AGGREGATE PRODUCTION PLANNING BY OBJECTIVE LINEAR TRANSPORTATION NETWORK IN MANUFACTURING ENVIRONMENT +

Zaid Hikmat yaqoub * **Omar Hashim Hassoon **** **Mazin Ghezie ****

Abstract:

Aggregate Production Planning (APP) is intermediate-range production planning usually covering 3 to 18 months. In this paper, mixing (proactive and reactive) aggregate production planning strategy for Pepsi-cola products (family package) produced in baghdad company for soft drink for three periods. Objective linear transportation network is used to minimize total production cost also minimize inventory and work-hour cost that represents two resource used in APP. WinQsb software is used to determine optimal solution to APP problem in this company.
Keywords: Aggregate Production Planning (APP), APP strategy, objective linear programming, mixing aggregate production planning.

التخطيط الاجمالي للانتاج بواسطه شبكات النقل الخطيه في بيئه تصنيعيه

زيد حكمت يعقوب عمر هاشم حسون مازن غازي عبد الرزاق

المستخلص:

التخطيط الاجمالي للانتاج هو تخطيط الانتاج لمرحله او فتره متوسطه تتراوح بين شهرين الى ثمانيه عشر شهرا. في هذا البحث، تم تطبيق ستراتيجه الدمج (ستراتيجيه الطلب و الطاقه) للتخطيط الاجمالي لمنتج البيبسي كولا (العبوه العائليه) و المنتج في شركه بغداد للمشروبات الغازيه و لثلاث فترات زمنيه. استخدمت شبكات النقل الخطيه للحصول على اقل كلفه كليه للتخطيط الاجمالي، اضافه الى تقليل كلف الخزين و كلفه ساعات العمل و التي تمثل اهم مصدرين مستخدمين في حساب التخطيط الاجمالي. تم استخدام برمجيه WINQSB للحصول على افضل النتائج لحل مشكله التخطيط الاجمالي في الشركه.

Introduction:

Because the rapid developments in the globalization of markets and international trade, managing operations in today's competitive marketplace pose a significant challenge for companies [1]. The concepts of production are managing many industrial production systems [2]. Production planning also provides key communication links from top management to manufacturing [3, 4]. Production planning is under the intensive pressure

+Received on 20/11/2011 , Accepted on 27/5/2013 .
*Lecture/ university of technology
**Assist. Lecture/ university of technology

from global competitions. With product life cycle growing shorter, time needed for and different customer needs has forced producers to improve efficiency and productivity of production activities. Without major investments, production system must be able to adapt or quick response to demand changes [5].

Aggregate Production Planning (APP) is a relevant stage of production planning process [6]. APP is concerned with the determination of optimal production, inventory, and work force levels to meet fluctuating demand requirements over a planning horizon that medium ranges from 3 to 18 months [7, 8]. An APP problem is determining the maximize profits and minimize work hour and inventory cost for each period of the planning horizon for a given set of production resources and constraints [9, 10]. Figure (1) represents periods production planning.

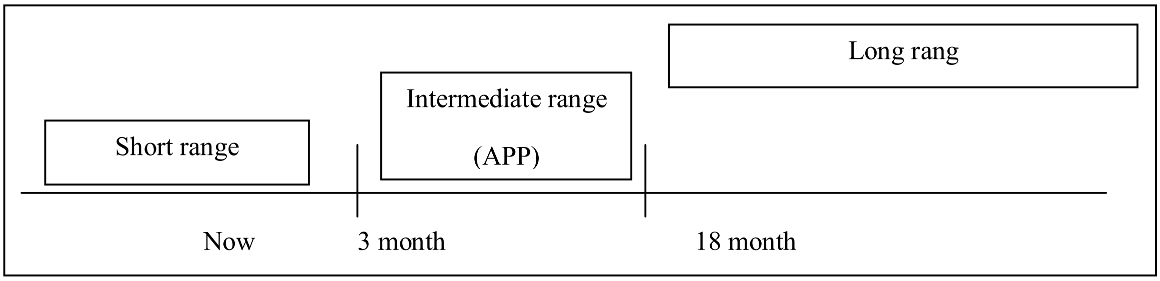

Fig. (1): Periods of Production Planning (APP) [11]

In this research, proactive strategy (alter demand to match capacity) and reactive strategy (alter capacity to match demand) are mixed to aggregate production planning problem for Pepsi-cola product (family package) produced in baghdad company for soft drink. Mathematical linear programming network used for obtaining optimal solution to APP problem allocation of scarce resource in term of total cost minimization of APP also inventory and work hour cost minimization in three period (three months).

Related works:

This paragraph reviewed the literature on aggregate production planning problem:

STEPHEN C. H. LEUNG, YUE WU and K. K. LAI. introduce multi-objective model is developed to solve the production planning problems, in which the profit is maximized but production penalties resulting from going over/under quotas and the change in workforce level are minimized. To enhance the practical implications of the proposed model, different managerial production loading plans are evaluated according to changes in future policy and situation. Numerical results demonstrate the robustness and effectiveness of the developed model [1].

