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Full Length Research Paper

Transportation optimization model of oil products

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Transporting massive amounts of oil products, it is essential to optimize the total efforts from leaving origins (refineries) until reaching destinations (depots). In this paper, integer mathematical programming model were developed to satisfy this oil transportation optimization problem. Specifically, it is dedicated to obtain refineries -to-depots optimal assignments by setting distance and cost minimization as the objective function. The adopted approach is to run the program using I-Log software. The used data was selected from some of the real case study. Thus, the outcomes of this study are highly feasible in reality to achieve the best refinery -to- depots assignments with the minimized total transportation distance as well as the total transportation cost.

Key words: Transportation, inventory, decision support system, linear programming (LP), oil refinery.

INTRODUCTION

Logistics, according to the Council of Supply Chain Management Professionals (CSCMP), is part of supply chain management encompasses all activities associated with the flow and transformation of goods from the raw material stage (extraction), through to the end user, as well as the associated information flows (Handfield and Nichols, 1999). And transportation costs can account for up to 50% of a product's total logistics costs (Bauer, 2002). Under an increasingly competitive global context, how to effectively manage transportation operations has been becoming one of the major factors for oil companiesto survive and to maintain competitive advantages.

The oil industry is vertically integrated activities dealing with a very large range of activities extending from oil and gas exploration to refining and distribution. Figure 1 in general illustrates a high level view of oil industry supply chain.

The major oil companies usually setup their refineries close to the depots, where the depots become a distribution center to the customers. The decision of setting up a depot is basically based on the location of the customers. According to Hill (2003), the strategy of facility location is normally forecasted by the sales and marketing departments. The company then will look into its capability and capacity to fulfill the costumer requirement. The company will devise its aggregate strategic planning.

Vehicle model is the most influential predictor variable: some vehicle models are much more likely to fail in emissions tests than an "average" vehicle. Five out of 14 vehicle models that performed the worst (out of a total of 52 models) were manufactured by foreign companies or by their joint ventures with Chinese enterprises (Chang and Ortolano, 2008). The comprehensive set of tailpipe particle emission factors presented for different vehicle and road type combinations enable the full size range of particles generated by fleets to be quantified, including ultrafine particles (measured in terms of particle number). These emission factors have particular application for regions which may have a lack of funding to undertake measurements, or insufficient measurement data upon which to derive emission factors for their region (Keogh et al., 2009).

Oil refineries model have abundant resources of petroleum products in pipelines and storage tanks. Included are storage tanks at retail gasoline station, home heating oil tanks, lubricant storage at automotive service facilities, propane tanks in all sorts of application and oil refineries terminals across the world (Tahar and Abduljabbar, 2010). In the operations research and management science, recent research focus on refineries food chain modeling reported in the literature only one address of the chain, such as crude logistics using

