การออกแบบเครือข่ายโซ่อุปทานเพื่อลดต้นทุนรวมของอุตสาหกรรมไก่แช่แข็ง โดยใช้แบบจำลองทางคณิตศาสตร์

Supply Chain Network Design for Reduce Total Cost of Frozen Chick Industry Using Mathematical Model

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บทคัดย่อ

งานวิจัยนี้นำเสนอแบบจำลองทางคณิตศาสตร์สำหรับการออกแบบเครือข่ายห่วงโซ่อุปทานของอุตสาหกรรมไก่สดแช่แข็ง โดยมีวัตถุประสงค์เพื่อลดต้นทุนโดยรวมที่เกิดขึ้นในห่วงโซ่อุปทาน การวิจัยครั้งนี้เริ่มจากภาพรวมของอุตสาหกรรมห่วงโซ่อุปทานไก่แช่แข็ง ซึ่งกิจกรรมเริ่มต้นจากเกษตรกรผู้เลี้ยงไก่ โรงชำแหละไก่ คลังสินค้า/ศูนย์กระจายสินค้าและลูกค้า (ลำดับขั้นที่ 1) งานวิจัยนี้จะให้ความสนใจไปที่ต้นทุนของสินค้า ค่าใช้จ่ายในการจัดเก็บ ค่าใช้จ่ายในการขนส่งและเงินลงทุนที่เกิดขึ้น และเน้นต้นทุนของสินค้า เพื่อกำหนดระดับที่เหมาะสมของขีดความสามารถและต้นทุนเพื่อใช้ในการกำหนดตัวแปรในทางคณิตศาสตร์ โดยใช้โปรแกรม Lingo ในการแก้ปัญหาของกรณีศึกษา และได้รับค่าใช้จ่ายทั้งหมดของห่วงโซ่อุปทาน หลังจากที่ได้รับข้อมูลเบื้องต้นเกี่ยวกับค่าใช้จ่ายที่อยู่ในห่วงโซ่อุปทาน ทางเลือกการขนส่ง จะทำการจัดกิจกรรมในห่วงโซ่อุปทาน วิเคราะห์ค่าใช้จ่ายและเพิ่มประสิทธิภาพโดยปรับเปลี่ยนการออกแบบห่วงโซ่อุปทานใหม่ที่จะส่งผลในการลดค่าใช้จ่ายเพื่อให้ต้นทุนโดยรวมต่ำสุด

คำสำคัญ: *ห่วงโซ่อุปทาน การออกแบบเครือข่าย แบบจำลองทางคณิตศาสตร์*

Abstract

This research presents the mathematical model for supply chain network redesign of frozen chicken industry. The objective is to reduce the overall cost occurred in the supply chain. This research starts with an overview of the supply chain industry frozen chicken. Activities supply chain begins of production, slaughter, processing, warehouse / distribution center and end customers (Tier 1), Storage costs, cost of transportation and investments for the costs incurred in the research is focused the cost of goods. In order to determine the appropriate level of capability and cost, the information will be used to determine the variables in mathematical. Then analyze and interpret the equation with Lingo, to obtain the total cost of the supply chain. After the basic costs within the chain and supply lines for these goods are acquired, the activities in this supply chain will be analyzed and optimizing the cost. By redesigning the supply chain, would result in cost reduction for minimizing total cost.

Keywords: *supply chain, network design, mathematical model*

1. Introduction

At the present, the competition of manufacturers in the frozen chicken industry is intense since there are many manufacturers in this industry. The adaptation of each manufacturer is needed for surviving in this industry. A sustainable surviving is to improve frozen chicken supply chain performance. In each frozen chicken supply chain, there are many parts concerned, such as suppliers, manufacturer, distributors, retailers, and customers. They connect each other similarly to be a network. To improve the supply chain network performance is to redesign the supply chain network. Additionally, cost is an important factor that can reflect the performance of the supply chain. Hence, the authors redesign supply chain network for minimizing cost of frozen chicken supply chain by using mathematical models. In this paper, the authors focus the network in the supply chain. They have studied capacities, investment, and product flow on the link. The network flow optimization perspective for the supply chain network design present the modeling of the economic activities associate with Frozen Chicken Industry network. The supply chain network model (Nagurney, 2010) presents the supply chain network design optimal product flow and investment capacities for the minimized total cost and demand at the retail outlets. (Nagurney, 2009) described a meat-market supply chain network design model in an oligopolistic setting by formulating a variational inequality problem and then proposed an algorithm which the underlying structure network design problem. We represent the supply chain network redesign by implement minimize cost cooperate mathematical model for finding the optimal levels of capacity and network flow including having minimal cost and maximum profit.