Adiel Teixeira de Almeida Filho, Fernando Menezes Campello de Souza and Adiel Teixeira de Almeida. Present a model based on multicriteria decision analysis to overcome the problem of aggregate planning. This decision model takes into account performance objectives obtained in the manufacturing strategy planning process. In this sense, the decision maker chooses the most appropriate combination of resources to meet foreseen demand, according to the trade-offs amongst the performance objectives. Therefore the resulting aggregate plan reflects the competitive factors of the business. That is, the proposed decision model allows the implementation of the manufacturing strategy by the production function [6].

Seyed Mohamad Javad Mirzapour Al-e-Hashem, Mir Bahador Aryanezhad & Seyed Jafar Sadjadi. Present a multi-objective model to deal with a multi-period multi-product multi-site aggregate production planning problem for a medium-term planning horizon under uncertainty. The first objective function attempts to minimize sum of the expected value and the variability of total costs with reference to inventory levels, regular, overtime and subcontracting levels, backordering levels, and labor, machine and warehouse capacities. The second objective function highlighted the concept of customer service level through minimizing the expected value of maximum shortages among all customers' zones from which the variability of that is conducted. The last objective function aims to maximize workers productivity, a weighted average of productivity levels in all factories and in all periods which is weighted by the number of k-level labors. Then, we use an efficient algorithm that is a combination of an augmented ε-constraint method and genetic algorithm to solve our proposed model. The results demonstrate the practicability of the proposed multi-objective stochastic model as well as the proposed algorithm [12].

P. Aungkulanon, B. Phruksaphanrat and P. Luangpaiboon. Introduce an application of a fuzzy programming approach for multiple objectives to the aggregate production planning (APP). The parameters levels have been applied via a case study from the SMEs company in Thailand. The proposed model attempts to minimize total production cost and minimize the subcontracting units [13].

Ratiros Yimmee and Busaba Phruksaphanrat. Introduce fuzzy goal programming model for aggregate production and logistics planning with interval demand and uncertain production capacity is proposed. Two fuzzy goals are considered in the model; profit goal and change of workforce level goal. In conventional aggregate production planning (APP) models, logistics planning is not included. Even it is a critical criterion that creates extra cost. Moreover, demand is considered as crisp demand, which is not realistic. Actual demand is uncertain in nature and does not exactly equal to forecast demand. So, APP with interval demand that the best solution of possible demand can be selected is proposed in this research. Uncertain capacity is also considered in the proposed model. The proposed model can extremely increase profit and reduce change of workforce level. Furthermore, uncertain demand and production capacity are also cooperated, which make the model more realistic for the industrial applications. A case study of a real factory is illustrated to show the effectiveness of the proposed model [14].

Adiel Teixeira de Almeida Filho, Fernando Menezes Campello de Souza and Adiel Teixeira de Almeida. Present a model based on multi criteria decision analysis to overcome the problem of aggregate planning. This decision model takes into account performance objectives obtained in the manufacturing strategy planning process. To do so, the decision maker chooses the most appropriate combination of resources to meet foreseen demand, in accordance with trade-offs amongst the performance objectives. Therefore the resulting aggregate plan reflects the competitive factors of the business. That is, the proposed decision model allows the implementation of the manufacturing strategy by the production function [15].

Methodology of transportation network for solving (APP) problem:

Using transportation network in APP case is trying to assignment resource in company (inventory and normal time) to satisfy demand in future. Transportation network is optimization method that leads to optimal solution to reduce production cost to a minimum. This method also flexible because help in specify production quantity in normal time and inventory. The suggestion algorithm to solve APP by transportation network shows in Figure (2).