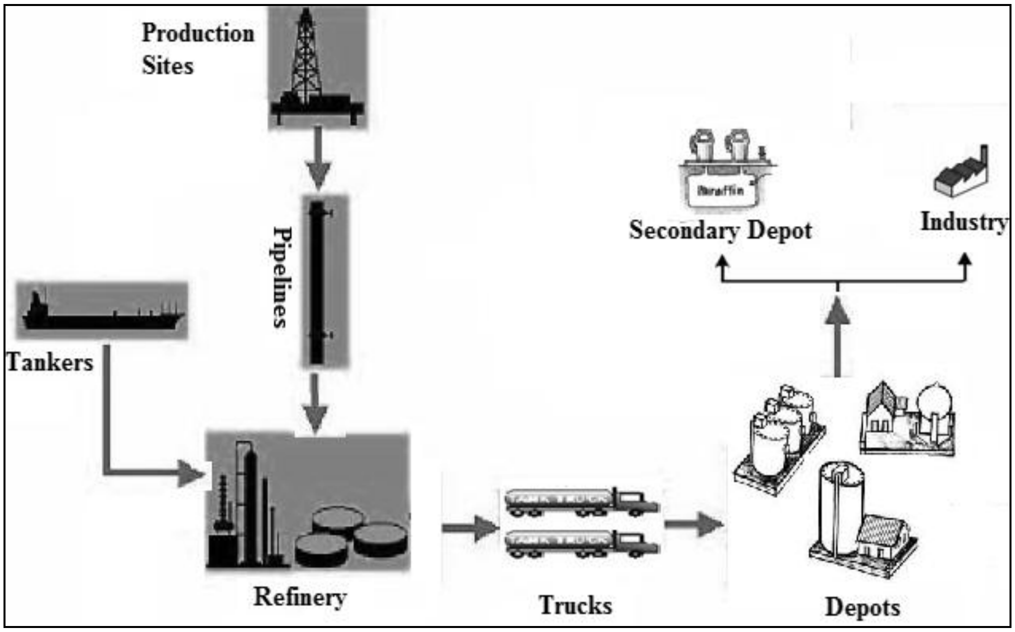

Figure 1. Oil industry supply chain.

discrete event simulation and optimal control (Neiro and Pinto, 2004; Reddy et al., 2004). Hughes (1971) sets up a network model to determine where to locate the terminals with respect to customer distribution sites. The efficient ways of loading and unloading into the storage tanks at oil terminals (Christofides et al., 1980). The transportation costs involved in loading and unloading these storage tanks are not investigated, additionally the article does not address the terminal profits. Simulation-based short-term scheduling of crude oil from port to refinery tanks and distillation unit, agent-based crude procurement (Cheng and Duran, 2004; Chryssolouris et al., 2005; Julka et al., 2002). External the refinery environment (Banks et al., 2002), Supply chain management (SCM) simulation studies at IBM and Virtual Logistics and talk about issues related to strategic and operational SCM, distributed SCM simulation, and commercial packages for SCM simulation (Kleijnen, 2005).

From a mathematical point of view, this paper presents series of equations to modeling some aspect of the real transportation and attempts to optimize the transporting assignments from refineries to depots. The final objectives are to minimize the transportation distance and the transportation cost. The major assumptions include:

1) All oil produced at the refineries must be sent out to their respective destinations; 2) Exactly the same # of trucks that go from refinery to depot return from depot to refinery; 3) Each truck arrives at a depot as early as possible and leaves as early as possible; also 4) All vehicles are stationed at the refineries, unlimited in number and travel full-load.

PROPOSED MODELS

Model foundation

Linear programming (LP) deals with a class of programming problems which both the objective function to be optimized is linear and all relations among the variables correspond to resources, known as constraints, are linear.

Formulation of an LP model can be tedious and troublesome task. A wrong model can result because a wrong set of variables is included or some improper relationships among the variables are constructed. There are some guidelines in an effective model formulation. Any LP consists of four parts: a set of decision variables, the parameters, the objective function, and a set of constraints.

A minimization problem of an LP written in the matrix form is:

$$\text{Minimize } Z(\mathbf{X}) = CX = \sum_{j=1}^{n} C_j X_j \quad (1)$$

$$\text{Subject to } AX = B \quad (2)$$
$$X \geq 0$$

Where **A** is an $m \times n$ matrix that represent rows of coefficients of the constraints 1 to m each having n coefficients. The variables $X_1, ..., X_n$ are the column vector of decision variables. The **C** is the row vector or a $(1 \times n)$ matrix of coefficients of the objective function and

B are the parameters of the constraints, which is a ($n \times 1$) matrix or a column vector.

A feasible solution for this problem is a numerical vector, X that satisfies all the constraints and sign restrictions. An optimum feasible solution (or an optimum solution) is a feasible solution that minimizes the objective function, Z(X) among all feasible solutions. Murthy (1983) has proved that if the above LP has a feasible solution, it has an optimum feasible solution if and only if X(y) $\geq$ 0 for every homogeneous solution y corresponding to that LP. Kolman (1993) proved that a homogeneous systems of m equations in n unknowns always has a nontrivial solution if m < n, that is, if the number of unknowns exceed the number of equations.

