UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF A CROSS DOCKING SYSTEM MODEL FOR DISTRIBUTION CENTERS

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By

MOHAMMADNASSIR SHEIKHOLESLAM

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of requirement for the Degree of Master of Science

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DEDICATION

First and foremost I would like to thank God, my creator, for giving me the intellectual capacity to learn about His creation, without His gift and grace to me, I could do nothing. I would like to express my utmost appreciation to both of my beloved parents, without whose encouragement and support I would have never achieved any success.

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Abstract of thesis presented to the Senate of Universiti Putra of Malaysia in partial fulfillment of the requirement for the degree of Master of Science

DEVELOPMENT OF A MODEL BASED ON CROSS DOCKING SYSTEMS FOR DISTRIBUTION CENTERS

By

MOHAMMADNASSIR SHEIKHOLESLAM

July 2014

Chairman: Assoc. Prof. Norzima bt. Zulkifli, PhD

Faculty: Engineering

Distribution is one of the important factors is in the warehousing and logistic industry which can play a major role in determining the total cost or the profit of the companies. This study presented a problem in the distribution systems and the delivery of the required products to the companies which receive their items through the distribution systems. The inventory level in the distribution centers has been one of the problems that the scholars have tried to solve by applying different methods. This study is trying to solve the problem of extra inventory and holding costs by developing a cross docking model for the distribution centers. The cross docking model has been developed by considering some of the required changes in the distribution center for storage elimination, such as scheduling the inbound and outbound containers and their sequence of entering and exiting the center and it has been developed in such a way that the products enter the distribution center and exit from it without any long term storage. Thus, the storing of the products in the distribution centers are eliminated and they are transformed into a cross docking center. The traditional distribution centers can profit from the advantages of cross docking distribution by trying to become a cross docking center and operate as one. The objective of the study is to develop a model based on the cross docking systems to assist the traditional distribution centers operate as a cross docking center and at the same time, delivering the required items of the customers. In order to achieve this objective, linear programming has been applied to develop a model to solve the problem as well as helping the distribution center of the company to turn into a cross docking center and operate as one. In the model, the concept of an auction has been considered, in which the profit of the distribution center needs to be maximized in the auction transaction. Therefore, the developed model is a maximization model to maximize this profit by considering the time, cost and profit parameters in the distribution center. The objective function of this maximization problem calculates the net income of the distribution center after the transaction is completed by considering the income of the distribution center from selling the products to the buyers, the costs that the center has to tolerate for buying the products from the sellers and the fixed costs and the cost of time. After the model was developed, it was programmed in Lingo software to achieve the optimum results in a short time

and then it was implemented for a real life case to validate the model. Model implementation resulted in delivering the required items of the customers and helped the distribution center to be able to operate as a cross docking center and the inventory level was significantly reduced; before implementing the model, the inventory level of the company was about 900,000,000 R (Iranian Rials) and after it was implemented, the inventory level was reduced to about 200,000,000 R (Iranian Rials), which indicates 78% decrease in the level of inventory. Finally, by cross checking the achieved outcomes with the previous records of the company, the results indicated 8% increase in the profit of the company.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
Sebagai memenuhi keperluan untuk ijazah MasterSains