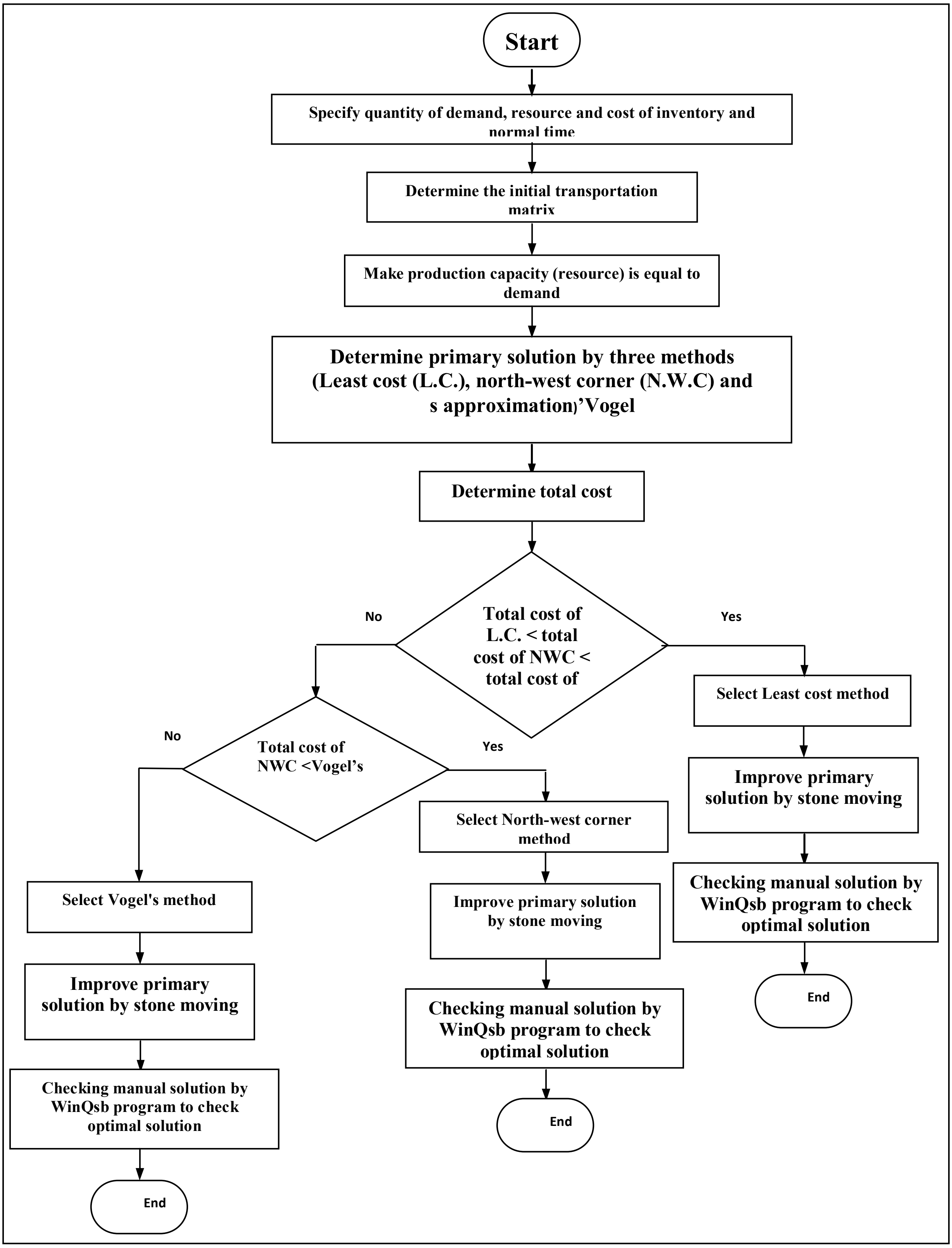

Fig (2): Algorithm of APP

1 Problem description

Baghdad company produces several varieties of soft drink and multiple sizes, types and quantity. Pepsi-cola drink (family size pack) was selected because this product is one of the most popular products in the markets, which on this basis will be built aggregate production planning in company. The research problem is giving the company optimal APP for product through investigation minimization cost of inventory and normal time criteria. The mixing between proactive strategy (alter demand to match capacity) and reactive strategy (alter capacity to match demand) by mathematical linear programming network lead to optimal solution to APP problem allocation of scarce resource or criteria in term of total cost minimization of APP also inventory and work hour cost minimization in three period (three months). The month's which data take it is March, April and May of the year 2011. These months represent transition case between winter and summer which affect the product in terms of inventory and work hour. The data in three months represent in table (1).

Table (1): Company data

	Inventory cost (ID)	Work hour cost (ID)	Demand (package)	Resource (Production quantity (Normal time)) (package).	Resource (Inventory) (package)
March	$88*10^3$	180000	28420	8400	103116
April	$80*10^3$	61000	32000	2740	175
May	$80*10^3$	32000	42120	1340	175

2 Model formulation by mathematical linear transportation

Linear transportation network is one of the useful tools in aggregate production planning solving in intermediate-stage through using some of constraints (inventory, work-hour and demand) that lead to achieve minimization total and partial cost. The assumptions used in this model are:

1-The goal is minimization total production cost and (inventory, work-hour) cost.
2- The production and transportation cost is fixed.
3- The measurement units of production and demand is similar.
4- The units produced in plant are similar.
5- Production capacity is equal to demand.

The optimal solution is determined by three steps:

<u>First step (built transportation network)</u>:

Figure (3) shows a transportation network for this problem. This network consists of the capacity plants on the right. The lower part of the network represents the demand. Also notes that the demand exceeds production capacity, so it is balancing the matrix by adding a column to fill the demand Moreover, the transport costs from the factory to supplier appear inside the small box in its own cell.

		Periods				
		3	4	5	Excess capacity	Resource
First period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	0	103116
	Normal time	$180*10^3$	61000	32000	0	8400
Second period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	0	175
	Normal time	$180*10^3$	61000	32000	0	2740
Third Period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	0	175
	Normal time	$180*10^3$	61000	32000	0	1340
	Demand	28420	32000	42120	13406	115946 / 115946

Fig. (3): Primary transportation Network

<u>Second step (determine primary solution)</u>: The initial solution to transportation network present starting point to get to the optimal solution. There are several methods for initial solution, such as lower cost method Least-Cost method, Vogel's approximation method and North-West Corner (NWC) method. The above methods used to determine primary solution (minimum total cost). The total cost to Least-Cost (LC) method (8,430,560,000 ID), Vogel's approximation method (7,318,520,000 ID) and North-West Corner (NWC) method (8,430,560,000 ID). The primary solution of North-West Corner shows in Figure (4).

