the impact percentage of them on Logistics Performance?

1) Market Level,
2) Distribution Center Level,
3) Manufacturing or Plant Level,
4) Supplier Level,

B) If you focus on the Key Inventory Planning Parameters (KIPP) separately below, How much each parameter influences total Logistics Performance independently?

1) Forecast Methodology, (Accuracy of the Forecast)
2) Material Flow Planning Methodology, (Product requirements are planned and communicated at the distribution centers)
3) Replanning Frequency, (How often Materials Management issued)

C) According to answers of the questions that you replied above, What you could tell about up to which level your company’s Logistics Performance rised?
4. Computational Results:

We chose 12 different industrial manufacturing companies in Istanbul and Gebze industrial zones in TURKEY. Asked the questions to 27 Logistic Staff and had answers only 20 person using face to face and in depth interview. All of them have workforce quantity each equal 65 person or more. Questionnaire applied only Logistics Dept.s staff. Main aspect of these companies are having Logistic problems and also high operational costs on warehouse and inventory activities. All of them have agreed on that changing the system and model for their own warehouse management but do not know how to perform.

So we asked the questions and had the results then suitable model and change method will be offered to those companies as flashback.

Table 1: Observed Results of the Survey

<table>
<thead>
<tr>
<th>Logistics Staff</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>2</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>3</td>
<td>4.0</td>
<td>5.0</td>
<td>5.0</td>
<td>3.0</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>4</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>5</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>6</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>7</td>
<td>5.0</td>
<td>5.0</td>
<td>4.0</td>
<td>5.0</td>
<td>3.0</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>8</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>9</td>
<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td>10</td>
<td>3.0</td>
<td>3.0</td>
<td>2.0</td>
<td>3.0</td>
<td>2.0</td>
<td>2.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>11</td>
<td>4.0</td>
<td>4.0</td>
<td>3.0</td>
<td>4.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>12</td>
<td>2.0</td>
<td>1.0</td>
<td>3.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>13</td>
<td>3.0</td>
<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>3.0</td>
<td>5.0</td>
</tr>
<tr>
<td>14</td>
<td>5.0</td>
<td>3.0</td>
<td>5.0</td>
<td>4.0</td>
<td>5.0</td>
<td>5.0</td>
<td>3.0</td>
<td>5.0</td>
</tr>
<tr>
<td>15</td>
<td>2.0</td>
<td>3.0</td>
<td>5.0</td>
<td>4.0</td>
<td>3.0</td>
<td>3.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>16</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>5.0</td>
<td>5.0</td>
<td>4.0</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>17</td>
<td>3.0</td>
<td>5.0</td>
<td>4.0</td>
<td>5.0</td>
<td>3.0</td>
<td>4.0</td>
<td>3.0</td>
<td>5.0</td>
</tr>
<tr>
<td>18</td>
<td>4.0</td>
<td>5.0</td>
<td>4.0</td>
<td>5.0</td>
<td>4.0</td>
<td>5.0</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>19</td>
<td>5.0</td>
<td>4.0</td>
<td>5.0</td>
<td>4.0</td>
<td>3.0</td>
<td>3.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>20</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>5.0</td>
<td>4.0</td>
<td>4.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

LEGEND: (Source: 12 Companies, 20 Logistic Staff) – (Evaluation Alternatives: 1 – 5)

Comparative evaluation across methods and experiments is important for understanding in data categorization. Carefully analyzing not only empirical evidence but also the test conditions under which classifiers are evaluated, the factors underlying performance variations will become much more transparent and better understood, leading to improved evaluation methodology for certain results.

Specifically, we checked and researched the impact of Inventory on Logistics Performance and operational costs by using Regression Analysis. On Figure 1, we realized the correlation between two parameters (Inventory and Logistic Performance) as Logistics Performance = 1.920 + 0.564 * KIPP.
Our results indicate that Inventory Planning has a significant effect on Logistic performance throughout the key inventory planning parameters. Means that if the KIPP rises up 1 unit, up to that Logistic Performance rises only 0.564. As our methodology section indicated, the supply chain analysis requires data, warehouse design, and flow planning parameters.