Model construction

The transportation models that will be proposed coming sub-sections will be based on a basic model written by Winston (2004). There are a set of *m* supply points from which a good is shipped and there are a set of *n* demand points to which good is shipped. Each unit produced at supply point *i* and shipped to demand point *j* incurs a variable cost of C_{ij}. The number of units shipped from supply point *i* to demand point *j* equals X_{ij}. Thus, giving the following transportation model:

Minimize $$\sum_{j=1}^{n}\sum_{i=1}^{m} C_{ij} X_{ij} \quad (3)$$

Subject to $$\sum_{j=1}^{n} X_{ij} \leq S_i (i = 1, 2, ..., m)$$ (Supply constraints) (4)

$$\sum_{i=1}^{m} X_{ij} \geq D_j (j = 1, 2, ..., n)$$ (Demand constraints) (5)

$$X_{ij} \geq 0 (i = 1, 2, ..., m; j = 1, 2, ..., n) \quad (6)$$

The objective function minimizes the cost of transportation by summing up all products of cost per unit with the number of units transported for each origin-destination (*i*-*j*) pair. The supply constraints state a condition that for every supply point S_i, whatever is sent out to all destinations must not be more than the available supply amount. Similarly for the demand constraints, the total supplies sent from all origins to a particular demand point must not be more than what is demanded by that destination D_j. The last set of constraints is the non-negativity condition. In the supply and demand constraints it is noticed as a basic rule that supply cannot be more than what is available, and satisfy demand up to what is actually demanded.

Specific to the models that are going to be constructed the followings are defined.

The index

i	refineries
j	destinations where oil production reach
p	product type

The decision variable

X_{ij} Is the integer number of trips taken to transport a product from origin *i* to destination *j*.

The parameters

C_{ij} - Distance between refinery *i* and destination *j*

$D_j^{\,p}$ - Processing capacity of product *p* at destination *j*

$S_i^{\,p}$ - Total M^3 supply for product *p* at refinery *i*

V^p - M^3 capacity of vehicle transporting product *p*

In a conventional transportation problem, a homogeneous product is to be transported from several sources to several destinations in such a way that the total transportation cost is minimum. Suppose there are *m* supply nodes and *n* demand nodes. The *i*th supply node can provide S_i units of a certain product and the *j*th demand node has a demand for D_j unit (Figure 2).

Supply nodes

In the oil industry there is a set of *m* refineries each supplying S_m M^3 of oil per day to another set of *n* depots, each with processing capacity of D_n M^3. More generally there is a set of *m* refineries each supplying $S_m^{\,p}$ M^3 of product *p* and send to eight depots each with processing capacities of $D_n^{\,p}$ M^3 of product *p*.

The transportation of products from the *i*th supply node to the *j*th demand node carries a cost of C_{ij} per unit of product transported. The problem is to determine a feasible way of transporting all the available amounts without violating the demand or the capacity constraints of the receiving node that minimize total transportation cost.

The model is to assign right number of trucks to each route in order to minimize the cost of transportation and meet the volume requirements.

Determine a feasible way of transporting the available products to their respective destinations at a total minimum haulage distance.

Transportation model can be simplified and much more easily comprehended by looking at the transportation problem of one product first, specifically oil. As depicted earlier there are the refineries as the supply origins and the depots as the destinations where oil will be delivered. The refineries have specific annual oil production and the depots have stipulated oil capacity. The problem is how to distribute the oil from all the refineries to their nearest depots so that the total transportation is minimized. In essence the model is to find the best refinery-depot assignment so that total cost is minimized.