		Periods				
		3	4	5	Excess capacity	Resource
First period	Inventory	28420 / $88*10^3$	32000 / $80*10^3$	42120 / $80*10^3$	576 / 0	103116
	Normal time	$180*10^3$	61000	32000	8400 / 0	8400
Second period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	175 / 0	175
	Normal time	$180*10^3$	61000	32000	2740 / 0	2740
Third Period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	175 / 0	175
	Normal time	$180*10^3$	61000	32000	1340 / 0	1340
	Demand	28420	32000	42120	13406	115946 / 115946

Fig. (4): Primary solution for North-West Corner

Min cost = $(88*10^{3*}28420) + (80*10^3*32000) + (80*10^3*42120) + (576*0) + (8400*0) + (175*0) + (2740*0) + (175*0) + (1340*0)$ = 8,430,560,000 ID

The primary solution of least-cost shows in Figure (5).

		Periods				
		3	4	5	Excess capacity	Resource
First period	Inventory	28420 $88*10^3$	32000 $80*10^3$	42120 $80*10^3$	576 0	103116
	Normal time	$180*10^3$	61000	32000	8400 0	8400
Second period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	175 0	175
	Normal time	$180*10^3$	61000	32000	2740 0	2740
Third Period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	175 0	175
	Normal time	$180*10^3$	61000	32000	1340 0	1340
	Demand	28420	32000	42120	13406	115946 / 115946

Fig. (5): Primary solution for Least-Cost matrix

Min cost = ($88*10^{3*}$28420) + ($80*10^3$*32000) + ($80*10^3$*42120) + (576*0) + (8400*0) + (175*0) + (2740*0) + (175*0) + (1340*0) = 8,430,560,000 ID

The primary solution of Vogel's shows in Figure (6).

		Periods				
		3	4	5	Excess capacity	Resource
First period	Inventory	28420 $88*10^3$	32000 $80*10^3$	29640 $80*10^3$	13056 0	103116
	Normal time	$180*10^3$	61000	8400 32000	0	8400
Second period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	175 0	175
	Normal time	$180*10^3$	61000	2740 32000	0	2740
Third Period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	175 0	175
	Normal time	$180*10^3$	61000	1340 32000	0	1340
	Demand	28420	32000	42120	13406	115946 / 115946

Fig. (6): Primary solution for Vogel's matrix

Min cost = ($88*10^{3*}$28420) + ($80*10^3$*32000) + ($80*10^3$*29640) + (32000*8400) + (32000*2740) + (32000*1340) + (13056*0) + (175*0) + (175*0) = 7,318,520,000 ID

After determine the primary solution of three above method, the minimum total cost from these methods is determined by Vogel's approximation method is (7,318,520,000 ID). Therefore, this method is improving by stepping stone moving to determine optimal solution.

<u>Third step (improve primary solution (optimal solution)</u>: Find the best solution by a stepping stone moving method for the Vogel's as:

1 - Choose the closed path of the cell empty and put the positive signal and the other is negative and we are working on the entire path closed, then we add and subtract costs for the cells selected and determine value. If value is negative must be to improve the path and if a positive value or zero the path is neglected and move on to another course.

2 - Choose a value that has less negative values in the closed path then multiple in the path result.

3-Subtract the result of multiplication from the total cost of transport.

4 - Built a new matrix and add the value that we chose in step 2 to the path of the cell empty.

Applying the above steps, the final matrix of optimal solution as show in Figure (7):

		Periods				
		3	4	5	Excess capacity	Resource
First period	Inventory	28420 $88*10^3$	32000 $80*10^3$	29640 $80*10^3$	13056 0	103116
	Normal time	$180*10^3$	61000	8400 32000	0	8400
Second period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	175 0	175
	Normal time	$180*10^3$	61000	2740 32000	0	2740
Third Period	Inventory	$88*10^3$	$80*10^3$	$80*10^3$	175 0	175
	Normal time	$180*10^3$	61000	1340 32000	0	1340
	Demand	28420	32000	42120	13406	115946 / 115946

Fig. (7): Optimal solution matrix by stepping stone method

The minimum cost after improve initial solution = (88*103*28420) + (80*103*32000) + (80*103*29640) + (32000*8400) + (32000*2740) + (32000*1340) + (13056*0) + (175*0) + (175*0) = 7,318,520,000 ID

<u>3 Implementing and testing manual solution using WINQSB software</u>

To use WINQSB program, must know how to run program and choose the technique that it will implement the data and insert the number of rows, columns, and entering data and processing by methods described and determine results and match results with the solution that we extract it manually using the transformation matrices. This steps present below:

1- Select new network models from WINQSB. Select transportation problem from net problem specification windows. The user selects the minimization objective. The data of number of sources (6 rows) and number of destinations (3 columns) is entered by spreadsheet matrix form as shows in Figure (8).

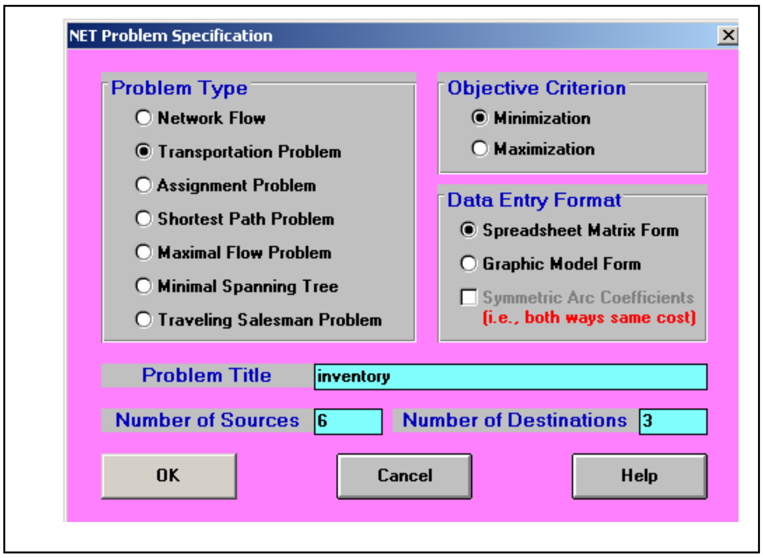

Fig. (8): Transportation network problem description

2-The matrix of initial solution which contains costs, Resource and demand as shows in Figure (9).