PEMBANGUNAN MODEL BERDASARKAN SISTEM dok CROSS UNTUK PUSAT PENGAGIHAN

Oleh

MOHAMMADNASSIR SHEIKHOLESLAM

Julai 2014

Pengerusi: Prof. Madya. Norzima bt. Zulkifli, PhD

Fakulti:Kejuruteraan

Pengedaran adalah salah satu faktor penting dalam industri pergudangan dan logistik yang boleh memainkan peranan utama dalam menentukan jumlah kos atau keuntungan syarikat. Kajian ini membentangkan masalah dalam sistem pengedaran dan penghantaran produk-produk yang diperlukan untuk syarikat-syarikat yang menerima barang-barang mereka melalui sistem pengagihan. Tahap inventori di pusat-pusat pengedaran telah menjadi satu masalah yang para pengkaji telah cuba untuk menyelesaikan dengan menggunakan kaedah yang berbeza. Kajian ini cuba untuk menyelesaikan masalah inventori tambahan dan kos pegangan dengan membangunkan model dok bersilang untuk pusat-pusat pengedaran. Model dok silang telah dibangunkan dengan mengambil kira beberapa perubahan yang diperlukan di pusat pengedaran untuk penghapusan penyimpanan, seperti penjadualan bekas masuk dan keluar dan urutan mereka memasuki dan keluar pusat dan ia telah dibangunkan dengan cara bahawa produk memasuki pusat pengedaran dan keluar daripadanya tanpa apa-apa simpanan jangka panjang. Oleh itu, penyimpanan produk di pusat pengedaran dihapuskan dan mereka berubah menjadi pusat dok silang. Pusat-pusat pengedaran tradisional boleh mendapat keuntungan daripada kelebihan pengedaran dok bersilang ini dengan menjadi pusat dok bersilang di samping beroperasi sebagai satu pusat pengedaran. Objektif kajian ini adalah untuk membangunkan satu model berdasarkan sistem dok bersilang untuk membantu pusat pengedaran tradisional beroperasi sebagai pusat dok bersilang dan pada masa yang sama, menyampaikan barang-barang yang dikehendaki pelanggan. Untuk mencapai matlamat ini, pengaturcaraan lelurus telah digunakan untuk membangunkan satu model untuk menyelesaikan masalah serta membantu pusat pengedaran syarikat itu bertukar menjadi pusat dok bersilang dan beroperasi sebagai satu. Dalam model ini, konsep lelongan telah dipertimbangkan, di mana keuntungan daripada pusat pengedaran yang perlu dimaksimumkan dalam urus niaga lelong. Oleh itu, model yang dihasilkan adalah model pemaksimuman untuk memaksimumkan keuntungan dengan mempertimbangkan parameter masa, kos dan keuntungan di pusat pengagihan. Fungsi objektif masalah pemaksimuman ini mengira pendapatan bersih pusat pengedaran selepas transaksi itu selesai dengan mempertimbangkan pendapatan pusat pengedaran daripada menjual produk kepada pembeli, kos bahawa pusat itu perlu bertolak ansur untuk membeli produk-produk dari penjual dan juga kos tetap dan kos masa. Selepas model itu dibangunkan, ia

telah diprogramkan dalam perisian Lingo untuk mencapai hasil optimum dalam masa yang singkat dan kemudian ia telah dilaksanakan ke atas sebuah syarikat pengedaran untuk mengesahkan model. sebelum melaksanakan model, paras inventori syarikat itu adalah kira-kira 900,000,000 R (Rials Iran) dan selepas ia dilaksanakan, tahap inventori telah dikurangkan kepada kira-kira 200,000,000 R (Rials Iran), yang menunjukkan 78% penurunan dalam tahap inventori. Akhir, dengan salib memeriksa hasil dicapai dengan rekod sebelum ini syarikat itu, keputusan menunjukkan peningkatan 8% dalam keuntungan syarikat.

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I certify that a Thesis Examination Committee has met on (date of viva voce) to conduct the final examination of Mohammadnassir Sheikholeslam on his thesis entitled "Development Of A Model Based On Cross Docking Systems For An Improved Functionality Of Traditional Distribution Centers" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the (insert the name of relevant degree).
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APPROVAL

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

CD	Cross Docking
JIT	Just-in-Time
LP	Linear Programming
MILP	Mixed Integer Linear Programming
SCM	Supply Chain Management