Let X_{ij} be the number of vehicle trips to transport oil productions from refinery i to depot j through a distance of C_{ij}. Thus model can be written as the following.

$$\text{Minimize } Z = \sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_{ij} \tag{7}$$

Subject to $V \sum_{j=1}^{n} X_{ij} = S_i$, $i = 1,\ldots,m$ (supply constraints), (8)

$$V \sum_{i=1}^{m} X_{ij} \le D_j, \quad j = 1,\ldots,n \text{ (demand constraints)} \tag{9}$$

$X_{ij} \ge 0$ and integer $\forall i, j$

Where X_{ij} Number of vehicle trips from *i* to *j*,

C_{ij} Distance between *i* and *j*,

D_j Processing capacity of depot *j*,

S_i Supply at refinery *i*,

V Capacity of the tanker.

The objective function minimizes the total transportation distance in delivering oil from the refineries to the depots. The double summations (denoted by two *sigmas*, one after the other) indicate that the two variables are multiplied before their products are added up. The number of trips taken to deliver the oil between refinery *i* and depot *j* is multiplied by the distance between them gives the total transportation distance for the specific *i* and *j*. The supply constraints consist of *m* equalities,

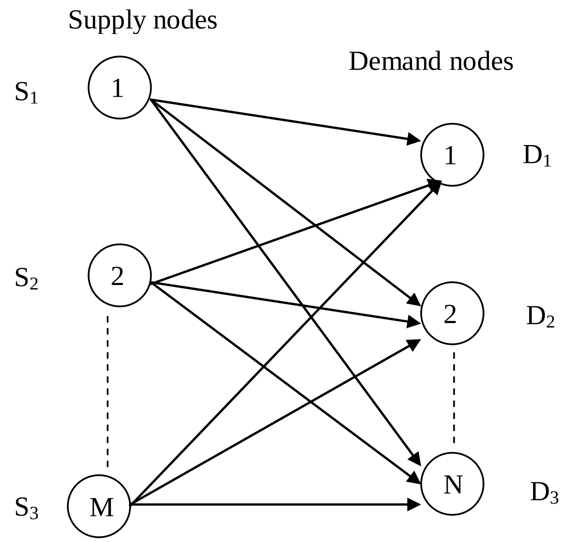

Figure 2. Origin-destination transportation network.

each for a particular refinery. For each refinery, the number of trips that go out from that refinery to the depots multiplied by the size of the tanker must equal the total oil production of that refinery. Equal sign for these constraints also indicates that all the oil from the refineries must be sent out. On the other hand, the demand constraints which are altogether *n* in number, the amount of oil received by the specific refineries cannot be more than their processing capacities. The last constraints are the non-negative restriction on the decision variables and the number of trips must be integer numbers.

DATA COLLECTION SOURCE

Oil production

A set of two refineries in the center of Iraq is selected. AL-Dura Refinery in the capital city for the state of Iraq sends oil production to some of depots (Resafa Depot, Meshahda Depot, Latefia Depot and Kut Depot). Beji Refinery in the north of Iraqsends oil production to (Khanqeen Depot, Ramadi Depot and Baquba Depot). Information concerning oil production for these refineries for the year 2006 was gathered (Containor dimensions and Capacity, 2006). Phone calls and facility visits were made to get reasonably good estimates. This was done during the year 2010.

All the seventh depots gave their actual productions capacity approved by the oil marketing company (SOMO). Since their combined capacity is less than the total oil production for all the two selected refineries (AL-Dura Refinery and Beji Refinery), another depots was selected. The nearest depot was at AL-Anbaar (Falahat Depot). Now, the combined capacity of the eighth depots exceeded oil production for the two refineries.

Table 1 give depicts the yearly cubic meter of the commodities for the two refineries, and Table 2 capacity for the depots.

Origin-destination distance estimation

The origins were the refineries and the destinations were the

Table 1. Oil production for the refineries.

Refinery name	Symbol	Oil output (M^3 /year)	Oil output (M^3 /week)
AL-DUARA	I	21590321	415198
BAEIJI	J	7216548	138779
Total Production	T	28806869	553978.25

Table 2. Capacity for the depots.