From \ To	2	3	4	Supply
inventory 1	88000	80000	80000	103116
time 1	180000	61000	32000	8400
inventory 2	88000	80000	80000	175
time 2	180000	61000	32000	2740
inventory 3	88000	80000	80000	175
time 3	180000	61000	32000	1340
Demand	28420	32000	42120	

Fig. (9): Transportation matrix

3-in above the Vogel's method is achieved min cost in initial solution. Therefore, the user selects the Vogel's method from transportation simplex initial solution method window as shows in Figure (10).

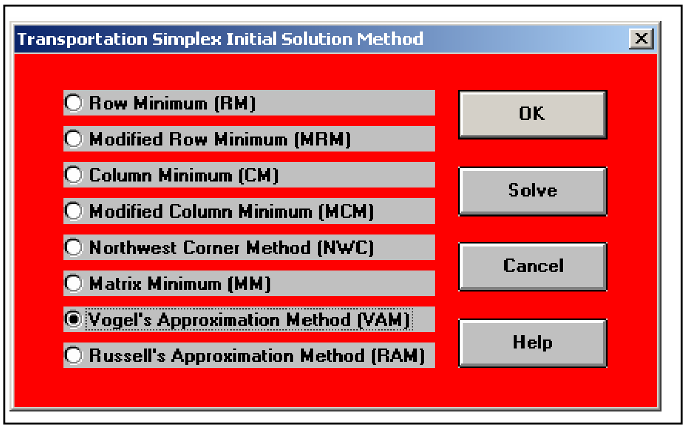

Fig. (10): Select Vogel's method

4- The minimum cost achieved for Vogel's method is (7,318,520,000 ID) which represent the initial solution as shows in Figure (11).

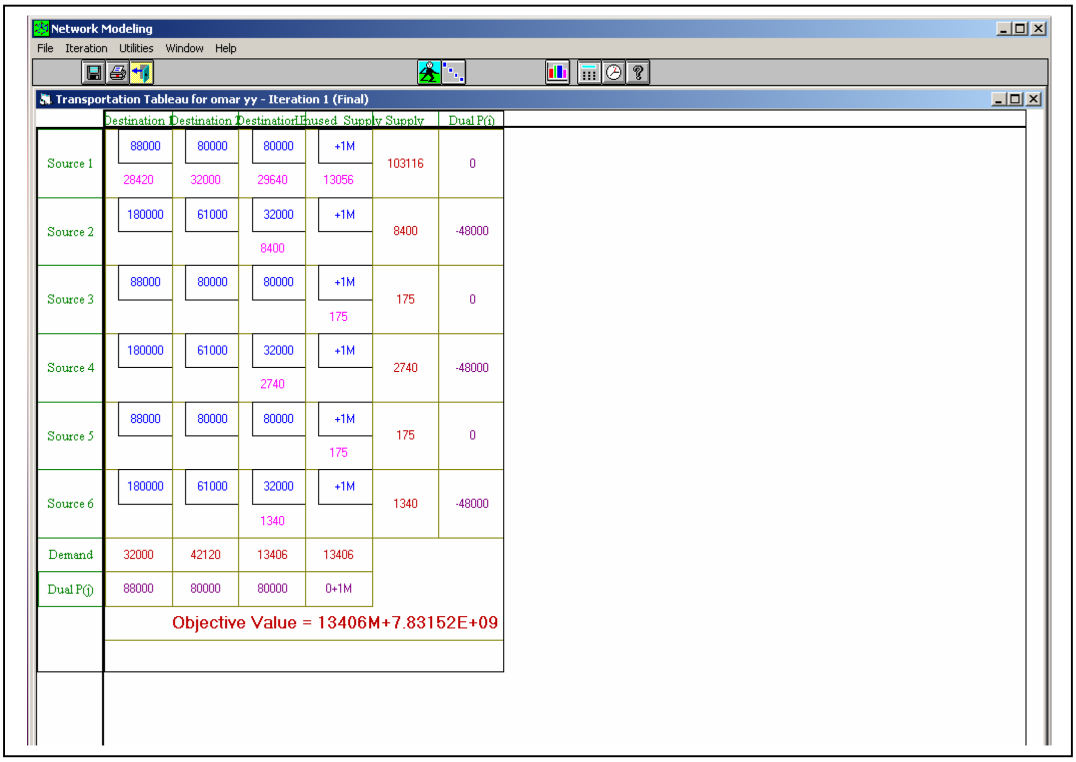

Fig. (11): Initial solution of Vogel's method

5- The minimum cost after improving initial solution of Vogel's method by stepping stone method is same as (7,318,520,000 ID) which represent in Figure (12).