CHAPTER 1

INTRODUCTION

1.1 Overview

Organizations have been faced with different challenges in their path. Increasing levels of competition and decreasing acceptable response times are considered as the challenges that the organizations have to overcome (Lockamy and McCormack, 2004). In many industries, the main base for competition is upon the strategic assets and how the organizations handle and deploy these assets. However, currently the base for competition is the capabilities of the organizations and their skills (Day, 1994). The organizations who have more knowledge about management can be the more successful ones. One of the management concepts that has been widely considered by many of the researchers in industrial fields is the concept of Supply Chain Management (SCM) (Zigiaris, 2000). It is a concept that due to its comprehensive and integrated view about the factors and elements that play a role in producing a product or service for the final customer or consumer, rapidly developed and established. These factors and elements have a wide range and this range starts from raw material suppliers to the final customers of a product (Zigiaris, 2000). The important parts that constitute the Supply Chain are central and local warehouses, transportation companies, retailers and distributors and they play a major role in the proper distribution of goods (Zigiaris, 2000). But one of the main objectives of supply chain management is to try to increase the productivity and making the processes more effective (Stadtler and Kilger, 2008). On this basis, there is a growing need to use ideas about reducing costs and increasing efficiency within each component of the supply chain and the interactions among them (Stadtler and Kilger, 2008).

Today, one of the goals of the organizations is to find a way to implement a strategy that can strengthen the linkages of supply chain in cooperative and collaborative ways into cohesive and integrated business model (Chen et al., 2009; Chen and Paulraj, 2004). One of the advanced strategies that has passed the test of time in nurturing the competitive advantage at the level of supply chain is Just in Time (JIT) (Vokurka and Lummus, 2000; Green and Inman, 2005; Matsui, 2007; Bayraktar et al., 2007). One of the objectives of Just in Time (JIT) is to maintain a low inventory that can lead to frequent deliveries, thus the companies will be requiring innovative and novel transportation and storage solutions (Hauser and Chung, 2012). Companies and organizations can benefit from a strategically interconnection with their partners in supply chain (Schoenherr and Swink, 2012). An external integration can lead to a reduction in uncertainties and can result in enhanced and improved capabilities in performance of the companies (Schoenherr and Swink, 2012). The internal operations of a company such as logistics, manufacturing, planning, and purchasing can benefit from flexibility and delivery performances (Schoenherr and Swink, 2012). As mentioned earlier, Hauser and Chung (2012) have stated that companies require innovative and novel transportation and storage strategies. In addition, due to what has been pointed out by Schoenherr and Swink (2012), the internal operations of a company can benefit from delivery performances. One idea and strategy in distribution and delivery systems, which has shown a high potential

in decreasing the costs is the idea of using "Cross Docking" centers in supply chain (Apte et al., 2000, Waller et al., 2006; Liao at al., 2010). Functions of Cross Docking centers have resulted in more inventory flow in the whole supply chain and decreased storage costs compared to traditional distribution systems. Also they have provided the possibility of decreasing the logistics costs by using the advantages of transportation in economic scale (Dondo at al., 2011; Mousavi and Tavakkoli-Moghaddam, 2013; Yu & Egbelu, 2008).

However, little attention has been paid to providing the manufacturers with all of their product needs all at the same time and through the cross docking centers so that the cost of logistics will be reduced as well as the cost of the storage in the respective company. There has been some research in this field (Zimmer, 2002; Waller et al., 2006; Arabani et al., 2010; Liao at al., 2010; Dondo at al., 2011; Hauser and Chung, 2012; Mousavi and Tavakkoli-Moghaddam, 2013) which will be presented in the next chapter, but the idea of providing the needs of the manufacturers with their whole required items and the items that depend on each other at the same time through the cross docking center has not been tried yet. All that said, in the following, the problem that this study is trying to solve will be presented.

