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INFORMATION SCIENCE, ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MATERIALS HANDLING AND LOGISTICS

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Analysis of Generic Food Supply Chain: The Case of Olive Oil Industry in Turkey

Booklet of PhD Theses

by

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1. Preliminary

Effective supply chain management is the main source of sustainable competitive advantage for companies. Therefore, the concepts of supply chain and supply chain management have received attention from many practitioners and academicians, especially in the recent years. However, most of the emphasis of academic research on supply chains has been conducted in general manner. Although potential positive outcomes that will occur after the successful implementation of supply chain management practices, there are not enough studies on industry specific supply chain models and practices. Meanwhile, food industry has become one of the leading sectors that affect social and economic environment especially in the recent years. Accordingly, supply chain practices in the food industry have become more critical for food companies' competitiveness. Therefore, the supply chain system in food industry should be designed and managed according to the requirements and constraints of the sector due to the special characteristics of the food product. Hence, food supply chain research would be valuable both for researcher and practitioners of the field. In this context, this thesis aims to examine on food supply chains by a mathematical model and application of it into olive oil industry.

As the preliminary study, literature review on supply chain and food supply chain is provided in the thesis.

2. Objectives:

The objective of this thesis is to optimize the distribution network of olive and olive oil supply chain of Tariş Olive and Olive Oil Company (Tariş), operating in the olive oil industry in Turkey. For this objective, a generic model is provided for a food supply chain. Also, a specific model is developed for Tariş. Current distribution system of Tariş is analyzed and a mathematical programming model is developed to provide a distribution design for the company to maximize its profits.

2.1. The Generic Model

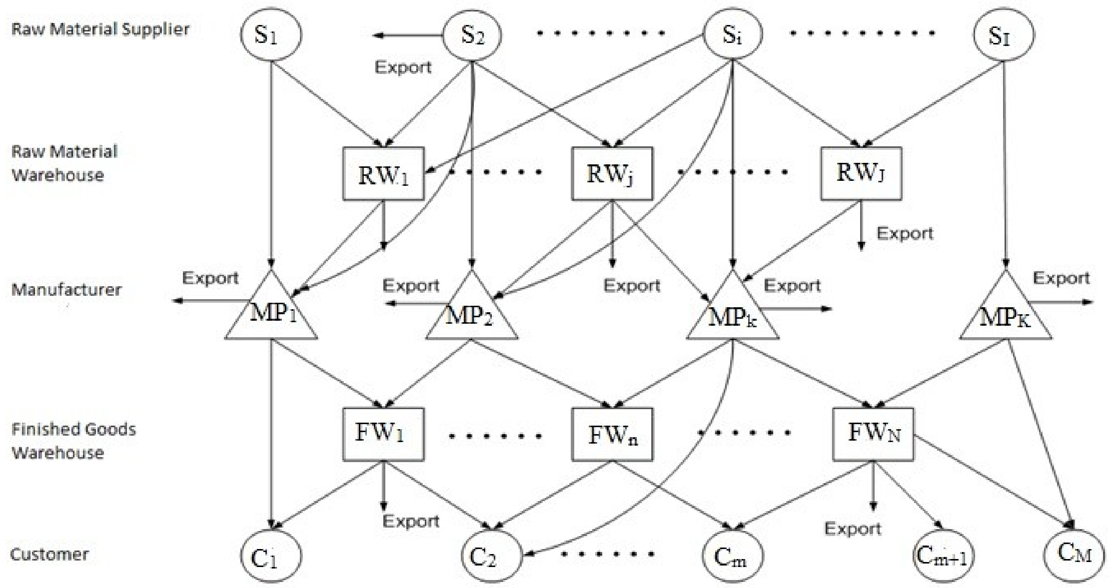
We aim to give a conceptual framework of distribution network structure of food supply chain. For this aim, distribution network structure of a generic food supply chain is illustrated in Figure 1. It should be noted that distribution network structure may change by product.

The generic model illustrates the network flow from raw material supplier to the customer. All possible members of the generic food supply chain and the flows within and between them are shown in the figure.

Figure 1 Distribution Network Structure of a Generic Food Supply Chain

2.2. Minimum – cost network flow minimization model

In this thesis, we utilized minimum – cost network flow minimization formulation. General



multi-commodity minimum cost flow formulation is shown and explained as follows:

"Let O(k), k $\in$ *K, be the set of origins of commodity k; D(k), k* $\in$ *K, the set of destinations of commodity k; T(k), k* $\in$ *K, the set of transshipment points with respect to commodity k;* o_i^k *, I* $\in$ *O(k), k* $\in$ *K, the supply of commodity k of vertex i;*

d_i^k, $i \in D(k)$, $k \in K$, the demand of commodity k of vertex i; $u_{ij}^{\square}$, $(i,j) \in A$, the capacity of arc (i,j) (i.e. the maximum flow that arc (i,j) can carry); u_{ij}^k, $(i,j) \in A$, $k \in K$, represent the flow of commodity k on arc (i,j). Moreover, let C_{ij}^k (x_{ij}^k), $(i,j) \in A$, $k \in K$, be the cost for transporting x_{ij}^k flow units of commodity on arc (i,j)."

Minimize

$$\sum_{k \in K} \sum_{(i,j) \in A} C_{ij}^k x_{ij}^k$$

subject to

$$\sum_{\{j \in V:(i,j) \in A\}} x_{ij}^k - \sum_{\{j \in V:(j,i) \in A} x_{ji}^k = \begin{cases} o_i^k, if\ i \in O(k), \\ -d_i^k, if\ i \in D(k), \\ 0, if\ i \in T(k), \end{cases} (1)$$

$$x_{ij}^k \leq u_{ij}^k, (i,j) \in A, k \in K, (2)$$

$$\sum_{k \in K} x_{ij}^k \leq u_{ij}, (i,j) \in A, (3)$$

$$x_{ij}^k \geq 0, (i,j) \in A, k \in K, (4)$$

"The objective function is the total cost, constraints correspond to the flow conservation constraints holding at each vertex $i \in$ V and for each commodity *$k \in K$.*

Constraints impose that the flow of each commodity k $\in$ *K does not exceed capacity* u_{ij}^{k} *on each arc (i,j)* $\in A$ *. Constraints (bundle constraints) require that, for each (i,j)* $\in A$ *, the total flow on arc (i,j) is not greater than the capacity* $u_{ij}^{\square}$ *."*

2.3. Model for Tariş Olive Oil Supply Chain and Application

Tariş is one of the leading companies operating in olive oil industry in Turkey. Based on the generic food supply chain network flow model and the minimum – cost network flow minimization formulation we proposed a distribution network model for Tariş. Figure 2 shows, distribution network structure of Tariş. Main supply and demand nodes, manufacturing plant, warehouses and flows between these are illustrated in the figure.

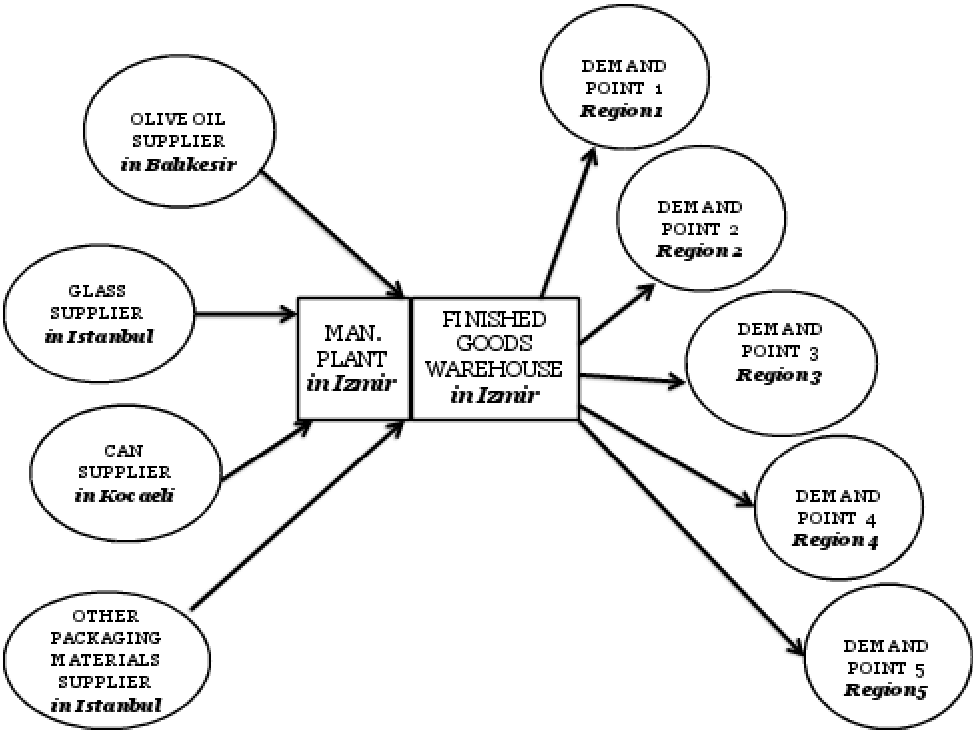


Figure 2 Olive Oil Network Model of Tariş in Turkey

In order to optimize distribution and production system of Tariş by minimizing cost and maximizing profit, we propose the following mathematical model.

Notations used in the model proposed in this study are as follows:

i**:** product types, $i=\{1,\ldots,I\}$

k**:** sales regions, $k=\{1,\ldots,K\}$

p_i**:** sales price of product *i*

oil_i**:** amount of oil required to produce product *i*

oc**:** unit cost of oil

t**:** unit transportation cost of oil from Kuzey Ege (Balikesir) to the factory

toil**:** total amount of oil available for production

pc_i**:** packaging cost of product *i*

tc_i**:** unit transportation cost of packaging material for product *i* from suppliers to the factory

***(can from Kocaeli, glass from Istanbul)

c_{ik}: cost of transportation for product *i* from factory to sales region *k*

d_{ik}: demand of sales region *k* for product *i*

Decision Variables:

X_i: number of product *i* produced

Y_{ik}: number of product *i* shipped to sales region *k*

Mathematical Model:

Maximize

$$p$$
$$¿$$
$$¿ i - c_{ik} ¿ Y_{ik} - \sum_{i=1}^{I} (oc * oil_i - pc_i) X_i - t * toil$$
$$¿$$
$$¿$$
$$\sum_{k=1}^{K} ¿$$
$$\sum_{i=1}^{I} ¿$$

Subject to:

$$X_i \leq \sum_{k=1}^{K} Y_{ik} \forall i (1)$$

$$\sum_{i=1}^{I} oil_i X_i \leq toil (2)$$

$$Y_{ik} \leq d_{ik} \forall i, k (3)$$

$X_i \geq 0 \; \forall i \; (4)$

$Y_{ik} \geq 0 \; \forall i, k \; (5)$

The objective function aims to **maximize the total profit.** Constraint set 1 shows that the amount of product i shipped to customer region k must be less than or equal to the amount produced. Constraint set 2 limits the number of products by the total available olive oil. Constraint set 3 states that the demand of each region may not be fully met. Constraint sets 4 and 5 state that decision variables are positive integers.

3.Theses

Thesis 1

We formulated a generic model as a conceptual framework of distribution network structure of food supply chain. The generic model includes all possible members of the generic food supply chain and network flows from raw material supplier to the customer. The generic network model is also illustrated as a figure.

Thesis 2

Based on the generic model, we also developed a specific model to optimize the distribution network of olive and olive oil supply chain of Tariş Olive and Olive Oil Company (Tariş) which is operating in the olive oil industry in Turkey. We illustrated distribution network of olive and olive oil supply chain of Tariş Olive and Olive Oil Company (Tariş) is illustrated. We formulated a mathematical programming model and analyzed the current distribution system of Tariş. We proposed the model order to optimize distribution and production system of Tariş by minimizing cost and maximizing profit. We modelled the problem using integer programming model and solved the problem exactly using Cplex solver on GAMS Software.

Thesis 3

In order to optimize the distribution network of olive and olive oil supply chain of Tariş, real data was needed. For this reason, data on the olive and olive oil industry especially in the Aegean Region of Turkey and supply chain of Tariş is gathered. Data collection is conducted by observations and site visits to production plant and warehouses of Tariş, face to face interviews with the managers of Tariş and the secondary sources including reports, articles and books on Tariş and olive oil industry.

Thesis 4

We compared the results of solution and the real data and we realized that the production volumes for each product type proposed by the results are different than the real production volumes. Mixed Integer Programming Method is used for the analysis and the solution. Based on the optimal results proposed by the solution, required changes on the production volumes are given. Findings and recommendations for potential improvements and developments are provided.

Further Research

As reference to further research, problems of other companies operating in the same sector can be further investigated. The solution may also be done by using real demand data. Other potential members of supply chain can be included to the model and the problem can be tested again. Same problem could be applied for the other product categories.

4. Author’s Selected Publications on the Related Topics

Chapters in Scientific Books

Yurt, Ö., Mena, C., Stevens G. (2010), “Sales and operations planning for the food supply chain: case study” in the book titled “Delivering performance in food supply chains” which is edited by Mena C., Stevens G., pp. 117-140, Cambridge, UK, Woodhead Publishing Ltd, ISBN: 978 1 84569 471 5.

Yurt Ö., Kerepeszki I., Cselenyi J., (2004) “The Needs for Changing the Distribution Chains”, in the book titled Logistics Networks – Models, Methods and Applications which is edited by T. Banyai – J. Cselenyi, pp: 353-358; University of Miskolc, Miskolc, ISBN: 963 661 641 8.

Publications in Proceedings Books of International Conferences

Yurt Ö.(2007), Cselenyi J., Illes, B.(2007), “Valuation of Existing Supply Chain of Olive And Olive Oil”, “Proceedings of MicroCAD-2007 International Scientific Conference-Supplementary Volume”, pp:141-151,Miskolc,Hungary.

Yurt Ö., Cselenyi J., Illes, B.(2006), “Method for Evaluation of Food Supply Chain in Case of Inland Use”, “Proceedings of Conversations at Miskolc”, pp: 77-84, Miskolc, Hungary.

Yurt Ö., Cselenyi J., Kerepeszki I.(2006), “Examination of Typical Food Supply Chain”, “Proceedings of MicroCAD-2006 International Scientific Conference, pp:191-197, Miskolc, Hungary.

Kerepeszki I., Cselenyi J., Illes, B., **Yurt Ö.**(2005), “Buyer-Supplier Assignment Problems in Virtual Logistics Support Networks”, “Proceedings of 3rd Logistics and Supply Chain Congress: Logistics and Supply Chain Management in a Globalizing World”, pp: 232-237, Istanbul, Turkey.

Kerepeszki I., **Yurt Ö.**(2005), “Formation of Virtual Logistics Support Networks for SMEs”,

"Proceedings of 3rd Logistics and Supply Chain Congress: Logistics and Supply Chain Management in a Globalizing World", pp: 399-405, Istanbul, Turkey.

Yurt Ö., Cselenyi J., Kerepeszki I.(2005), "Fundamentals of Surveying Customer Satisfaction within Characteristics Food Supply Chains", "Proceedings of 5th International Conference of PhD Students", pp: 217-222, Miskolc, Hungary.

Yurt Ö., Kerepeszki I., Cselenyi J. (2005), "Concept of an Optimized Distribution Chain Considering Customer Demand and Customer Satisfaction", "Proceedings of MicroCAD-2005-International Scientific Conference", pp:129-135, Miskolc, Hungary.

PhD Thesis of the Author in the Field of Marketing and Supply Chain Management

Yurt Ö. (2007) "The Impact of Services Supply Chain Orientation on Perceived Industrial Service Quality: An Empirical Analysis", PhD Thesis, Izmir, Turkey.

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