05-31-2012	From	To	Shipment	Unit Cost	Total Cost	Reduced Cost
1	Source 1	Destination 1	28420	88000	2.50096E+09	0
2	Source 1	Destination 2	32000	80000	2.56E+09	0
3	Source 1	Destination 3	29640	80000	2.3712E+09	0
4	Source 1	Unused_Supply	13056	0	0	0
5	Source 2	Destination 1	0	180000	0	140000
6	Source 2	Destination 2	0	61000	0	29000
7	Source 2	Destination 3	8400	32000	2.688E+08	0
8	Source 2	Unused_Supply	0	0	0	48000
9	Source 3	Destination 1	0	88000	0	0
10	Source 3	Destination 2	0	80000	0	0
11	Source 3	Destination 3	0	80000	0	0
12	Source 3	Unused_Supply	175	0	0	0
13	Source 4	Destination 1	0	180000	0	140000
14	Source 4	Destination 2	0	61000	0	29000
15	Source 4	Destination 3	2740	32000	8.768E+07	0
16	Source 4	Unused_Supply	0	0	0	48000
17	Source 5	Destination 1	0	88000	0	0
18	Source 5	Destination 2	0	80000	0	0
19	Source 5	Destination 3	0	80000	0	0
20	Source 5	Unused_Supply	175	0	0	0
21	Source 6	Destination 1	0	180000	0	140000
22	Source 6	Destination 2	0	61000	0	29000
23	Source 6	Destination 3	1340	32000	4.288E+07	0
24	Source 6	Unused_Supply	0	0	0	48000
	Total	Objective	Function	Value =	7.83152E+09	

Fig. (12): Improving initial solution of Vogel's method by stepping stone method

6- The initial solution of northwest corner and lest cost is larger than minimum cost of initial solution in Vogel's as present in Figure (13 & 14).