1.2 Problem Statement

Distribution centers are one of the most important parts of the supply chain and they play a major role in the distribution of products. A very large number of producers and product suppliers, use distribution centers to dispense their products. Therefore, the current situation in many distribution centers is that they have to deal with a large volume of products coming into and going out of them. In addition, one other issue in these centers is that there are almost no schedules for the inbound and outbound containers as well as no determined sequence for them to enter and exit the center. This can lead to a queue for the containers or it can lead to accumulation of products. If this situation is not handled properly, it can lead to a very high level of inventory and in turn, lead to extra storage and holding costs. As a result of an improper management of the inventory level in the distribution centers, many of the distribution centers have to put up with extra inventory and holding costs and they need to get rid of these costs at the earliest time. In addition, there are many warehouses that act as distribution centers and they are willing to find a way or mechanism to deliver the demanded items of their customers as soon as possible so that they will not have to pay any extra inventory costs as well as keeping their customers satisfied. Therefore, one of the current needs of the distribution centers is to find a way to reduce the level of inventory. There are some approaches to deal with this problem, however, one of the most effective methods is to use cross docking systems. This study will use the cross docking system to deal with this problem and eliminate the storage or at least, reduce the level of inventory in the distribution centers as much as possible. These systems are special distribution centers with no storage, which their working mechanism exactly corresponds to the need that this study is looking for. The distribution centers, as their name implies, are made for product distribution and by using this model they can benefit from the advantages of a Cross-Docking center by becoming one. Since the model that this study is seeking to develop can turn a traditional distribution center to a Cross-Docking center, thus, there will be no more storage and inventory cost. According to

the current literature, this particular issue and solution has never been tried and studied before.

In short, this study is trying to solve the problem of extra inventory and holding costs by developing a cross docking model for the distribution centers, so that the distribution center can transfer into a cross docking center and there will not be any more storage of the products in the distribution centers, thus, there will be no more extra inventory costs.

1.3 Research Question

The following question has been proposed in this study:

How can a traditional warehouse or distribution center, turn into or operate as a cross docking center and decrease its inventory costs?

How can a number of required items of a company be delivered to that certain company all at the same time through a cross docking center?

1.4 Objectives of the Study

The main objective of this study is as follows:

- To develop a Cross-Docking system model for the distribution centers to assist them transfer to a Cross-Docking center and decrease their inventory costs as well as delivering the required items of their customers

- To verify the model

1.5 Significance of the Study

Although there have been a number of researches on the inventory costs of the distribution centers as well as a number of studies about the cross docking operations in supply chain, almost no attention has been paid to integrate the distribution centers with cross docking systems so that the cost of logistics will be reduced as well as the cost of the storage and inventory.

In today's competitive market, one of the key factors in being successful is the factor of time. In a distribution center (or a warehouse), receiving, storage, order picking and shipping are the four major functions. Storage is the most costly operation out of these four functions and the reason is due to the inventory holding costs (Belle et al., 2012). So if the holding time of the inventory is reduced, then there will be a reduction in the total operation costs of the distribution center (or a warehouse). The most important characteristic of a cross docking center is that the inventory will not be stored and even if there has to be storage for some of the cargos, the time of the storage is less than 24 hours. This study is trying To develop a cross docking model

to assist the traditional distribution centers operate as a Cross-Docking center and deliver the required items of the companies (customers).

1.6 Scope of the study

This study has focused on the traditional warehouses or traditional distribution centers. It has also emphasized the applicability of cross docking centers and has used the concept of auctions as well as cross docking as the tools to reach the objective of the study. This research has considered one particular company in Iran as a case study. The results of this study can be used in distribution centers and can become guidelines for the future design of warehouses or distribution centers. However, future studies on other warehouses and distribution centers are recommended to reach even better and more results.

1.7 Thesis Outline

This thesis has been arranged into five chapters. The first chapter provides an overview about the problem that this study is seeking to solve, the objectives of the study, the scope and the limitations of the thesis. In the second chapter, this study has provided a brief introduction to the main topics of this research, cross docking and auctions and then a comprehensive literature review about them. The third chapter has presented the methodology of this study and how the objectives of this study will be achieved. In the fourth chapter, the results of the study as well as the discussion about the results have been covered. The fifth chapter summarizes the overall finding of the current research and recommendations for future work.

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