Depot	Latefia	Meshahda	Resafa	Kut	Khanqeen	Ramadi	Falahat	Baquba	Total
symbol	A	B	C	D	E	F	G	H	T
Capacity (M^3)	501208	512534	385109	85800	9910	123744	43324	46156	1707785

Table 3. Origin/destination distance matrix C_{ij} in miles.

i / j	A	B	C	D	E	F	G	H	I	J
A	-	63	41	62	104	92	63	67	20	157
B	63	-	23	125	64	88	57	55	39	118
C	41	23	-	103	95	79	48	39	20	135
D	62	125	103	-	144	166	139	115	82	217
E	104	64	95	144	-	146	117	34	101	214
F	92	88	79	166	146	-	27	180	85	119
G	63	57	48	139	117	27	-	207	57	90
H	67	55	39	115	34	156	131	-	70	248
I	20	39	20	82	101	85	57	70	-	157
J	157	118	135	217	214	119	90	248	157	-

depots. These distances were mostly actual miles by traversing to all the facilities in their respective locations (Table 3).

RESULTS

Here the output when the integer programming models were run on the computer were presented. Data needed as the input for the programming runs are shown in tables. The output for the oil transportation problem is presented using the original locations of the refineries and depots. The results show the optimal refineries -to-depots assignments; that is which refinery will send its oil to which depot and by how much, so that total transportation distance is minimized.

Input parameters

The commodities to be transported is the main concern, the main product is the oil, considered as the waste product. Below, Table 4 give the truck type information for small and big trucks, Table 5 show the value of load time for each truck type, Table 6 give the earliest departure and latest arrive times for each depot, Table 7 show the shipment that will be carried back from a refinery to a depot by a truck.

Table 4. Truck Type Information.

Truck types	Capacity M^3	Speed miles/h	Cost $/miles
Small Truck	35	55	10
Big Truck	40	45	15

Table 5. Values for load Time

Refinery	Small Truck	Big Truck
I	30	55
J	35	50

I-Log outputs

After we run the program, we got three solutions with three objectives and automatically I-Log software sign the optimal solution and it was be the third one with objective 388080 $.Table 8 shows the optimal values for earliest

Table 6. Depot's Information.

Depots	Earliest departure time	Latest arrive time
A	360	1080
B	400	1150
C	380	1200
D	340	900
E	420	800
F	370	1070
G	320	700
H	410	1100

Table 7. Shipments that will be carried back from a refinery to a depot.

Origin	Destination	Total volume (M^3)	Origin	Destination	Total volume (M^3)
A	B	300	E	A	123
A	C	250	E	B	234
A	D	350	E	C	143
A	E	145	E	D	78
A	F	300	E	F	107
A	G	125	E	G	98
A	H	250	E	H	115
B	A	185	F	A	201
B	C	200	F	B	157
B	D	221	F	C	169
B	E	263	F	D	212
B	F	197	F	E	104
B	G	220	F	G	201
B	H	180	F	H	99
C	A	143	G	A	215
C	B	178	G	B	147
C	D	258	G	C	149
C	E	221	G	D	190
C	F	106	G	E	114
C	G	190	G	F	210
C	H	110	G	H	199
D	A	75	H	A	181
D	B	135	H	B	137
D	C	245	H	C	139
D	E	283	H	D	180
D	F	155	H	E	124
D	G	260	H	F	160
D	H	165	H	G	221

unloading time and latest in minutes for each route. Table 9 showed the possibly values of route and number of trucks for each rout and each type of trucks.

Also through the outputs from I-Log program we got chart on the CPLEX statistics Figure 3 the vertical axis of this chart is the value of the objective and the horizontal axis is time in seconds. The chart shows the variation of the best node and best integer values and highlights the integer values found during the search:

(i) The green line shows the evolution of the Best Integer value, that is, the best value of the objective found that is also an integer value.
(ii) The red line shows the evolution of the best value of the remaining open nodes (not necessarily integer) when moving from one node to another. This gives a bound on

Table 8. Values for earliest unloading time and latest loading time.