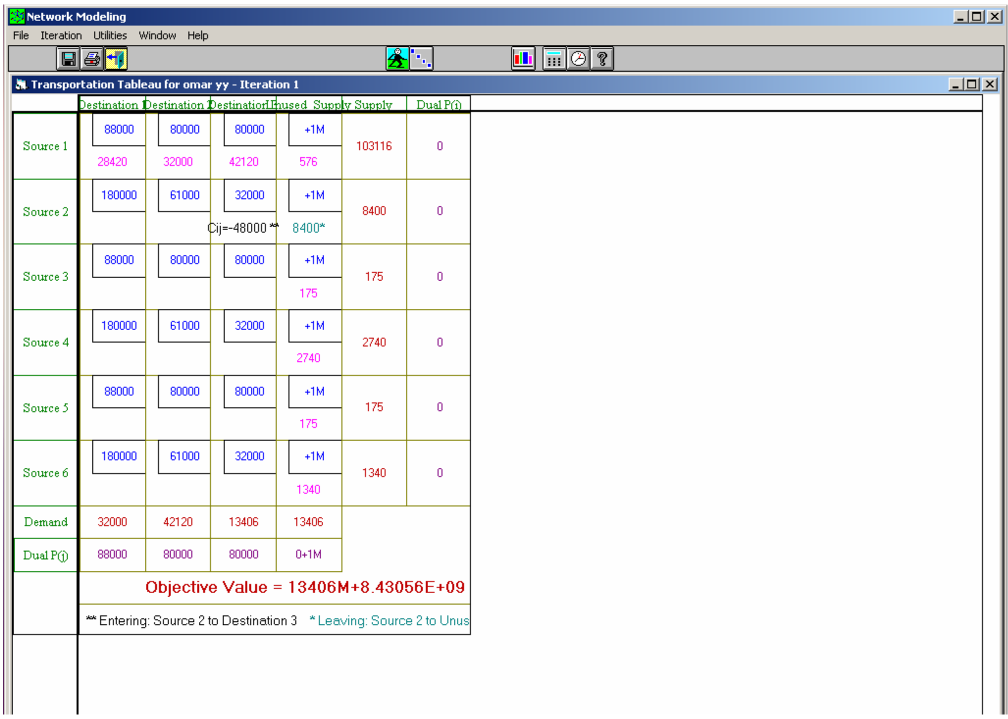

Fig. (13): Initial solution of northwest-corner method

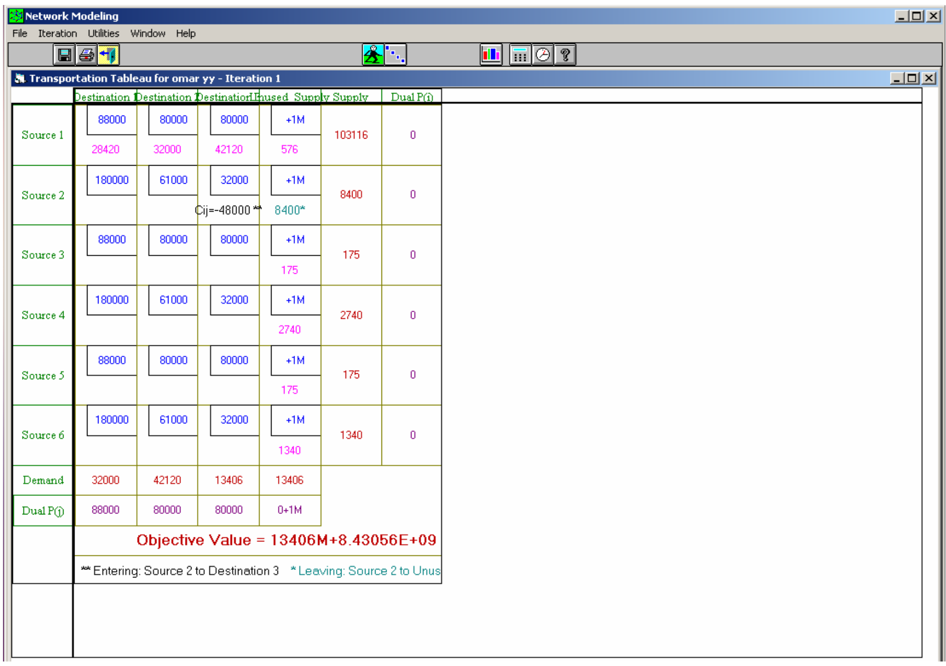

Fig. (14): Initial solution of least-cost method

7- Improving initial solution of northwest corner and least cost method by stone moving after four iteration lead to access of minimum cost is equal to minimum cost of Vogel's method as shown in Figure (15 & 16).

05-31-2012	From	To	Shipment	Unit Cost	Total Cost	Reduced Cost
1	Source 1	Destination 1	28420	88000	2.50096E+09	0
2	Source 1	Destination 2	32000	80000	2.56E+09	0
3	Source 1	Destination 3	29640	80000	2.3712E+09	0
4	Source 1	Unused_Supply	13056	0	0	0
5	Source 2	Destination 1	0	180000	0	140000
6	Source 2	Destination 2	0	61000	0	29000
7	Source 2	Destination 3	8400	32000	2.688E+08	0
8	Source 2	Unused_Supply	0	0	0	48000
9	Source 3	Destination 1	0	88000	0	0
10	Source 3	Destination 2	0	80000	0	0
11	Source 3	Destination 3	0	80000	0	0
12	Source 3	Unused_Supply	175	0	0	0
13	Source 4	Destination 1	0	180000	0	140000
14	Source 4	Destination 2	0	61000	0	29000
15	Source 4	Destination 3	2740	32000	8.768E+07	0
16	Source 4	Unused_Supply	0	0	0	48000
17	Source 5	Destination 1	0	88000	0	0
18	Source 5	Destination 2	0	80000	0	0
19	Source 5	Destination 3	0	80000	0	0
20	Source 5	Unused_Supply	175	0	0	0
21	Source 6	Destination 1	0	180000	0	140000
22	Source 6	Destination 2	0	61000	0	29000
23	Source 6	Destination 3	1340	32000	4.288E+07	0
24	Source 6	Unused_Supply	0	0	0	48000
	Total	Objective	Function	Value =	7.83152E+09	

Fig. (15): Improving initial solution of northwest-corner method by stepping stone method

05-31-2012	From	To	Shipment	Unit Cost	Total Cost	Reduced Cost
1	Source 1	Destination 1	28420	88000	2.50096E+09	0
2	Source 1	Destination 2	32000	80000	2.56E+09	0
3	Source 1	Destination 3	29640	80000	2.3712E+09	0
4	Source 1	Unused_Supply	13056	0	0	0
5	Source 2	Destination 1	0	180000	0	140000
6	Source 2	Destination 2	0	61000	0	29000
7	Source 2	Destination 3	8400	32000	2.688E+08	0
8	Source 2	Unused_Supply	0	0	0	48000
9	Source 3	Destination 1	0	88000	0	0
10	Source 3	Destination 2	0	80000	0	0
11	Source 3	Destination 3	0	80000	0	0
12	Source 3	Unused_Supply	175	0	0	0
13	Source 4	Destination 1	0	180000	0	140000
14	Source 4	Destination 2	0	61000	0	29000
15	Source 4	Destination 3	2740	32000	8.768E+07	0
16	Source 4	Unused_Supply	0	0	0	48000
17	Source 5	Destination 1	0	88000	0	0
18	Source 5	Destination 2	0	80000	0	0
19	Source 5	Destination 3	0	80000	0	0
20	Source 5	Unused_Supply	175	0	0	0
21	Source 6	Destination 1	0	180000	0	140000
22	Source 6	Destination 2	0	61000	0	29000
23	Source 6	Destination 3	1340	32000	4.288E+07	0
24	Source 6	Unused_Supply	0	0	0	48000
	Total	Objective	Function	Value =	7.83152E+09	

Fig. (16): Improving initial solution of least-cost method by stepping stone method

Conclusion :

Aggregate production planning (APP) is concerned with matching supply and demand of forecasted and varying customer orders over the medium term, often from 3 to 18 months in advance. An APP problem is about determining the maximize profit and minimize workforce, and inventory levels for each period of the planning horizon for a given set of production resources and constraints

After manual solution of three transportation network method noted. The Vogel's method is led to the minimum cost comparing with others, the cost is 7,318,520,000 ID. The optimal minimum cost after applying steeping stone moving method to improve primary solution of Vogel's also still 7,318,520,000 ID. The adoption transportation method has facilitated overcome the problems of aggregate production planning of Baghdad company. These methods are characterized by account for easy access to the detailed results for each of the factors and addition to the final or optimal cost through determine initial solution and improved it to determine optimal solution by stone-moving. Through the improving final results, the following points were noted:

1-In March, the inventory factor cost of the first period is 2,500,960,000 ID. In April of the same period is 2,560,000,000 ID. In May of the same period 2,371,200,000 ID.