2. Problem Mathematical Model

The mathematical model had been used Lingo for solving this problem. In this research, The model had been designed in which investment capacity and product flow in the optimization problem with the supply chain network redesign. (Figure 1)

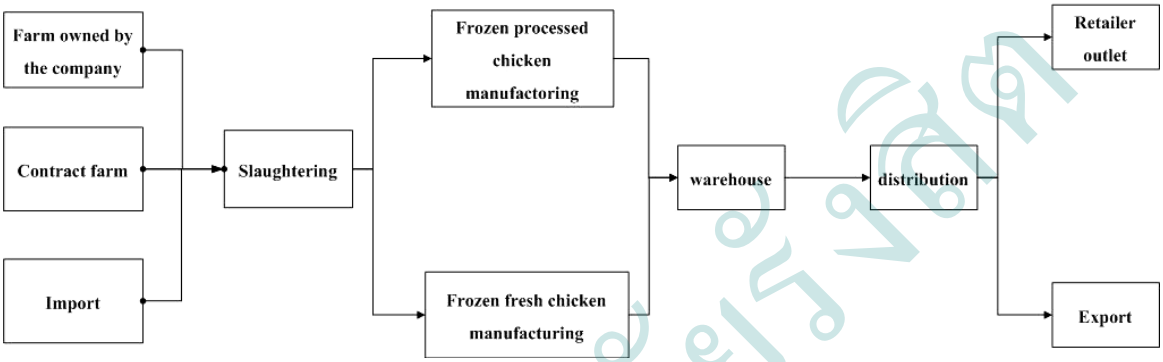

Figure 1: The supply chain network design of frozen chicken industry

Parameter

$l_{j,k}$ Link of node j to k

d_{n_R} Demand of product at demand market

f_a Flow of product on link a

x_p Flow of product on node p

u_a Capacity of link a

$\hat{\pi}_a$ Total investment cost on adding capacity u_a

$\hat{C}_a$ Total cost on link a

$\hat{C}_p$ Total cost on node p

Decision Variable

$$Y_{a,p} = \begin{cases} 1, If\ link\ a\ contained\ in\ path\ p \\ 0, Otherwise \end{cases}$$

$$W_p = \begin{cases} 1, If\ link\ a\ contained\ in\ node\ p \\ 0, Otherwise \end{cases}$$

$$D_p = \begin{cases} 1, If\ link\ a\ contained\ in\ node\ p \\ 0, Otherwise \end{cases}$$

Objective function

$$Minimize \sum_{a\in L} \ddot{C}_a + \sum_{r\in N} \ddot{C}_r + \sum_{a\in L} \hat{\pi}_a \quad (1)$$

Constraints

$$\sum_{a\in L_{n_R}} f_a = d_{n_R} \quad (2)$$

$$n_R = 1, \dots, n_R \quad (3)$$

$$x_p \geq 0 \quad ;\forall a \in L \quad (4)$$

$$f_a \leq u_a \quad ;\forall a \in L \quad (5)$$

$$u_a \geq 0 \quad ;\forall a \in L \quad (6)$$

$$\sum_{p\in P} x_p Y_{a,p} \leq f_a \quad ;\forall a \in L \quad (7)$$

$$\sum_{p\in P_{n_R}} x_p = d_{n_R} \quad ;\forall a \in P \quad (8)$$

$$\sum_{i=1}^{I} \sum_{n=1}^{N} C_{s_{n_S^i}^i} X_p = \hat{C}_{s_{n_S^i}^i} \quad ;\forall a \in P \quad (9)$$

$$\sum_{i=1}^{I} \sum_{n=1}^{N} C_{M_{n_M^i}^i} X_p = \hat{C}_{M_{n_M^i}^i} \quad ;\forall a \in P \quad (10)$$

