A MATHEMATICAL TOOL FOR WAREHOUSING OPTIMIZATION

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Abstract: - Cross docking is a technique that eliminates storing and order picking functions of a warehouse while still allowing it to serve its receiving and shipping functions. The tradeoff of the method is the reduction in warehousing cost and the increase in customer service with the substantial need of material flow’s coordination. We refer to the application of cross-docking technique in the leader retailer in Greece, on its distribution centre at Inofita Viotia Greece

Key-Words: cross-docking, optimization, warehousing.

1 Introduction

An integral part in the Supply Chain Management theory and practice is the function of Warehousing. According to Tracey et al [1] a firm’s performance on the warehousing field affects the entire business operation and performance. The reason for this lies on the fact that material warehousing and inventory control as well support manufacturing operations thus requiring a coordination through many business sections, such as marketing, finance, human resources departments. Any disruption of the coordination can cause severe problems on the entire manufacturing operation. Given the importance of the warehousing it becomes profound that any effort for warehousing operations optimization attracts much of attention from logistics practitioners and academics.

Before we deal with warehousing optimization, essential it becomes to give the definitions of warehousing and cross docking and their relation. Warehousing is the functions where material is kept in appropriate facilities for future usage while cross docking[2] is a “methodology pioneered by Wal Mart in which goods are not actually warehoused in a facility. Instead, trucks from suppliers each carrying a different type of product deliver goods to a facility. There the inventory is broken into smaller lots and quickly loaded onto store-bound trucks that carry a variety of products some from each of the supplier trucks”. Derived from the definitions that cross docking is a warehousing methodology, actually a very elaborated and modern warehousing
methodology.

As mentioned above a crucial issue for optimization in cross docking warehouses is the coordination. A way to achieve the coordination is the implementation of Management Information Systems. In warehousing case we discern the Warehousing Management Systems which are system that provide necessary information to manage and control the flow of products in a warehouse from receiving to shipping[3]. The W.M.S are distinguished into three types : Basic WMSs , Advanced WMSs , Complex WMSs. Further to our analysis concerning the Information Systems we mention another technological achievement that is used in warehousing is bar coding technology[4]. Despite the problems that may incurred during implementation phase these systems offer an upper level of coordination thus a definite commercial advantage in efficiency and customer service. As a matter of fact excellent supply chain information systems provide organizations with the ability to gather, process and disseminate data which is critical to response to demand fluctuations. Profound it becomes that the most influential area of supply chain management is the Information Technology systems.

Further to technological perspective warehousing optimization in cross docking systems there is also the operational perspective. This deals with problems of Operation Research (O.R.) discipline. One of them is carrier –to- dock assignment . The objectives for this problem is to designate doors as strip and stack doors assign destinations and inbound trucks to stacks and strips doors responsively for the minimization of cost 1. The other problem which is analyzed throughout our presentation is the impact of the number of doors in the performance measures of cross docking warehousing process and the calculation of the optimal number of doors a facility must have . Other optimization problem concerns scheduling in warehouse processes which is solved through an algorithm based on ant colonies [5].

3 Analysis of Cross-Docking on a major retailer in Greece

A major and popular type of cross-docking is the retail cross-docking mainly used by large retail corporation in almost every country. The Greek retail cross-docking facility is located at the outskirts of Athens, at Inofyta Viotia near Thiva. The problem faced by the logistics managers of the cross-docking facility is the performance analysis of the system and the cross-docking expansion strategy that must be followed. As the first step of our methodology, we configure the number of states. This is given by the above formula

$$N^{C_1, C_2, B} = (C_1 + 1)(C_1 + C_2 + B + 1) - [C_1(C_1 + 1)/2]$$

where

- $C_1$: number of strip doors
- $C_2$: number of stack doors
- $B$: buffer capacity
At the second step we configure the state table. On the 3rd step we configure the transition matrix Q. On the 4th step we calculate the vector of static possibilities \( \pi = [\pi_{00}, \ldots, \pi_{45}] \) by solving the matrix equation \( \pi \cdot Q = 0 \). By using MATLAB software we take static possibilities’ matrix for number of strip doors 4,5,6 and stack doors 3,4,5,6. Then we have:

\[
\begin{bmatrix}
\pi_0 \\
\pi_1 \\
\vdots \\
\pi_{45}
\end{bmatrix}
\]

Table 1. Performance measures for 4 strip doors.

<table>
<thead>
<tr>
<th>Stack doors</th>
<th>wip</th>
<th>Thr</th>
<th>MFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>7.7865</td>
<td>5.5639</td>
<td>1.3995</td>
</tr>
<tr>
<td>4</td>
<td>7.5894</td>
<td>6.5154</td>
<td>1.1648</td>
</tr>
<tr>
<td>5</td>
<td>7.3297</td>
<td>6.9036</td>
<td>1.0617</td>
</tr>
<tr>
<td>6</td>
<td>7.1720</td>
<td>7.0250</td>
<td>1.0209</td>
</tr>
</tbody>
</table>

Table 2. Performance measures for 5 strip doors.

<table>
<thead>
<tr>
<th>Stack doors</th>
<th>wip</th>
<th>Thr</th>
<th>MFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>9.2495</td>
<td>5.8539</td>
<td>1.5801</td>
</tr>
<tr>
<td>4</td>
<td>9.3773</td>
<td>7.3105</td>
<td>1.2827</td>
</tr>
<tr>
<td>5</td>
<td>9.2036</td>
<td>8.1628</td>
<td>1.1275</td>
</tr>
<tr>
<td>6</td>
<td>8.9825</td>
<td>8.5362</td>
<td>1.0523</td>
</tr>
</tbody>
</table>

Table 3. Performance measures for 6 strip doors.

In the following figures, we can see the performance of the system in the case when the strip doors (input doors) are 4,5 and 6 respectively: (4 doors in red, 5 doors in blue, 6 doors in black)

1. WIP
2. Throughput
3. Mean flow time:

4 Conclusion
Concluding, cross docking is a new and promising distribution technique. The substantial need for coordination on the cross docking facility, a managerial problem for a major Greek retailer, lead us to evaluate performance measures for cross –
docking model in several cases (depending of the numbers of the strip and stack doors)

References: