Research Journal of Recent Sciences ISSN 2277-2502
Vol. **4(7),** 119-129, July **(2015)** *Res.J.Recent Sci.*

Cutting logistics Costs with an Optimal distribution with Balancing approach and Cost minimization: A Case Study Model in one Producer-multiple Warehouses Condition in Supply chain management

Kaveh Iravanazam*, Hasanmehrmanesh and Jalal haghighatmonfared
Department of Industrial Management, Science and Research Branch, Islamic Azad University, Tehran, IRAN

Available online at: www.isca.in, www.isca.me
Received 20th October 2013, revised 26th February 2014, accepted 21st May 2014

Abstract

Logistics as a part of supply chainis a process of creating value through scheduling and stock locating. Increasing competitive conditions in the market of goods and services supply and main advancements of communicative and IT industries have caused suppliers, producers and distributors to focus highly on logistics systems to decrease costs and improve customers' services (providing the product in the right time and place for the customer). To this end, internal and external logistics costs (products` final distribution) and total cost in logistics system is a key factor to improve management performance. In the present study, it has been attempted to decrease total transport cost by selecting the appropriate capacity of transportation. Then, forkliftare optimally allocated to each department based on measured time per minute to do transport operations related to a transport cycle through each forklift in each department at assembly saloon. Afterwards, the most optimal transport channel of ingredient is determined by each forklift from two existing warehouses to assembly saloon using TOPSIS ranking method. Finally, the total expected distribution cost consisting the model`s target function is minimized using an optimal distribution model in one producer-multiple warehouses condition.

Keywords: Logistics management, supply chain management, total transportation cost, vehicle allocation of transport, transport channel selection, topsis method.

Introduction

Affordability and decreasing cots is the main reason of applying logistics in different organizations. However, the importance of logistics is not only due to its affordability but due the fact that it improves providing better services for customers. By better services, it is referred to more flexibility and speed[1]. The firms of most countries have recognized the importance of logistics in a new competitive environment since decreasing logistics costs, as a part of total costs of each system, also plays a deterministic role in producing a high quality and low cost product as well as determining appropriate place in competitive market of organization[2]. As the researches show, fifty percent of investigated firms have introduced logistics as their first or second preferences[3].

Various researchers and authors have presented different attitude and definitions of supply chain. Followings are brief and comprehensive definitions can be provided for supply chain management.

Generally, supply chain involves all activities related to goods change from extraction stage to delivery stage as well as information flows associated with them. Regarding commodity flow, there are two other flows including information and financial resources[4].

Supply chain is the process of supplying ingredients, changing them into final products (through production) and delivering to customer (through distribution or delivering to retailers or both)[5]. Notably, supply chain is not connected to a simple and isolated chain consisted of some commercial elements but it is more a network consisting of a large number of members with complex relations[6].

Supply chain management is defined by MIT as a process-oriented integration approach to provide ingredients and required items, goods production and delivery and customer services[7].

According to Chopra and Mindel, supply chain includes all parts attempted to meet customer`s needs directly or indirectly[8]. This definition involves some point which can be stated as follows

Supply chain includes some various components that their operational nature has not legal nature necessarily. A supply chain is formed based on customer`s demand. In fact, customers` demand selected to be responded creates supply chain (its strategy and structure, activities type, and the way of implementation). Although customer`s demands are of importance for all the chain members, all of them cannot respond customer`s needs only. Many of chains` members are common in several supply chain and perform the activities which are not directly related with customer`s need in a certain supply chain. Provided definition of supply chain involves the issues of information systems management, sourcing and supplies, production scheduling, orders processing, stock management, warehousing, and customer services.

Here, some related works conducted regarding investigated topic are discussed.

Asgari and Aghdasi proposed an integrated stock planning and transport model in supply chain management to minimize presented transport costs applied in a case study of Iran Khodro Company in which Iran Khodro companies and parts suppliers were the considered supply chain[9]. The presented mathematical model was multi-objective seeking to minimize the cost of maintenance and buyer ordering, the transportation cost of buyer or supplier.

Teymouri and Ghiami presented a model to determine the order point and optimal order size in two independent enterprises with respect to transportation costs[10]. They considered the costs of two independent non equal through a distribution channel as well as related transportation costs between these two members simultaneously[11]. The proposed model determines inventory policies to minimize total costs of system with respect to referred costs[12].

Ghazanfari and Seyed Hasani conducted a study on integration and minimization of total costs in logistics supply chain. Previous works focused only on the models of supply, production or distribution or a combination of both models[13]. But none of them investigated the relation among three models. It worth to investigate since costs integration reduces total costs[14]. Their research includes three models of supply, production and distribution and an integrated model integrating the systems of production and distribution[15].

Watanabe et al. presented a mathematical model to minimize transportation and inventory costs in a productive company with a multi-stage production in which time limitations for producing a part has been considered to the time of transport request[16].

Nozick and Turnquist conducted a case study in an automobile plant in which a mathematical model was proposed with respect to operations` integration attitude, transportation cost and inventory cost[17].

Another research conducted by Daski and Certer presented a model for supply-distribution system based on application of continuous functions to determine the cost of distribution and customer`s demand[18].

The above mentioned issue was modeled as fuzzy in the study of Nishaaki et al.[19]. Target function is as minimizing transportation cost, zero time or the number of vehicles.

Main body: Logistics is a combination of orders, inventory, transportation, warehousing, and packaging materials over supply chain as a continuous process[20]. It plays the role of replacing and locating inventory to provide the access in right time and place as well as obtaining profit with the lowest total cost[21]. Logistics also is critical for supply chain efficiency and integration[22].

If the companies do not obey required appropriate time and place, there will be nothing to sell. This chain should be integrated to maximize profit since decision making for a certain section of this chain may affect costs of other sections[23]. Logistics activities include orders, purchasing, inventory control, facilities planning and transportation, warehousing, and packaging in supply chain system flowing in three stages of supply, production and distribution[24].

Suppliers, producers and distributors have focused on logistics systems to find a solution to reduce costs and improve customer services. To this end, internal and external logistics costs (products` final distribution) and total cost in logistics system is a key factor to improve management performance. Effective management of supply system and logistics distribution is impossible only through logistics organizing as a system and minimizing total cost of providing customer services[25].

Therefore, huge savings in costs, satisfying customer and increasing sale is the main features of logistics[26]. Accordingly, it is considered as a key factor to gain superiority in competitive market. So, it seems necessary to create an internal and external distribution model of logistics total cost[27].

The present study seeks to minimize logistics total costs in metal industrial company of Iran using total external logistics distribution and internal transport appropriate capacity. Notably, the present study is the first research aimed to use such model in such context.

The research objectives: The research objective can be presented as the following: Decreasing the cost of internal supply logistics supply in metal industrial Company of Iran making use of transpiration capacity. Optimal allocation of transportation equipments for each department to decrease cycle time of internal supply transport in metal industrial Company of Iran. Determining the best channel of transporting ingredients fromwarehouse to assembly salon to decrease the distance and time of internal supply transport in metal industrial Company of Iran. Presenting a model to optimize and decreasing total expected cost of final products` distribution in logistics system in metal industrial Company of Iran

Methodology

Considering the fact that the data was gathered through studying documents (logistics engineering and management section of assembly salonconex), articles, theses, and various books; using observation and timing (stopwatch) methods; and using experts` opinions, it can be said that the present research is an applied descriptive study using field and quantitative methods. It is a case study done in an Iranian metal industrial company investigating total cost of logistics distribution in official/administrative and research conex production in the company. There is no sampling and statistical population includes conex assembly salon of Iranian metal industrial company.

Results and Discussion

Computing the number of vehicles allocated to operators: After computing the standard times of transport cycle in each department, the number of Pallets transported in a working hour in each department is estimated.

For example, if a Pallet is transported in an average time of 2/09 minutes in cutting department, the number of estimated Pallets to be transported during a working hour will equal with:

The number of Pallets to be transported in cutting department during a working hour= $\frac{60}{2/09}$ = 28/7

The number of Pallets to be transported in other departments has been computed in table-2.

Then, having access to the information regarding the appropriateness the number of forklifts allocated to each department (table-1) and measuring the forklifts` time allocated to each department facilitating producing 1/125 conexes per day to fulfill commitment at the maximum time of 10 working day, can be computed as follow:

The number of vehicles allocated to each department=

$$\frac{the\ forklifts`\ observed\ time\ allocated\ to\ each\ department\ in\ 8\ working\ hours}{a\ working\ hour\ (480\ minutes)}$$

For example, the number of forklifts allocated to cutting department operator is:

The number of vehicles allocated to cutting department operator = $\frac{302/4}{480}$ = 0/63

The number of forklifts allocated to other departments operators have been presented in table-2.

Computing total expected transportation cost: In this stage, with respect to operator`s hourly cost rate (15 dollars) and forklift`s hourly cost rate (45 dollars) per hour, the total expected transportation cost during working hour in each department for each Pallet can be computed as follow:

The total expected transportation cost = $\frac{operator`s\ horly\ rate+(number\ of\ allocted\ veihchles\ \times forklift`s\ hourly\ rate)}{number\ of\ Pallets\ to\ be\ replaced}$

For example, in cutting department we have:

The total expected transportation cost = $\frac{5000+(\frac{0}{63}\times 15000)}{18/04}$ = 801

The expected cost of other departments has been shown in table-3.

Table-1
Appropriateness of Pallets` transportation in each department

Department`s name	**Cutting**	**Welding**	**Painting**	**Installing wall, window and decorations**
appropriateness of Pallets` transportation in each department	**0/31**	**0/21**	**0/2**	**0/28**

Table-2
The number of vehicles allocated to operators in

Department`s name	**Standard time of transportation cycle**	**The number of estimated Pallets to be transported during 1 working hour**	**The forklifts` observed time allocated to each department in 8 working time (minutes)**	**The least transportation of Pallets` umber to satisfy receivable order per hour in each department**	**The number of vehicles allocated to operators**
Cutting	2/09	28/71	302/4	18/04	0/63
Welding and grinding	3/2	18/75	312	12/22	0/65
Painting, pre-painting and de-fatting	3/2	18/75	297/6	11/64	0/62
Installing wall, window and decorations	2/82	21/28	369/6	16/29	0/77

Table-3
Total expected transportation cost

Department`s name	The number of Pallets to be transported according to the production program to satisfy requested order	The number of vehicles allocated to operators	Operator`s hourly	Forklift`s hourly rate	Total expected transportation cost
Cutting	18/04	0/63	5000	15000	801
Welding and grinding	12/22	0/65	5000	15000	1207
Painting, pre-painting and de-fatting	11/64	0/62	5000	15000	1228/5
Installing wall, window and decorations	16/29	0/77	5000	15000	1016

According to table-3, internal transportation`s total cost based on 10 working hours is:

C_1= 20000(6/31+6/55+6/24+7/69)8 = 4286400

Thus: C_2 = 4286400

Decreasing total expected transportation considering the use of maximum observed transportation capacity: Now, cost is computed to use the maximum transportation capacity.

Considering the fact that 52 pallets should be transported to produce each conex, 4680 Pallets are needed to be transported to produce 90 conexes.

Considering the appropriateness mentioned in table-1 earlier, each department`s transportation can be illustrated as follow:

Considering the number of Pallets which should be transported in a working day (8 hours) and the number of Pallets which should be transported to produce 90 conexes, the days leading to concluding project in each department has been presented in table-6.

Table-4
Total expected transportation considering the use of maximum observed transportation capacity

Department`s name	The number of estimated Pallets to be transported during 1 working hour	The number of vehicles allocated to operators	Operator`s hourly	Forklift`s hourly rate	Total expected transportation cost
Cutting	28/71	1	5000	15000	696/6
Welding and grinding	18/75	1	5000	15000	1066/6
Painting, pre-painting and de-fatting	18/75	1	5000	15000	1066/6
Installing wall, window and decorations	21/28	1	5000	15000	939/8

Table-5
Appropriateness of Pallets transportation in each department to produce 90 conexes

Department`s name	Cutting	Welding and grinding	Painting, pre-painting and de-fatting	Installing wall, window and decorations
appropriateness of Pallets in each department	1450/8	982/8	936	1310/4

Therefore, internal transportation`s total cost can be stated as follow with respect to the use of maximum observed transportation capacity.

C_1 = 20000(6/31+6/55+6/24+7/69)8 = 4286400
Thus: C_2 = 4286400

Comparing C_1 and C_2 reveals that if the company`s production strategy is based on using appropriate transportation capacity, in addition to decreasing production tome up to 2-3 working day, transportation cost will be reduced up to 10/7%.

Optimal allocation for each forklift to each department in assembly salon using Hungarian allocation method: All the computations were done based on allocations of first forklift to the first department, the second forklift to the second department, the third forklift to the third department, and the fourth forklift to the fourth department, now, the accuracy of all allocations should be revealed. Forklifts are allocated to each department optimally based on the measured timed (in minutes) to implement transportation operations related to a transportation cycle by each forklift in each department in assembly salon which has been presented in the following table.

Therefore, it can be concluded that allocating forklift 1 to cutting department has been correct but other forklifts should have been allocated to other departments. So, primary allocation of forklifts to departments has not been appropriate. The following table indicates the appropriate allocation of forklifts.

Table-6
The number of days to conclude production project

Department`s name	The number of estimated Pallets to be transported during 1 working hour	The number of estimated Pallets to be transported during 8 working hours	The number of Pallets required to produce 90 conexes	The number of days to conclude production project
Cutting	28/71	229/68	1450/8	6/31
Welding and grinding	18/75	150	982/8	6/55
Painting, pre-painting and de-fatting	18/75	150	936	6/24
Installing wall, window and decorations	21/28	170/24	1310/4	7/69

Table-7
The average transportation time (in minute) of ingredients to each department through each forklift in each transportation cycle

Department / Forklift	Cutting	Welding and grinding	Painting, pre-painting and de-fatting	Installing wall, window and decorations
Number 1	2/09	3/1	2/9	3/1
Number 2	2/9	3/2	2/8	2/7
Number 3	2/7	2/9	3/2	3
Number4	2/8	3/3	2/6	2/82

The final result obtained from using Hungarian method is as follow:

Table-8
Final result obtained from using Hungarian method

Department / Forklift	Cutting	Welding and grinding	Painting, pre-painting and de-fatting	Installing wall, window and decorations
Number 1	(0)	0/81	0/81	1/01
Number 2	0/2	0/3	0/1	(0)
Number 3	0	(0)	0/5	0/3
Number 4	0/2	0/5	(0)	0/22

Table-9
Optimal allocation of each forklift to each department

Forklift no	Department
No 1	Cutting
No 2	Welding and grinding
No 3	Painting, pre-painting and de-fatting
No 4	Installing wall, window and decorations

Considering table-10 and comparing forklifts allocation to departments before and after implementing optimal allocation model, it can be concluded in table-10.

According to table-11, the result of a conex production can provided the conclusion.

For example, the time duration of 10/92 Pallets` transportation cycle to produce a conex in welding department before and after allocation is computed as follows:

Before optimal allocation: 10/92 = 34/94 × 3/2

After optimal allocation: 10/92 = 29/48 × 2/7

According to table-12, production time of a conex can be reduced up to 8/24% (11/77 minutes). I other words, production will be ended 2/2 days earlier.

Ranking transportation channels of ingredients from warehouse to assembly salon using TOPSIS method for a decision maker to determine the best transportation channel: To determine the most optimal transportation channel by existing forklift from two existing warehouse to assembly salon, three indices of distance, time and cost of transportation have been considered. With forming primary table of decision making, the best transportation channel is determined using TOPSIS ranking method.

Table-10
The number of Pallets required to produce each conex

Department`s name	Cutting	Welding	Painting	Installing wall, window and decorations
appropriateness of Pallets in each department	16/12	10/92	10/4	14/5

Table-11
Comparison of transportation cycle duration before and after implementing Hungarian allocation model

Department	The amount of Pallet transported to produce a conex	Transportation cycle duration of Pallet before optimal allocation	Transportation cycle duration of Pallet after optimal allocation
Cutting	16/12	2/09	2/09
Welding and grinding	10/92	3/2	2/7
Painting, pre-painting and de-fatting	10/4	3/2	2/9
Installing wall, window and decorations	14/5	2/82	2/6

Table-12
Comparison of the results before and after implementing Hungarian allocation model

Department	The amount of Pallet transported to produce a conex	Transportation cycle duration of Pallet to produce a conex before optimal allocation	Transportation cycle duration of Pallet to produce a conex after optimal allocation
Cutting	16/12	33/69	33/69
Welding and grinding	10/92	34/94	29/48
Painting, pre-painting and de-fatting	10/4	33/28	30/16
Installing wall, window and decorations	14/5	40/89	37/7
Total		142/8	131/03

Table-13
Primary table of decision making to determine the best transportation channel

Index / Alternative	Distance (m)	Supply quality	Time duration mean of a Pallet`s transportation (minute)
First channel	53	Excellent	4
Second channel	76	Average	2/5
Third channel	43		3

This stage is implemented as follow: extracting decision matrix A

$$A=\begin{bmatrix}53 & 9 & 4\\ 76 & 5 & 2/5\\ 43 & 7 & 3\end{bmatrix}$$

determining weights matrix: Entropy technique is used to determine weights matrix as follow:

$$P=\begin{bmatrix}0/31 & 0/43 & 0/42\\ 0/44 & 0/24 & 0/26\\ 0/25 & 0/33 & 0/31\end{bmatrix}$$

For example, row and column include:

$$P_{11}=\frac{53}{172}=0/31$$

Then, matrix E_j(constant matrix) is obtained.

$$E_j=[0/9710/9710/974]$$

Now, uncertainty matrix or deviation degree is computed.

$$E_j'=1-E_j=[0/029\ 0/029\ \ 0/026\ ]$$

And weights matrix is extracted.
Wj =É j ÷ÉΣ j

Wj = [0/0/0345/34531]
weighted matrix D can be obtained from matrix$[d_{ij}]$ as follow:

$$D=\left[d_{ij}\right]_{m\times n},\qquad d_{ij}=\frac{a_{ij}}{\sqrt{\sum_{i=1}^{m}a_{ij}{}^2}}$$

$$D=\begin{bmatrix}0/511 & 0/722 & 0/715\\ 0/747 & 0/845 & 0/447\\ 0/423 & 0/567 & 0/536\end{bmatrix}$$

For example, for $d_{31:}$

$$d_{31}=\frac{43}{\sqrt{(53)^2+(76)^2+(43)^2}}=0/423$$

Supposing W (theoretical weights matrix of indices), “weighted normalization V” can be obtained from matrix D as follow:

$W_{n\times n}$ = W و V = $DW_{n\times n}$

$$\begin{bmatrix}0/345 & 0 & 0\\ 0 & 0/345 & 0\\ 0 & 0 & 0/31\end{bmatrix} V=\begin{bmatrix}0/511 & 0/722 & 0/715\\ 0/747 & 0/845 & 0/447\\ 0/423 & 0/567 & 0/536\end{bmatrix}$$

$$V=\begin{bmatrix}0/176 & 0/25 & 0/221\\ 0/257 & 0/291 & 0/138\\ 0/146 & 0/195 & 0/166\end{bmatrix}$$

Ideal positive and ideal negative alternatives can be obtained as follow:

Ideal positive alternative = $\{\max V_{ij} |\ j\ \in\ J), (\text{Min } V_{ij}\ |j\ \in \acute{J})\ i=1, 2, \ldots, m\}$

$$\{V_1^+, V_2^+, \ldots, V_n^+\}$$

ideal negative alternative $=\{(\text{Min } V_{ij}|j\ \in J), (\text{Max } V_{ij}|j\ \in \acute{J}|i=1, 2, \ldots, m\}$

$$\{V_1^-, V_2^-, \ldots, V_n^-\}$$

A^+= {MinV_{i1}, MinV_{i2}, MinV_{i3}} = {0/146, 0/291, 0/138}
A^-= {MaxV_{i1}, MaxV_{i2}, MaxV_{i3}} = {0/257, 0/195, 0/221}
The distance of i alternative can be obtained using Euclidean method as follow:

$$1, 2\ldots\ n=i, \sqrt{\sum_{j=1}^{n}\left(V_{ij}-V_j^+\right)^2}=d_i^+$$

$$n=1\ و2\ \ldots.i, \sqrt{\sum_{j=1}^{n}(V_{ij}-V_j^-)^2}=d_i^-$$

$$d_1^+=\sqrt{(0/175-0/146)^2+(0/25-0/291)^2+(0/221-0/138)^2}=0/0969$$

$$d_2^+=\sqrt{(0/275-0/146)^2+(0/291-0/291)^2+(0/138-0/138)^2}=0/111$$

$$d_3^+=\sqrt{(0/146-0/146)^2+(0/195-0/291)^2+(0/166-0/138)^2}=0/1$$

$$d_1^-=\sqrt{(0/175-0/275)^2+(0/25-0/195)^2+(0/221-0/221)^2}=0/0986$$

$$d_2^- = \sqrt{(0/275-0/275)^2+(0/291-0/195)^2+(0/138-0/22)^2} = 0/1268$$

$$d_3^- = \sqrt{(0/164-0/257)^2+(0/195-0/195)^2+(0/166-0/22)^2} = 0/1236$$

Relative closeness of alternative A_i to ideal solution is obtained s follow:

$cl_i^+ = \frac{d_i^-}{d_i^+ + d_i^-}$, $1 \le cl_i^+ \le 1$, i = 1, 2, …, m

$$cl_1^+ = \frac{d_1^-}{d_1^+ + d_1^-} = \frac{0/0986}{0/0969+0/0986} = 0/504$$

$$cl_2^+ = \frac{d_2^-}{d_2^+ + d_2^-} = \frac{0/1286}{0/111+0/1286} = 0/536$$

$$cl_3^+ = \frac{d_3^-}{d_3^+ + d_3^-} = \frac{0/1236}{0/1 + 0/1236} 0/552$$

Prioritization of alternatives in descending order of cl_i^+:

Table-14
Final ranking of transportation channels

Alternative	Rank
First channel	Third
Second channel	Second
Third channel	First

According to table-14, the selected channel under optimal conditions (third channel) decreases the distance and time of each Pallet`s transportation as much as 10 meters and 1 minutes on average.

Constructing logistics distribution model of conex`s assembly salon in Iranian metal industrial company: In the model, administrative- research conex ordered by 2 retailers is the final produced product (conex for 5 people and conex for 10 people) in assembly salon which is sent to two warehouses to be distributed after final quality control. The obtained information is presented as follow:

Table-15
Required volume for retailer based on warehouse i and product j (yijk)

Product	**Retailer`s need of warehouse 1 (i_1)**		**Retailer`s need of warehouse 2 (i_2)**	
	Need of retailer 1 K1	**Need of retailer 2 K2**	**Need of retailer 1 K1**	**Need of retailer 2 K2**
Conex for 10 people (**i_1**)	10	10	10	10
Conex for 5 people (**i_2**)	15	10	10	15