2-In second and third periods, the inventory factor cost in March, April and May is 0 ID.

3-The normal time of May in the first period of production is 268,800,000 ID. The normal time of May in the second period of production is 87,680,000 ID. The normal time of May in the third period of production is 42,880,000 ID.

4- The improving initial solution of northwest-corner and least cost methods by stepping stone method lead to access minimum cost determined in initial and improved solution in Vogel's method after four iterations as present in manual and computerized solution.

Using WIN QSB for the application of theoretical situation led to see the matching results in both cases and this demonstrates the validity and accuracy of the solution. The dependence on the program WIN QSB we can overcome the theoretical situation and increase the speed to get the results the optimal condition, which leads to reduce the time and effort to the overall planning of the company and with high accuracy.

By observing the results reached through the use of methods of transportation by manually and computerized; offer a range of recommendations that may help the company overcome the problem of planning the total medium time periods, as follows:

1- Use the software WIN QSB for the application of the results of the manual and make sure to optimize the solution in any way. As well as facilitate and reduce the time and effort to resolve manually through easy of inputting date and getting on the initial solutions and improving it to achieve optimization.

2- Use methods of transportation in the company's plan to reach the optimal solution and better distribution of resource and factors to satisfy demand.

3- For the three months taken in our project after the application of methods of transport on the data presented has been a process of improving the solution to reach the best solution.

4- A future plan and divide the year into periods to facilitate the conduct of its overall planning.

References:

1- Stephen C. H. Leung, Yue Wu and K. K. Lai, “Multi-site aggregate production planning with multiple objectives: a goal programming approach”, *Production planning and control*, Vol.14, No. 5, July-August, 425-436, 2003.

2- Qiaozhu Zhai, Xiaohong Guan and Feng Gao, “Optimization based production planning with hybrid dynamics and constraint”, *IEEE transactions on automatic control*, Vol. 55, No. 12, December 2010.

3- De-Li Yang, Hong-Bo Jiang, “A production planning expert system in manufacturing”, *IEEE*; 2011.

4- Mei Zhongyi and Cong Peiyong, “Research on production planning schedule system of the composite component manufacturing workshop”, *3rd international Conference on Advanced Theory and Engineering (ICACTE)*, 2010.

5- Amir Hasanzadeh *et. al.*, “Developing a model for integrating process planning and production planning and control in cellular manufacturing”, *IEEE*; 2009.

6- Adiel Teixeira de Almeida Filho, Fernando Menezes Campello de Souza and Adiel Teixeira de Almeida, “A multi-criteria decision model for aggregate planning based on the manufacturing strategy”, *Third International Conference on Production Research – Americas Region*, 2006.

7- Jose P. Garcia-Sabater, Julien Maheut and Julio J. Garcia-Sabater, “A decision support system for aggregate production planning based on MILP: A case study from the automotive industry”, *IEEE*, 2009.

8- Guillermo Gallego, “Aggregate production planning”, *IEOR4000: production management*, 2001.

9-Ratiros Yimmee and Busaba Phruksaphanrat, “Fuzzy goal programming for aggregate production and logistic planning”, *Proceeding of the International Multi-Conference of Engineering and Computer Scientists*, Vol.11, 2011.

10- Wenyun Zhu and William Chung, “A linkage of markdown pricing with aggregate production planning”, *IEEE*, 2008.

11- William J. Stevenson, *Operation Management*, Eight Editions; The McGraw-Hill Companies, Inc., 2005.

12- Seyed Mohamad Javad Mirzapour Al-e-Hashem, Mir Bahador Aryanezhad & Seyed Jafar Sadjadi. "An efficient algorithm to solve a multi-objective robust aggregate production planning in an uncertain environment", *Int J Adv Manuf Technol*, Vol. 58, P.765–782, 2012.

13- P. Aungkulanon*, B. Phruksaphanrat and P. Luangpaiboon, "Various Hybridisations of Harmony Search Algorithm for Fuzzy Programming Approach to Aggregate Production Planning", *Proceeding of the International Multi-conference of Engineers and Computer Scientist IMECS 2012,* march 16-18; Vol. I, Hong Kong, 2012.

14- Ratiros Yimmee and Busaba Phruksaphanrat, " Fuzzy Goal Programming for Aggregate Production and Logistics Planning ", *Proceeding of the International Multi-conference of Engineers and Computer Scientist IMECS 2012*, march 16-18, Vol. II, Hong Kong, 2012.

15- Adiel Teixeira de Almeida Filho, Fernando Menezes Campello de Souza and Adiel Teixeira de Almeida, "Manufacturing strategy incorporated in aggregate production planning through a multi-objective linear programming model", *Brazilian Journal of Operations & Production Management*, Volume 4, Number 1, pp. 23-37, 2007.