UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF LOCATION-INVENTORY MODEL BASED ON ALL-UNIT QUANTITY DISCOUNT POLICY

ZAHRA FIROOZI

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By

ZAHRA FIROOZI

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

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DEDICATION

I dedicate this thesis to my beloved family

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

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Chairman: Associate Professor Tang Sai Hong, PhD.

Faculty: Engineering

Distribution network design is one of the main issues in supply chain management. Two key decisions that must be determined to design a distribution network are facility allocation decisions and inventory control decisions. Despite the interaction exists between these two decisions, traditional methods ignored simultaneously optimizing them in a supply chain. Therefore, the obtained results are expected to be suboptimal in many situations. To deal with this problem, in recent years, joint location-inventory models are developed to simultaneously determine the inventory control decisions and facility locations decision of a distribution network.

Majority of the previous joint location-inventory models considered the simplest inventory model that is economic order quantity (EOQ) to replenish the demands of retailers. However, a very common policy offered by suppliers is quantity discount that provides the buyers the opportunity of purchasing in larger quantities and reducing their total cost. When quantity discount is available the buyers need to

trade-off between reduction in purchasing and ordering cost and increase in the inventory cost in order to find the optimal order quantity. However, EOQ (Q, r) model is not capable of doing such comparison and the buyers need to apply quantity discount models to find the optimal order quantity. Nevertheless, so far quantity discount has not been considered as inventory policy in joint location-inventory models.

Thus, this research has formulated and solved a joint location-inventory problem, while all-unit quantity discount is considered as the inventory policy of distribution network. In order to solve the model, two heuristics and one enumeration algorithm are developed. It is shown that considering quantity discount instead of EOQ policy saves the total cost up to 4.5%. In addition, the network configurations are shown to be different under two policies. To investigate the performance of the developed heuristic algorithms, results of the heuristics in terms of total cost and computational time (CPU time) are compared with results obtained by enumeration algorithm and results obtained by Lingo 12.0 software. Results of the developed heuristics are up to 92% betters that the results that the enumeration algorithm find in 24 hours, and 88% better than the results obtained by Lingo.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN SUATU MODEL LOKASI-INVENTORI DENGAN MENPERTIMBANGKAN SEMUA DASAR DISKAUN KUANTITI UNIT

Oleh

ZAHRA FIROOZI

Jun 2011

Pengerusi: Profesor Madaya Tang Sai Hong, PhD.

Fakulti : Kejuruteraan

Satu daripada isu utama pengurusan rangkaian bekalan adalah reka bentuk rangkaian pengagihan. Dua keputusan utama yang mesti ditentukan untuk mereka bentuk satu rangkaian pengagihan adalah keputusan peruntukan kemudahan dan keputusan kawalan inventori. Walaupun interaksi wujud antara dua keputusan ini, cara tradisional tidak mempertimbangkannya semasa mengoptimumkan mereka serentak pada suatu rantaian bekalan. Lantaran itu, hasil yang diperolehi dijangkakan suboptima di dalam pelbagai keadaan. Untuk menangani masalah ini, sejak kebelakangan ini, model lokasi-inventori bersama dibangunkan serentak untuk menentukan keputusan kawalan inventori dan keputusan lokasi kemudahan sesuatu rangkaian pengagihan.

Kebanyakan model lokasi-inventori bersama sebelum ini mempertimbangkan model inventori yang paling mudah iaitu kuantiti pesanan ekonomi (EOQ) yang memenuhi permintaaan peruncit. Walau bagaimanapun, suatu dasar yang sangat biasa yang ditawarkan oleh pembekal adalah diskaun kuantiti yang memberi peluang kepada

pembeli untuk membeli dalam kuantiti yang lebih besar dan mengurangkan jumlah kos. Bila adanya diskaun kuantiti, pembeli perlu mendapatkan keseimbangan di antara pengurangan kos pembelian dan pemesanan, dan peningkatan kos inventori untuk menentukan kuantiti pesanan optimum. Walau bagaimanapun, model EOQ (Q, r) tidak mampu melakukan perbandingan sedemikian dan pembeli perlu menggunakan model diskaun kuantiti untuk menentukan kuantiti pesanan optimum. Setakat ini, diskaun kuantiti tidak dipertimbangkan sebagai dasar inventori di dalam model lokasi-inventori bersama.

Oleh sebab itu, penyelidikan ini telah merumus dan menyelesai masalah lokasi-inventori bersama, sementara itu semua-unit diskaun kuantiti digunakan sebagai dasar inventori rangkaian pengagihan. Untuk menyelesaikan model, dua heuristik dan satu penghitungan algoritma telah dibangunkan. Dengan mempertimbangkan diskaun kuantiti tanpa polisi EOQ, jumlah kos penjimatan adalah sehingga 4.5%. Sebagai tambahan, konfigurasi rangkaian menunjukkan berbezaan di bawah dua dasar. Untuk menyiasat prestasi algoritma heuristik yang dibangunkan, keputusan heuristik pada aspek jumlah kos dan masa pengiraan (masa CPU) dibandingkan dengan keputusan algoritma penghitungan serta keputusan perisian Lingo 12.0. Keputusan heuristik adalah 92% lebih baik daripada keputusan algoritma penghitungan dalam masa 24 jam, dan 88% lebih baik daripada keputusan Lingo.

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I also would like to express a full heart of thankfulness to my beloved brother and sisters for their love and encouragement.

Lastly, I would like to thank all those who guided, helped and encouraged me throughout this research.

I certify that an Examination Committee has met on 16 June 2011 to conduct the final examination of Zahra Firoozi on her Master thesis entitled "Development of location-inventory model based on all-unit quantity discount policy" in accordance with the Universities and University College 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 Master of Industrial Engineering.

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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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DECLARATION

I declare that this thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

ZAHRA FIROOZI

Date: 16 June 2011

TABLE OF CONTENTS