بسم الله الرحمن الرحيم

HANAA ALY

شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

شبكة المعلومات الجامعية

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جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

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HANAA ALY

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Design and Production Engineering Department

Sustainable Supply Chain Network Design for Perishable Products

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Mechanical Engineering

(Design and Production Engineering Department)

by

Omnia Mohamed Nabil Othman Mohamed El-Sayed

Bachelor of Science in Mechanical Engineering

(Mechatronics Engineering Department)

Faculty of Engineering, Ain Shams University, 2016

Supervised By

Prof. Dr. Nahid Hussein Afia Abdel-Halim

Dr. Tamer Ahmed Aly Aly Ismail

Cairo - (2021)

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Statement

This thesis is submitted as a partial fulfilment of Master of Science in Mechanical Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Thesis Summary

This study addresses the problem of sustainable supply chain network design for perishable products. Perishable products lose their value or deteriorate in a short time, from the moment they are produced, therefore storing products in warehouse should be continuously monitored in order to avoid waste and reaching expiration. A mathematical model is developed to design sustainable, single product, multi period, three-echelon supply network including manufacturer, warehouse, and customer. The problem is formulated as mixed-integer nonlinear programming (MINLP). The model is solved by both Excel and GAMS solvers.

The aim is to find the best configuration of the supply chain and to decide the quantity of units to be produced at each period, without extra needless production, and also the quantities of units to be transferred from manufacturer to warehouse, and from warehouse to customer. This decision relies on the perishability of products, the demand of the customers, and handling inventory according to the different ages of products in the warehouse. First-in First-Out (FIFO) inventory policy is adopted by most of the producers in the field of perishable products. It is favoured in the real life industry as it avoids wastes and expiration of products. The FIFO inventory policy helps in organizing the flow of products in the warehouse, subsequently no products can expire. It assumes that the products produced first (older products) are the ones sold first. The recent ones are to be left as inventory. As a result, the remaining inventory consists of the most recent units. FIFO policy is best for perishable products where inventory has a short shelf life-time. This is because it prioritizes the oldest products that will maximize the use of inventory before products perishes in order to prevent expiration of products and to minimize costs arising from those expired products.

The proposed model's objectives are maximizing the profit and minimizing the environmental impact by deciding the optimal quantities transferred between the different facilities to prevent expiration of products.

The proposed model can be used to design supply chain network for perishable products, it optimizes multi-period network while considering inventory in the warehouse. It considers backlog, where the unmet demand in

any period can be fulfilled in the subsequent periods. It can prevent expiration of products, where only needed quantities are produced without waste.

In model verification, several scenarios have been proposed to verify the behaviour of the model. Profit has been analysed through different studies. In order to study the effect of different parameters on profit, all the parameters are considered fixed and only one parameter is changed. The addressed parameters are demand of customer, inventory holding cost per unit per period, shortage cost per unit per period, fixed cost, …. etc.

It can be concluded from the model results' analysis that as the customers' demand increases, the profit increases, as long as the demand does not exceed the pre-specified capacity of the manufacturer. On the other hand, when the customers' demand exceeds the manufacturer's capacity, the profit decreases due to the impact of shortage costs on the profit. Also, the profit decreases, when any of the cost parameters increases except the expiration cost, as the proposed model ensures that there are no expired quantities, subsequently there will be no expiration costs. The customers' demands can be fulfilled by the most adequate number of manufacturers, without the need of extra manufacturing centers, in order to maximize the profit. Assuming that the quantities transferred from the manufacturer to the warehouse are equal to the pre-specified manufacturer's capacity leads to expiration of products and even may be lead to loss in profit. In case that the model decides the optimal quantity transferred between the different facilities, the profit is maximized and the environmental impact is minimized, as expiration of products is prevented.

Key words:

Sustainable supply chain, Supply chain network design, perishable products, food, pharmaceutical, Inventory, FIFO, expiration.

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List of Abbreviations

SCND:	Supply Chain Network Design
SSCND:	Sustainable Supply Chain Network Design
SCM:	Supply Chain Management
Eco:	Economic objective function
Env:	Environmental objective function
Soc:	Social objective function
Oth:	Other objective functions
FIFO	First-in First-Out
GAMS	General Algebraic Modelling Language