$$\sum_{i=1}^{I} \sum_{n=1}^{N} C_{W_{n_W^i}^i} X_p W_p = \hat{C}_{W_{n_W^i}^i} \quad ;\forall a \in P \quad (11)$$

$$\sum_{i=1}^{I} \sum_{n=1}^{N} C_{D_{n_D^i}^i} X_p D_p = \hat{C}_{D_{n_D^i}^i} \quad ;\forall a \in P \quad (12)$$

$$\hat{C}_a = \hat{C}_a(f) \quad ;\forall a \in L \quad (13)$$

$$\ddot{C}_p = \ddot{C}_p(x) \quad ;\forall a \in L \quad (14)$$

$$\hat{\pi}_a = \hat{\pi}_a(u_a) \quad ;\forall a \in L \quad (15)$$

The objective function of the model is minimizing total cost on the link and node and total investment. In the link used constraint (2) are total a flow of demand market since the firm to a retailer on the link have constraint (3)-(5) are control flow of product the link by less than or amount level of capacity. Constraint (6) determines the flow of link on the path. In the node used constraint (7) is total flow of demand market since the firm to a retailer on the node. Constraint (8) - (11) are total cost of node supplier, manufacturing, warehouse and distribution center. Constraint (12) - (15) are total cost of flow on the path.

3. Research Method

In the figure 2 describes the supply chain of frozen chicken the first problem is usually caused by an imbalance of the supply from customers demand and investment. We had been generated mathematical model for analyzing supply chain network and used numerical example and Lingo used to solve the model for result is minimized total cost.

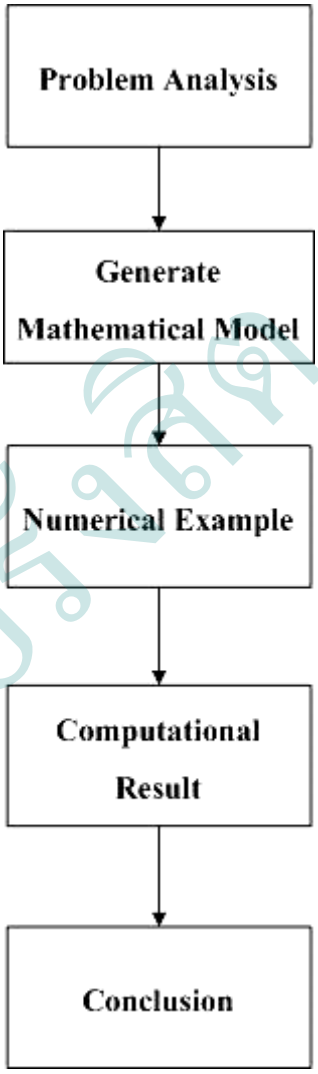

Figure 2: Research methodology

4. Conclusion

In this paper, We had been presented a mathematical model of the network flow optimization approach for the representation of economic activities associated with supply chain network, warehouse, distribution, as well as storage, which we then utilized to formulate both the supply chain network design problem. We had been calculating the product flow from upstream to

downstream compare with the flow product from solving by Lingo find to be lower cost. We illustrated the framework with numerical supply chain network examples for both the design for lead to redesign models in the future races that may studied continuously.

The result of the reaches, have the algorithm that we had been used to solve the embedded network optimization problems at each iteration of the proposed algorithm has been applied to solve large-scale transportation network and supply chain problem. The solution of the model result of the optimal supply chain network design at minimal cost and satisfaction of demand market at the retailers. The model in this paper can be extended in different direction and can be applied in different industrial setting. We can include multiple criteria associated with supply chain network design to incorporate, for example, risk and even environment emission, if sustainability is the goal (Nagurney, 2009)

5. References

Nagurney, A. (2009). "Supply Chain Network Design under Profit Maximization and Oligopolistic". Transportation Research E (2010) 46, pp. 281-294.

Nagurney, A. (2010). "Optimal Supply Chain Network Design and Redesign at Minimal Total Cost and with Demand Satisfaction". International Journal of Production Economics 128: (2010) pp.200-208.