Parameter	Values for earliest unloading time		Values for latest loading time	
	Small truck	Big truck	Small truck	Big truck
< A, I, 20 >	412	442	1028	998
< A, J, 157 >	567	620	873	820
< B, I, 39 >	473	507	1077	1043
< B, J, 118 >	564	608	986	942
< C, I, 20 >	432	462	1148	1118
< C, J, 135 >	563	610	1017	970
< D, I, 82 >	460	505	780	735
< D, J, 217 >	612	680	628	560
< E, I, 101 >	561	610	659	610
< E, J, 214 >	689	756	531	464
< F, I, 95 >	504	552	936	888
< F, J, 80 >	493	527	947	913
< G, I, 87 >	445	491	575	529
< G, J, 75 >	437	470	583	550
< H, I, 70 >	517	559	993	951
< H, J, 248 >	716	791	794	719

Table 9. Values for possible Truck on Route and truck on Route (Solution 3).

Parameter	Values for possible Truck on Route		Values for truck on Route	
	Small Truck	Big Truck	Small Truck	Big Truck
< A, I, 20 >	1	1	48	1
< A, J, 157 >	1	1	0	0
< B, I, 39 >	1	1	42	0
< B, J, 118 >	1	1	0	0
< C, I, 20 >	1	1	37	0
< C, J, 135 >	1	1	0	0
< D, I, 82 >	1	1	43	0
< D, J, 217 >	1	0	0	0
< E, I, 101 >	1	0	36	0
< E, J, 214 >	0	0	0	0
< F, I, 95 >	1	1	30	0
< F, J, 80 >	1	1	6	0
< G, I, 87 >	1	1	32	0
< G, J, 75 >	1	1	6	0
< H, I, 70 >	1	1	33	0
< H, J, 248 >	1	0	0	0

the final solution.
(iii) The yellow point indicates a node where an integer value has been found. These points generally correspond to the stars (asterisks) in the CPLEX log. Also in the CPLEX Log page.

The values in the discrete frame are dynamic and are updated every second; they change to indicate how the algorithm is progressing. The values in the General frame are static; they indicate the model characteristics.

Refineries - depots assignment

Given the supply of oil from Table 1 and the capacities of the depots from Table 2, the objective now is to find the optimal refinery to depots assignment so that total transportation distance is minimized, also the total cost is minimized.

The ILOG output of the integer programming for this model is shown in the columns labeled as ‘No. of trips X_{ij}’ in the Table 10 above. These are actually the values

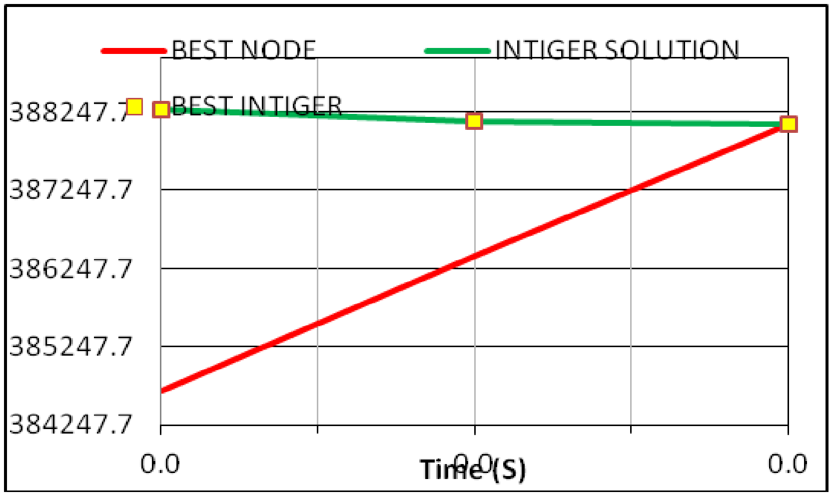

Figure 3. Chart on the CPLEX Statistics page showed the objective value.