This study has covered significant information related to Logistic Performance and Warehouse and Inventory Planning. Results showed that these parameters have a significant effect on performance. The main theme throughout is that the organization and planning related to the inventory records increases accuracy, better performance and followed by profit(s) also means that inventory planning and hi-tech equipments in warehouse affects company Logistic Performance very deeply.

5. Methodology

Inventory Planning Gap Analysis showed that the inventory planning decisions affect the logistic performance. A dimension of the inventory planning decisions is the stock area requirement. The economical order quantity and security stock calculations which are realized in the coverage of the stock optimization are directed at the stock costs at the basis, and it is not directly aimed at the stock area requirement. Although the depot expenditures are stipulated in the inventory holding cost, it has a low degree of influence. Consequently, the stock area is taken up as a separate evaluation criteria in the methodology suggested.

The customer service level is calculated as the rate of the covering of the orders/consumption. Depending on the distribution of the request, the security stock calculation is made in order to cover a certain percentage of the fluctuations. While increasing the security stock increases the customer service level, it also increases the inventory holding cost however it reduces the Stock-out Cost. On the other hand, increasing security stock and average stock increase the amount of area which is needed in the depot as well.

The depot design is a strategic decision, but the inventory planning is a tactical decision. Consequently, planning horizons are different. However, an important part of the depot is the product stock keeping area and the effective usage of this area is very important. This area is the total of the stock areas to be separated for each product. In this frame, it is necessary to take into consideration the customer service level of the products, stock cost and stocking keeping area criteria together in distributing the total area into the products. The flowchart of a methodology which evaluates the criteria stated together and which stipulates the decision maker interaction is seen in the Figure-1.

The methodology starts with the demand estimation belonging to the product and the data of distribution of this estimation, and by means of taking into consideration the inventory holding cost, stock-out cost and order cost, and evaluating the customer service level of 95% and the supply period in the starting, the security stock and total stock cost are calculated. The keeping stock area is specified according to the security and average stock values of the product. The values obtained are presented to the decision maker and, in case it is not considered appropriate, the changes are made at the customer service level and an appropriate solution group is formed.

The decision maker has to evaluate the characteristics of the product, level of the stock cost and the stocking area size of the depot together while taking decision for the customer service level, stock cost and stock keeping area values. It is stipulated in this methodology that the total stocking area may be variable. Consequently, the rental depot usage will ensure this change, instead of self-owned depot usage. In addition to this, beside the stock area, there are corridor, order preparation, value added services area in the depots as
well. The area transfer is possible also among these areas. On the other hand, the same product is kept available not only in the pallet stocking areas but also in the parcel stocking areas in the distribution centers in particular. Different service level preferences could be used at different stages.

Figure 1: Flow diagram of proposed methodology

6. Conclusion

Currently, most of the tactical warehouse and inventory issues are tackled independently and sequentially. Our aim through this work was to show the value of integrating more decisions of the warehouse and inventory fields. Consequently, we have presented global models which take into account the replenishment decision at
the inventory management level, the allocation of products to warehouse systems and the assignment of products to storage locations at the warehouse management level.

There will be different customer service level and stocking area amounts preferences usage will be in question for different products for the scarce resources of the enterprises. The characteristics of the product and even that of its customer, total stocking area and the flexibility of this area, restrictions on the stock costs are important in these preferences.

Some researches pointed out that observing the impact of changes in the objective cost coefficients on the total savings realized also on the warehouse and the inventory configuration. Few results showed that in most cases changes in the objective cost coefficients were not having a significant impact on the warehouse and the inventory configuration and the total savings realized. The main theme throughout is that the organization and planning related to the inventory records increases accuracy, better Performance and followed by profit(s) also means that Inventory Planning and Hi-tech equipments in Warehouse affects Company Logistic Performance very seriously.

The suggested methodology is based on a conceptual model which take into consideration the customer service level, stock cost and stock keeping area together. Consequently, a numerical study is not performed at this stage. It is suggested to perform the studies for this purpose and to perform the validation studies of this methodology in the future.

7. References