Table-16
Sum of retailer`s need based on warehouse i and product j

Warehouse / product	**Warehouse 1**	**Warehouse 2**
Conex for 10 people (**i_1**)	10 + 10 = 20	10 + 10 = 20
Conex for 5 people (**i_2**)	15 + 10 = 25	15 + 10 = 25

Table-17
Transportation cost (billion Rials) of product j through transportation channel R and transportation vehicle M

Transportation channel R_1	**Warehouse 1**				**Warehouse 2**			
	j1		j2		j1		j2	
	M1	M2	M1	M2	M1	M2	M1	M2
Transportation cost	2	2	1	1	3	1	2	1

Table-18
Maintenance cost (billion Rials) of product j in warehouse i

Warehouse / product	**Warehouse 1**	**Warehouse 2**
j1	4	5
j2	3	3

Table-19
Capacity (area) of warehouses and products (m^2)

Transportation vehicle type	**Fist type trailer (M_1)**	**Second type trailer (M_2)**
	120	90

Constructing the model of conex`s logistics distribution planning in Iranian metal industrial company: Min $Z = 6X_{1111} + 6X_{1121} + 4X_{1211} + 4X_{1221} + 8X_{2111} + 6X_{2121} + 5X_{2211} + 4X_{2221}$

$s.t:$

$10X_{1111} + 10X_{1121} + 6X_{1211} + 6X_{1221} \le 350$
$10X_{2111} + 10X_{2121} + 6X_{2211} + 6X_{2221} \le 350$
$X_{1111} + X_{1121} \ge 20$
$X_{1211} + X_{1221} \ge 25$
$X_{2111} + X_{2121} \ge 20$
$X_{2211} + X_{2221} \ge 25$

$10 X_{1111} \le 120$
$10 X_{1121} \le 90$
$6 X_{1211} \le 120$
$6 X_{1221} \le 90$
$10 X_{2111} \le 120$
$10 X_{2121} \le 90$
$6 X_{2211} \le 120$
$6 X_{2221} \le 90$
$X_{ijmr} \ge 0 , i = 1 , 2 , \dots , 4$

Optimal values of conexes (final product) distribution which should be distributed according to each retailer`s request and order from each distribution warehouse to deliver final customer are obtained by solving above model. The obtained values have been present in table 21. Also, figure 1 indicates solving model using VINQS.

Following results can be extracted from table-21: The amount of final distribution of 10 people conex from warehouse 1 and transportation channel 1 by transportation vehicle 1 is 12. The amount of final distribution of 10 people conex from warehouse 1 and transportation channel 1by transportation vehicle 2 is is 8. The amount of final distribution of 5 people conex from warehouse 1 and transportation channel 1 by transportation vehicle 1 is 20. The amount of final distribution of 5 people conex from warehouse 1 and transportation channel 1 by transportation vehicle 2 is 5. The amount of final distribution of 10 people conex from warehouse 2 and transportation channel 1 by transportation vehicle 1 is 11. The amount of final distribution of 10 people conex from warehouse 2 and transportation channel 1 by transportation vehicle 2 is 9. The amount of final distribution of 5 people conex from warehouse 2 and transportation channel 1 by transportation vehicle 1 is 10. The amount of final distribution of 5 people conex from warehouse 2 and transportation channel 1 by transportation vehicle 2 is 15.

**Comparing the results obtained from implementing the model of conex`s logistics distribution planning in Iranian metal industrial company:** Here, the results obtained from implementing the model of conex`s logistics distribution planning in Iranian metal industrial company are compared to distribute final product and the distribution system performance during receiving order under similar conditions in terms of the number of orders are investigated.

The results obtained from the comparison of values indicating expected total distribution cost of final product before and after implementing show that distribution costs are decreased up to 17%.

Notably, variables coefficients in the row of objective function and final costs before and after implementing the model are in Toman.

Table-21
Final distribution of products

Transportation channel	**Transportation vehicle**	i 1		i 2	
		j_1	j_2	j_1	j_2
R_1	M_1	12	20	11	10
	M_2	8	5	9	15

Table-22
Final distribution of product before implementing distribution model

Transportation channel	**Transportation vehicle**	**Warehouse 1**		**Warehouse 2**	
		j1	j2	j1	j2
R1	M1	15	18	14	12
	M2	5	7	6	13

Distribution $Cost_1$ = 15 x 6 x + 5 x 6 + 18 x 4 + 14 x 8 + 6 x 6 + 12 x 5 +13 x 4 = 480

Table-23
Final distribution of product after implementing distribution model

Transportation channel	**Transportation vehicle**	**Warehouse 1**		**Warehouse 2**	
		j1	j2	j1	j2
R1	M1	12	20	11	10
	M2	8	5	9	15

Distribution $Cost_2$ = 13 x 6 +8 x 6 x 20 x 4 + 5 x 4 + 11 x 8 + 9 x 6 + 10 x 5 + 15 x 4 = 402

	11:42:41		Friday	June	14	2013		
	Decision Variable	Solution Value	Unit Cost or Profit c(j)	Total Contribution	Reduced Cost	Basis Status	Allowable Min. c(j)	Allowable Max. c(j)
1	X1	12.0000	6.0000	72.0000	0	basic	-M	6.0000
2	X2	8.0000	6.0000	48.0000	0	basic	6.0000	M
3	X3	20.0000	4.0000	80.0000	0	basic	-M	4.0000
4	X4	5.0000	4.0000	20.0000	0	basic	4.0000	M
5	X5	11.0000	8.0000	88.0000	0	basic	6.0000	M
6	X6	9.0000	6.0000	54.0000	0	basic	-M	8.0000
7	X7	10.0000	5.0000	50.0000	0	basic	4.0000	M
8	X8	15.0000	4.0000	60.0000	0	basic	-M	5.0000
	Objective	Function	(Min.) =	472.0000	(Note:	Alternate	Solution	Exists!!)
	Constraint	Left Hand Side	Direction	Right Hand Side	Slack or Surplus	Shadow Price	Allowable Min. RHS	Allowable Max. RHS
1	C1	350.0000	<=	350.0000	0	0	350.0000	M
2	C2	350.0000	<=	350.0000	0	0	350.0000	M
3	C3	20.0000	>=	20.0000	0	6.0000	12.0000	20.0000
4	C4	25.0000	>=	25.0000	0	4.0000	20.0000	25.0000
5	C5	20.0000	>=	20.0000	0	8.0000	9.0000	20.0000
6	C6	25.0000	>=	25.0000	0	5.0000	15.0000	25.0000
7	C7	120.0000	<=	120.0000	0	0	110.0000	200.0000
8	C8	80.0000	<=	90.0000	10.0000	0	80.0000	M
9	C9	120.0000	<=	120.0000	0	0	60.0000	150.0000
10	C10	30.0000	<=	90.0000	60.0000	0	30.0000	M
11	C11	110.0000	<=	120.0000	10.0000	0	110.0000	M
12	C12	90.0000	<=	90.0000	0	-0.2000	80.0000	200.0000
13	C13	60.0000	<=	120.0000	60.0000	0	60.0000	M
14	C14	90.0000	<=	90.0000	0	-0.1667	30.0000	150.0000

Figure-1
Solving model using VINQS

Conclusion

Considering the fact that optimal allocation of transport equipment for each department, distributive products, ingredients transport channels, and using appropriate transport capacity are of the most important factors interfering in logistics systems, the present study attempted to decrease total cost by selecting appropriate transport capacity[28]. Then, forklift are optimally allocated to each department based on measured time per minute to do transport operations related to a transport cycle through each forkliftin each department at assembly saloon. Afterwards, the most optimal transport channel of ingredient is determined by each forklift from two existing warehouses to assembly saloon using TOPSIS ranking method[29]. Finally, the total expected distribution cost consisting the model`s target function is minimized using an optimal distribution model in one producer-multiple warehouses condition.

The followings are the results obtained from the study: With respect to increasing transport capacity in departments, in addition to decreasing order completion time in a maximum of 3 days, transport cost has also been decreased as much as 10/7%. By allocating forklifts optimally to each department using Hungarian method as well as comparing production times of a conex before and after optimal allocation, it is observed that time can be reduced as much as 8/24% (11/77 minutes) in a conex production time. In other words, time can be decreased as much as 1060 minutes (production is ended 2 days earlier). Also, selecting the most preferred transport channel (the third transport channel) decreases the distance and time as much as 10 meters and 1 minute for transporting each Pallet, averagely. Applying optimal model of total logistics distribution cost in one producer-multiple warehouses condition and considering the comparison of expected values of final products` total distribution costs before and after implementing the model, distribution costs are reduced up to 17%.

References

1. Herald C.M., Lamming R.C. and Cousins P.D., Developing the Concept of Supply Strategy, *International Journal of Operation and Production Management*, **(1999)**

2. Hans Christian and Hans Peter Buse, Inter Organizational Logistics Systems in Flexible Production networks; *International Journal Of Physical Distribution and Logistics Management*, **(2000)**

3. Iage Skjoett Larsen, European Logistics Beyond, *International Journal of Physical distribution and Logistics Management*, **(2000)**

4. Louden C. Kenneth and Louden P. Jane, Management Information Systems: Managing the Digital firm, 7th Edition, **(2002)**

5. Jo Son Tamara, One Size Does Not fitall, Dla Logistics College, advanced Logistics Management Course, Guide Book Series Chapter 3 Lambert, D.M., Cooper, M.C., Pagh, J.D., Supply Chain Management: Implementation Issues and Research Opportunities, *The International Journal of Logistics Management*, **(1998)**

6. Kazemzade R. and Matalebi M., Information systems of supply chain management, International conference of industrial engineering, Amir Kabir University of Industry, Tehran, **(2004)**

7. Chopra S and Meindl P, Supply Chain Management: Strategy, Planning and Operation, Pearson Education, Third Edition, **(2007)**

8. Asgari N. and Aghdasi M., Presenting an integrated inventory and transpiration planning model in supply chain management: A case study in Iran Khodro, The set of selected articles of the first logistics and supply chain conference **(2004)**

9. Teymouri A. and Ghiami Y., A model to determine the point and optimal volume of ordering in toe independent enterprises with respect to transportation costs, The set of selected articles of the first logistics and supply chain conference, **(2004)**

10. Ballou H Ronald, The evolution and future of logistics and supply chain management, *European Business Review,* **19(4) (2007)**

11. Capacino W and Rosenfield D, Modern logistics Management: integrating Marketing, Manufacturing and Physical Distribution; New York **(1985)**

12. Cardinali R., Does The Future of Military Logistics lie in outsourcing And Privatization?, Accountants – the New Year Keepers of War– Time Operation, **50(3) (2001)**

13. Chad W Autry, The Challenge of Reverse Logistics in catalog retailing, *International Journal Of Physical Distribution and Logistics management,* **31(1) (2001)**

14. Chou C. David, Xin Tan and Yen C. David, Web technology and supply chain management, *Information Management and Computer Security,* **12(4) (2004)**

15. Tavakoli A, Vadiei MA and Shams Kolookhi A, A Goal-Programming Model for Determining Economic Order Lot Sizing Regarding the Benefits of the Whole Supply Chain, *Res. J. Recent Sci*., **3(2)**, 8-15 **(2014)**

16. Gebauer H, Kucza G and Wang C., Spare parts logistics for the Chinese market, *An International Journal,* **18(6) (2011)**

17. Daski A, Certer V., A Continues model for production: Distribution system design, *European journal of operation research,* **129 (2001)**

18. Siroosnezhad Charandabi E and Bohlooli N, Investigation and Prioritizing the Key Factors of Success in Small and Medium Size Enterprises, *Res. J. Recent Sci.,* **3(2)**, 31-34 **(2014)**

19. Torabi Farsani Sh, Aboutalebi M and Motameni H, Customizing NSGAII to Optimize Business Processes Designs, *Res. J. Recent Sci.,* **2(12)**, 74-79 **(2013)**

20. Aghaei M, Asadollahi A, Tonekaboni M, Tajasom N and Abbasi S, Investigating the Impact of Store Brand Price-Image and Retailer Equity Dimensions on ETKA Chain Store Customer's Purchase Intention, *Res. J. Recent Sci.,* **2(11**), 5-11 **(2013)**

21. Aghaei M and Ebadati M, Design Supply Chain Management Networks by New Risk Passive Defense Model and solved it by Heuristic Algorithm Case Study: Warehouse and Retail ETKA Organization, *Research Journal of Recent Sciences,* **2(9)**, 18-24 **(2013)**

22. Ngaia E.W.T., Karen K.L., Moonb Frederick, Rigginsc J. and Candace Y. Yib., RFID research: An academic literature review (1995–2005) and future research directions **(2008)**

23. Jahromi A. and Faramarzi B., An evaluation of inventory level effect in productivity in supply chain, The first conference of logistics and supply chain **(2004)**

24. Ghazanfari H. and Seyed Hoseini S.M., Presenting models to integrate total logistics cost in supply chain management, The set of selected articles of the first logistics and supply chain conference, **(2004)**

25. Ghazanfari H. and Dizaj Khalili M., Developing a fuzzy model to facilitate using transportation equipments in logistics systems. The set of selected articles of the first logistics and supply chain conference, **(2004)**

26. Chow Garland, Trevor D. Heaver and Lennart E., Henriksson Logistics Performance: Definition and Measurement; *International Journal of Physical Distribution and Logistics Management,* **24(1) (1994)**

27. McGinnis A., Michael, Spillan E., John Virzi, Nicholas, An empirical study comparing Guatemalan and United States logistics strategies; *International Journal of Logistics Management*, **23(1) (2012)**

28. Helo P and Szekely B., Logistics information systems: An analysis of software solutions for supply chain co-ordination, *Industrial Management and Data Systems,* **105 (2005)**

29. Hans Christian Hans and Peter Buse, Inter Organizational Logistics Systems in Flexible Production networks, *International Journal of Physical Distribution and Logistics Management,* **(2000)**