Table 10. Number of trips, distance and cubic meter from two refineries to depots in Baghdad and Beji.

Origin	AL-Dura				Beji			
	No. of trips X		Distance (Miles)	Volume (M^3)	No. of trips X		Distance (Miles)	Volume (M^3)
	Small truck	Big truck			Small truck	Big truck		
Latefia	48	1	20	1720	0	0	0	0
Meshahda	42	0	39	1466	0	0	0	0
Resafa	37	0	20	1206	0	0	0	0
Kut	43	0	82	1318	0	0	0	0
Khanqeen	36	0	101	898	0	0	0	0
Ramadi	30	0	95	942	6	0	80	201
Falahat	32	0	87	1039	6	0	75	185
Baquba	33	0	70	1142	0	0	0	0
Total	**301**	**1**	**514**	**9731**	**12**	**0**	**155**	**386**

Total capacity 1707785 M^3, total supply 415198 M^3/Week, total transportation distance is 669 Miles, total transportation cost 388,080 $.

of the decision variables, X_{ij} which represents the number of trips taken by the trucks to transport all the available oil from each refinery as the origin to the depots as its destinations(one way) so that total transportation distance and the total cost are minimized.

DISCUSSION

The above results show that to transport 415198 M^3/week of oil from the tworefineries to the eight depots the minimum possible transportation distance is 669 Miles, which is known in linear programming as the Z value. The minimum week truck trips needed to do the transportation of the massive commodity are 314. This value comes by adding 302, which is the total oil trips to the AL-Dura refinery, with 12 tanker trips for the Beji refinery.

It is clearly seen in the results shown by the table above that the refineries located above in the center and north send their oil to the depots at Baghdad, Al-anbaar, Kut and Diala. Total oil transported from AL-Dura refinery is 9731 M^3. The other refinery is Beji with deliveries totaling 386 M^3.

A total of 9731M^3 of oil are sent to eighth depots although their combined capacity is 1707785 M^3, nearly 1698000 M^3 under-capacities. Simple explanation here is refinery at Beji is nearer to Ramadi and Falahat depots than to AL-Dura refinery, so instead of sending oil from AL-Dura refinery just to satisfy capacity requirements, it is better sent from Beji since the objective is to minimize the transportation cost.

In terms of total trips that go to Baghdad depots, there are altogether 302 trips and to Beji facility are 12 trips. At 24 working hours a week, a daily average of 8 trucks will queue at each of the depots in Al-Dura. A look at the first refinery depot (Resafa) shows that it takes 37 trips to haul 1206 M^3 of oil in a span of a week. 3 trucks are expected to leave the mill per week, not a busy situation for this small Resafa facility. As a comparison, the Latefia depot with 48 loaded tanker trucks leaving this premise for its destination in a week could be considered busier since on a daily basis it is seen more than 5 trucks going out.

Looking at distance, to transport 9731 M^3 of oil to the Baghdad depots distance recorded was 514 Miles, whereas for 386 M^3 distance to Beji was only 155 Miles. It is noticed here that although amount of oil to AL-Dura is 25 times more than that to Beji but distance is only 3.3 times more, the reason being cluster of depots around Baghdad are closer to their refinery (AL-Dura) than those depots around Beji, which are further spread out from their assigned depots. Observing transportation distance to Baghdad depots, Khanqeen has the highest at 101 Miles.

It is noticed that total capacity of the eight depots in the two locations exceeds total oil supplies from the two refineries by nearly 1292587 M^3. Thus, it is fair to expect in the result that none of the depots work at its full capacity, although it was informed by the managements that their facilities are working at full capacity. This leads to the conclusion that when the governing authorities assign capacities to these destinations, distance traversed from their origins is never of prime consideration.

One way to save the inefficient traveling is by increasing the oil production in the two refineries that have been assigned to the Baghdad and Beji by the proposed model, if they have not reached maximum production capacity. If the depots all working at full capacity it makes sense to approve a future refinery, at the proximity of the Baghdad area.

Conclusions

Optimality it is found the best refinery-to- depots assignments. This study found the minimum possible transportation cost. Two refineries that form a cluster, from the center at Baghdad, Iraq and Beji, Iraq send their oil to depots. The AL-Dura refinery with total production 415198 M^3 /week and the total capacity for the assigned depots was 1707785 M^3. The other refinery at Beji 138779 M^3/week and the total capacity of the assigned two depots was 167068 M^3. The total transportation distance to implement the above assignment is 669 Miles for one way trip and the total transportation cost is 388080 $/week.

REFERENCES

Banks J, Jain S, Buckley S, Lendermann P, Manivannan M (2002). Supply chain opportunities: Panel session: Opportunities for simulation in supply chain management. Winter Simulation Conference, ISBN: 0-7803-7614-5, pp. 1652-1658.

Bauer R (2002). Co-branding: growing family or family feud? *Franchising World*. May-June, 22-23.

Bin O (2003). A logit analysis of vehicle emissions using inspection and maintenance testing data. Transp. Res. D8:215-227.

Chang C, Ortolano L (2008). Analyzing Beijing's In-Use Vehicle Emissions Test Results Using Logistic Regression. Environ. Sci. Technol. 42(19):7309-7314.

Cheng L, Duran MA (2004). Logistics for worldwide crude oil transportation using discrete event simulation and optimal control. Comput. Chem. Eng. 28:897-911. DOI:10.1016/j.compchemeng.2003.09.025.

Christofides N, Mingozzi A, Toth P (1980). Dynamic loading and unloading of liquids into tanks. Oper. Res. 28:633-649. DOI:10.1287/opre.28.3.633.

Chryssolouris G, Papakostas N, Mourtzis D (2005). Refinery short-term scheduling with tank farm, inventory and distillation management: An integrated simulation-based approach. Eur. J. Oper. Res. 166:812-827. http://ideas.repec.org/a/eee/ejores/v166y2005i3p812-827.html.

Container Dimensions and Capacity. Retrieved December 12 (2006). from http://www.exportall.com/.

Handfield BH, Nichols EL (1999). *Introduction to supply chain management*. Upper Saddle River, NJ: Prentice Hall.

Hill AV (2003). The Encyclopedia of Operations Management Terms. University of Minnesota. Minneapolis, MN 55455-0413 USA.

Hughes HO (1971). Impact of management science in mobil. Oper. Res. Q. 22:19-37. http://www.jstor.org/pss/3008292.

Julka N, Karimi I, Srinivasan R (2002). Agent-based supply chain management Part 2: A refinery application. Comput. Chem. Eng. 26:1755-1769. DOI: 10.1016/S0098-1354(02)00150-3.

Keogh DU, Kelly J, Mengersen, K, Jayaratne R, Ferreira L, Morawska L (2009). Derivation of motor vehicle tailpipe particle emission factors suitable for modelling urban fleet emissions and air quality assessments. Environ. Sci. Pollut. Res. 17:724-739.

Kleijnen JPC (2005). Supply chain simulation tools and techniques: A survey. Int. J. Simul. Process Model. 1:82-89. DOI: 10.1504/IJSPM.2005.007116.

Kolman B (1993). Introductory Linear Algebra with Applications, Fifth Edition. New York: Macmillan Publishing Company.

Murthy KG (1983). *Linear Programming.* Canada: John Wiley & Sons.

Tahar RBM, Abduljabbar WK (2010). A Novel Transporting System Model for Oil Refinery. Am. J. Eng. Appl. Sci. 3:138-143.

Tahar RBM, Abduljabbar WK (2010). A simulation and optimisation model for the transport of refinery products. Int. J. Oil, Gas Coal Technol. 3:160-169.

Winston WL (2004). *Operations Research Applications and Algorithms*. Belmont, California: Thomson.